ACADEMIC CURRICULA
2015 - 2019

BACHELOR’S DEGREE PROGRAMME
B.Tech

Course Structure and Detailed Syllabi
for students admitted in
2015-16
Academic Session

KIIT UNIVERSITY
Declared U/S 3 of UGCA Act, 1956
Bhubaneswar, Odisha, India
# COURSE STRUCTURE FOR FIRST YEAR B.TECH PROGRAMME

**(FOR STUDENTS ADMITTED IN THE SESSION 2015-2016)**

(Syllabus common to All Branches of Engineering)

## FIRST SEMESTER

**(SCHEME-I)**

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3. EAA–1 ExtraAcademic Activity

P/NP
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| 2.         | EAA–1         | ExtraAcademic Activity         |       | P/NP   |
COURSE STRUCTURE FOR B.TECH IN CIVIL ENGINEERING
(SECOND YEAR TO FOURTH YEAR)

**SEMESTER-III**

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6 CE-6102 Construction Engineering Practices 3
7 CE-4069 Cost Effective Housing 3
8 CE-6241 Design of Bridges 3
9 CE-4029 Disaster Management 3
10 CE-4057 Drainage Engineering & Design 3
11 CE-4077 Earth & Earth Retaining Structures 3
12 CE-4061 Earthquake Engineering 3
13 CE-4063 Finite Element Method in Geo-mechanics 3
14 CE-4051 Flood and Drought Estimation and Management 3
15 CE-6437 Geo-synthetics & Reinforced Earth Structures 3
16 CE-4065 Infrastructure Planning 3
17 CE-4067 Offshore Geotechnical Engineering 3
18 CE-6303 Open Channel Hydraulics 3
19 CE-6105 Pre-stressed Concrete 3
20 CE-4059 Reinforced Concrete Repairs and Maintenance 3
21 CE-6431 Soil Exploration and Field Test 3
22 CE-6235 Soil-Structure Interaction 3
23 CE-4053 Solid and Hazardous Waste Management 3
24 CE-4033 Structural Dynamics 3
25 CE-6307 Remote Sensing & GIS 3

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# COURSE STRUCTURE FOR B.TECH IN COMPUTER SCIENCE & ENGINEERING
## (SECOND YEAR TO FOURTH YEAR)
### SEMESTER III

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### SEMESTER IV

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### Grand Total

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### SEMESTER VII

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COURSE STRUCTURE FOR B.TECH IN INFORMATION TECHNOLOGY  
(SECOND YEAR TO FOURTH YEAR)

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## COURSE STRUCTURE FOR B.TECH IN ELECTRICAL ENGINEERING
(SECOND YEAR TO FOURTH YEAR)

### SEMESTER-III

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**Total of Semester**                                   | 32   | 29 |

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**Total Practical & Sessional**                        | 9    | 6  |

**Total of Semester**                                   | 31   | 28 |
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### SEMESTER-V

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Semester Total: 33 29

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Semester Total: 29 25
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**Semester Total** 23 22

## SEMESTER- VIII

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## COURSE STRUCTURE FOR B.TECH IN ELECTRONICS & ELECTRICAL ENGINEERING
(SECOND YEAR TO FOURTH YEAR)

### SEMESTER-III

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| 2.     | CS2091           | Data Structures Lab         | 0  | 0  | 3  | 3     | 2      |

|         | Sessional         |                             |     |    |    |       |        |
| 1.     | HS2081           | Business Communication      | 0  | 0  | 3  | 3     | 2      |

|        | **Total of Practical & Sessional** |                             | 9  | 6  |    |       |        |

|         | **Semester Total** |                             | 31 | 28 |    |       |        |

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| 2.     | EI 2095          | Electrical & Electronic Measurements Lab | 0  | 0  | 3  | 3     | 2      |
| 3.     | EE2096           | Electrical Machines Lab      | 0  | 0  | 3  | 3     | 2      |

|        | **Total of Practical** |                             | 9  | 6  |    |       |        |

|         | **Semester Total** |                             | 30 | 27 |    |       |        |
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27
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# COURSE STRUCTURE FOR B.TECH IN ELECTRONICS & INSTRUMENTATION ENGINEERING (SECOND YEAR TO FOURTH YEAR)

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LIST OF DEPARTMENT ELECTIVES

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### COURSE STRUCTURE FOR B.TECH IN MECHANICAL ENGINEERING
(SECOND YEAR TO FOURTH YEAR)

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**Semester Total**

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**Total Practical & Sessional**: 12 9

**Semester Total**: 30 28

### SEMESTER-VI

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**Semester Total**: 33 28
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### LIST OF DEPARTMENT ELECTIVES

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COURSE STRUCTURE FOR B.TECH IN MECHANICAL (AUTOMOBILE) ENGINEERING (SECOND YEAR TO FOURTH YEAR)

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| Semester Total | **32** | **28** |

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|           | 3 | ME2090 | Material Testing Lab | 0 | 0 | 3 | 3 | 2 |
| Sessional | 1 | HS2081 | Business Communication | 0 | 0 | 3 | 3 | 2 |
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| Semester Total | **33** | **28** |
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**Total Practical & Sessional**: 12 \(\text{L}9\)

**Semester Total**: 30 \(\text{L}28\)

### SEMESTER-VI

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**Total of Theory**: 19 \(\text{L}19\)

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**Total Practical & Sessional**: 14 \(\text{L}9\)

**Semester Total**: 33 \(\text{L}28\)

38
### SEMESTER-VII

#### Theory

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### LIST OF INSTITUTE ELECTIVES

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<td>HS2004</td>
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<td>HS2006</td>
<td>International Economics</td>
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<tr>
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<td>HS3002</td>
<td>Organizational Behavior</td>
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<td>HS3004</td>
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<td>HS3006</td>
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<td>HS3008</td>
<td>Management Concepts &amp; Practices</td>
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### LIST OF DEPARTMENT ELECTIVES

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<thead>
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<th>Subject Name</th>
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<tr>
<td>1.</td>
<td>AE4032</td>
<td>Noise, Vibration and Harshness</td>
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<td>2.</td>
<td>AE4034</td>
<td>Automotive Safety and Lighting</td>
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<td>AE4036</td>
<td>Automotive Chassis, Suspension and Transmission System</td>
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<td>AE4038</td>
<td>Automotive Materials and Processes</td>
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<td>AE4041</td>
<td>Assembly Line Automation</td>
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<td>2.</td>
<td>AE4043</td>
<td>Optimization Techniques</td>
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<td>3.</td>
<td>AE4045</td>
<td>Automotive Electrical Systems and Electronics</td>
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<td>4.</td>
<td>AE4047</td>
<td>Theory and Design of Jigs and Fixture</td>
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<td>Fuels and Emissions</td>
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<td>AE4063</td>
<td>Total Quality Management in Automobiles</td>
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<td>AE4065</td>
<td>Engine Tribology</td>
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<td>AE4031</td>
<td>Tractor and Farm Equipments</td>
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<td>AE4033</td>
<td>Combustion Engineering</td>
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<td>3.</td>
<td>AE4035</td>
<td>Two and Three Wheelers</td>
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<td>AE4042</td>
<td>Automotive Instrumentation Systems</td>
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<td>AE4044</td>
<td>Vehicle Dynamics</td>
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<td>AE4046</td>
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OPEN ELECTIVES

In the B.Tech Curricula for all Branches of Engineering, three Open Electives have been introduced starting with 6th semester.

A tentative list of subjects have been prepared by various Schools to be offered as Open Electives to students of other Schools. The detailed Curriculum for some of those subjects included in the list have been approved by Academic Council and the remaining ones will be approved in due course.

The final list of subjects to be offered by each School for students of other Schools as Open Elective would be announced atleast one semester ahead of the actual semester where the Open Elective is offered so that students can give their choice of subjects out of this list based on the availability of slots in that subject.

Open Electives may also include industry sponsored courses (with limited number of seats) in a Branch for its own students or students of some other disciplines, which is listed at the end.
# LIST OF OPEN ELECTIVES (AUTUMN SEMESTER)

## SCHOOL OF APPLIED SCIENCES

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<td>Renewable energy sources (Chem)</td>
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<td>PH3041</td>
<td>Quantum Mechanics for Engineers (Phys)</td>
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<td>Advanced Numerical Techniques (Maths)</td>
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<td>Number Theory</td>
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<td>Linear Algebra</td>
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<td>Introduction to Analysis</td>
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<td>Statistics and Stochastic Processes</td>
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## SCHOOL OF CIVIL ENGINEERING

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<td>Basic Transportation Engineering</td>
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<td>CE4073</td>
<td>Fundamentals of RCC Structure</td>
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## SCHOOL OF COMPUTER ENGINEERING

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<td>Network Security &amp; Cryptography</td>
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<td>CS3028</td>
<td>Artificial Intelligence</td>
<td>Programming Skill</td>
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<td>CS4031</td>
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## SCHOOL OF ELECTRICAL ENGINEERING

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<td>Elements of Power Electronics</td>
<td>Basic Electronics &amp; Basic Electrical Engineering</td>
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<td>EE4045</td>
<td>Non-Conventional Energy Systems</td>
<td>Basic Electrical Engineering</td>
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<td>EE4047</td>
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<td>Control System</td>
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## SCHOOL OF ELECTRONICS ENGINEERING

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<td>Introduction to Control Systems</td>
<td>Basic Electrical Engg.</td>
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<td>EC4041</td>
<td>Microprocessor, Microcontroller &amp; Applications</td>
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<td>Industrial Instrumentation</td>
<td>Basic Electronics &amp; Basic Electrical Engg.</td>
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<td>EC4031</td>
<td>Mobile Communication Engineering</td>
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<td>Optical &amp; Satellite Communication</td>
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### SCHOOL OF MECHANICAL ENGINEERING

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<tr>
<th>Sl. No</th>
<th>Subject Code</th>
<th>Subject Name</th>
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<tbody>
<tr>
<td>1</td>
<td>ME4035</td>
<td>Computer Controlled Manufacturing Systems</td>
<td>NIL</td>
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<tr>
<td>2</td>
<td>ME4039</td>
<td>Fundamentals of Computational Fluid Dynamics</td>
<td>Introduction to Fluid Mechanics and Heat Transfer</td>
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<tr>
<td>3</td>
<td>ME4061</td>
<td>Renewable Energy Sources</td>
<td>NIL</td>
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<tr>
<td>4</td>
<td>ME4065</td>
<td>Automobile Technology</td>
<td>Applied Thermodynamics / Thermodynamics and Hydraulics / Thermodynamics and Fluid Mechanics</td>
</tr>
<tr>
<td>5</td>
<td>ME4067</td>
<td>Quality Engineering and Management</td>
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### SCHOOL OF LAW

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<tbody>
<tr>
<td>1</td>
<td>LW1011</td>
<td>Law of Contract</td>
<td>NIL</td>
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<td>2</td>
<td>LW3015</td>
<td>Intellectual Property Law</td>
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<td>3</td>
<td>LW4811</td>
<td>Law Relating to Patent</td>
<td>NIL</td>
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<td>4</td>
<td>LW2011</td>
<td>Constitutional Law of India - I</td>
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### SCHOOL OF MANAGEMENT

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<tbody>
<tr>
<td>1</td>
<td>BB1201</td>
<td>Financial Accounting</td>
<td>NIL</td>
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<td>2</td>
<td>BB1702</td>
<td>Psychology</td>
<td>NIL</td>
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<tr>
<td>3</td>
<td>BB2101</td>
<td>Organizational Behavior</td>
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### LIST OF OPEN ELECTIVES (SPRING SEMESTER)

### SCHOOL OF APPLIED SCIENCES

<table>
<thead>
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<th>Sl. No</th>
<th>Subject Code</th>
<th>Subject Name</th>
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<tbody>
<tr>
<td>1</td>
<td>CH4042</td>
<td>Material Technology (Chem)</td>
<td>NIL</td>
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<tr>
<td>2</td>
<td>PH4042</td>
<td>Nano Science &amp; Technology (Phys)</td>
<td>NIL</td>
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<tr>
<td>3</td>
<td>PH4044</td>
<td>Photonics (Phys)</td>
<td>NIL</td>
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<tr>
<td>4</td>
<td>MA4042</td>
<td>Finite Element Analysis (Maths)</td>
<td>NIL</td>
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<tr>
<td>5</td>
<td>MA 4044</td>
<td>Functional Analysis</td>
<td>Mathematics - I &amp; II</td>
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<td>6</td>
<td>MA 4046</td>
<td>Optimization Techniques</td>
<td>Mathematics - I &amp; II</td>
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<tr>
<td>7</td>
<td>MA 4048</td>
<td>Fuzzy Logic</td>
<td>Mathematics - I &amp; II</td>
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### SCHOOL OF CIVIL ENGINEERING

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<th>Subject Code</th>
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<tbody>
<tr>
<td>1</td>
<td>CE3070</td>
<td>Fundamentals of Project Management</td>
<td>NIL</td>
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<tr>
<td>2</td>
<td>CE3072</td>
<td>Bio-remediation</td>
<td>NIL</td>
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<tr>
<td>3</td>
<td>CE3074</td>
<td>Construction Materials &amp; Specifications</td>
<td>NIL</td>
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<tr>
<td>4</td>
<td>CE3076</td>
<td>Tropical Hydrology &amp; Water Resources</td>
<td>NIL</td>
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<tr>
<td>5</td>
<td>CE4070</td>
<td>Global Warming &amp; Climate Change</td>
<td>NIL</td>
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<tr>
<td>6</td>
<td>CE4072</td>
<td>Green Buildings</td>
<td>NIL</td>
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<td>7</td>
<td>CE4074</td>
<td>Environmental Chemistry</td>
<td>NIL</td>
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## SCHOOL OF COMPUTER ENGINEERING

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<th>Subject Name</th>
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<tbody>
<tr>
<td>1</td>
<td>IT3040</td>
<td>Introduction to Software Engineering</td>
<td>NIL</td>
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<tr>
<td>2</td>
<td>CS3044</td>
<td>Relational Database Management System</td>
<td>NIL</td>
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<tr>
<td>3</td>
<td>IT3042</td>
<td>Web Technology</td>
<td>C++</td>
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<tr>
<td>4</td>
<td>CS3040</td>
<td>Data Structure using C</td>
<td>C</td>
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<tr>
<td>5</td>
<td>CS3044</td>
<td>Introduction to Operating System</td>
<td>NIL</td>
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<tr>
<td>6</td>
<td>CS3046</td>
<td>Introduction to Computer Graphics</td>
<td>NIL</td>
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<tr>
<td>7</td>
<td>CS3042</td>
<td>Computer Organization</td>
<td>NIL</td>
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<td>8</td>
<td>IT3021</td>
<td>E-Commerce</td>
<td>NIL</td>
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<td>9</td>
<td>IT3025</td>
<td>ERP</td>
<td>NIL</td>
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<td>10</td>
<td>CS4041</td>
<td>Pattern Recognition</td>
<td>Programming Skill</td>
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<tr>
<td>11</td>
<td>IT4021</td>
<td>Internet of Things</td>
<td>Programming skill JAVA/ Web Technology</td>
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<tr>
<td>12</td>
<td>IT3027</td>
<td>Multi Media Application</td>
<td>NIL</td>
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<tr>
<td>13</td>
<td>IT4042</td>
<td>Cloud Services</td>
<td>Programming skill &amp; Software Engineering</td>
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## SCHOOL OF ELECTRICAL ENGINEERING

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Subject Code</th>
<th>Subject Name</th>
<th>Prerequisite</th>
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<tbody>
<tr>
<td>1</td>
<td>EE3040</td>
<td>Electric Power Generation Technology</td>
<td>Basic Electrical Engineering</td>
</tr>
<tr>
<td>2</td>
<td>EE3042</td>
<td>Principles of Energy Conversion</td>
<td>Basic Electrical Engineering</td>
</tr>
<tr>
<td>3</td>
<td>EE3044</td>
<td>Circuit Theory</td>
<td>Basic Electrical Engineering</td>
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<tr>
<td>4</td>
<td>EE3046</td>
<td>Solar Power Technologies</td>
<td>Physics &amp; Basic Electrical Engineering</td>
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<tr>
<td>5</td>
<td>EE4042</td>
<td>Sensor Technology</td>
<td>Electrical Instrumentation</td>
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<tr>
<td>6</td>
<td>EE4044</td>
<td>Energy Management and Audit</td>
<td>Basic Electrical Engineering</td>
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<tr>
<td>7</td>
<td>EE4046</td>
<td>Fundamentals of Electrical Drives</td>
<td>Introduction to Electrical Machines and Power Electronics / Principles of Energy Conversion and Elements of Power Electronics</td>
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## SCHOOL OF ELECTRONICS ENGINEERING

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<tr>
<th>Sl. No</th>
<th>Subject Code</th>
<th>Subject Name</th>
<th>Prerequisite</th>
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<tbody>
<tr>
<td>1</td>
<td>EC2015</td>
<td>Analog Circuits</td>
<td>Basic Electronics</td>
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<tr>
<td>2</td>
<td>EC2011</td>
<td>Digital Electronics</td>
<td>Basic Electronics</td>
</tr>
<tr>
<td>3</td>
<td>EL3024</td>
<td>Industrial Automation &amp; Control</td>
<td>Control Systems / Introduction to Control Systems</td>
</tr>
<tr>
<td>4</td>
<td>EC3044</td>
<td>Introduction to Communication Engineering</td>
<td>Basic Electronics</td>
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<td>5</td>
<td>EC6108</td>
<td>Digital Image Processing</td>
<td>Introduction to Digital Signal Processing</td>
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<tr>
<td>6</td>
<td>EC3011</td>
<td>VLSI Design</td>
<td>Digital Electronics</td>
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### SCHOOL OF MECHANICAL ENGINEERING

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<th>Prerequisite</th>
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<tr>
<td>1</td>
<td>ME3032</td>
<td>Introduction to Fluid Mechanics and Heat Transfer</td>
<td>Mathematics-I</td>
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<td>2</td>
<td>ME3034</td>
<td>Applied Thermodynamics</td>
<td>Mathematics-I</td>
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<td>3</td>
<td>ME3036</td>
<td>Strength of Materials</td>
<td>Engg. Mechanics</td>
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<td>4</td>
<td>ME3038</td>
<td>Kinematics and Dynamics of Machinery</td>
<td>Mathematics-I</td>
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<td>5</td>
<td>ME3040</td>
<td>Engineering Materials</td>
<td>Chemistry</td>
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<td>6</td>
<td>ME4050</td>
<td>Robotics</td>
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<td>7</td>
<td>ME4054</td>
<td>Biomechanics</td>
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<td>ME4056</td>
<td>Mechatronic Systems</td>
<td>Basic Electronics</td>
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<td>9</td>
<td>ME4052</td>
<td>Introduction to Composite Materials</td>
<td>NIL</td>
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<td>10</td>
<td>ME4058</td>
<td>Finite Element Method for Engineers</td>
<td>Mathematics-I</td>
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### SCHOOL OF LAW

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<tr>
<td>1</td>
<td>LW1012</td>
<td>Special Contract</td>
<td>NIL</td>
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<td>2</td>
<td>LW2012</td>
<td>Constitutional Law of India - II</td>
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### SCHOOL OF MANAGEMENT

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<tr>
<td>1</td>
<td>BB1202</td>
<td>Cost &amp; Management Accounting</td>
<td>NIL</td>
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<td>2</td>
<td>BB1706</td>
<td>Principle &amp; Practice of Management</td>
<td>NIL</td>
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### INDUSTRY SPONSORED COURSES
(Under Open Elective – I)

<table>
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<th>Subject Code</th>
<th>Subject Name</th>
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<tbody>
<tr>
<td>1</td>
<td>EC3042</td>
<td>Media &amp; Applications</td>
<td>E&amp;TC, Comp. Sc &amp; IT</td>
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<tr>
<td>2</td>
<td>EE3030</td>
<td>Overhead Power Transmission Line Construction &amp; Management</td>
<td>Electrical</td>
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<td>3</td>
<td>ME3030</td>
<td>Product Life Cycle Management</td>
<td>Mechanical</td>
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</table>
APPLIED SCIENCES
Course Outcome: At the end of the course, the students will be able to:

CO1. Learn the concept of wave, wave motion, interference and diffraction phenomena.

CO2. Understand the mechanism of LASER technology and optical fibers and also the utilization in various disciplines (Medical, Defence, Security, and Communication system).

CO3. Learn the generation of electromagnetic waves and their interaction with matter.

CO4. Understand the fundamentals of solid structure, arrangements, and orientations etc. for the study materials particularly in the field of experimental research.

CO5. Understand the different properties of matter which are used in various fields of engineering.

Prerequisite: NIL

Oscillations and Waves:

Laser and Optical Fiber:
Spontaneous and stimulated emission, population inversion, pumping, Ruby Laser, applications. Principle of optical fiber, optical fiber as wave guide, Types of optical fiber, acceptance angle, numerical aperture, Applications.

Electromagnetic Theory:
Gradient, divergence and curl, Maxwell’s equations in differential and integral form, electromagnetic wave equation in free space, plane wave solutions, transverse nature of electromagnetic waves.

Quantum Mechanics:
Inadequacy of Classical mechanics, de Broglie hypothesis for matter waves, Phase velocity and Group velocity, Heisenberg’s uncertainty principle, wave function and its physical interpretation, Schrodinger’s equations, particle in one dimensional box, potential barrier, tunneling and applications.

Thermodynamics:
Laws of thermodynamics, thermodynamic processes, variables, internal energy, enthalpy, entropy, Gibb’s free energy, Maxwell’s relations, T-S diagrams.
Mechanical Properties of Matter:
Stress, strain, Hooke's law, elastic constants and their relations, torsional pendulum, cantilever, stress-strain diagrams.

Crystallography:
Lattice, basis and crystal structure, unit cell, crystal systems, number of atoms per unit cell, coordination number, packing fraction for cubic lattice, lattice planes, Miller indices, relation between interplanar distance and Miller indices, X-ray diffraction and Bragg's law.

Text Books:

Reference Books:

CH-1003 CHEMISTRY Cr - 3

Course Outcome: At the end of the course, the students will be able to:

CO1. Understand the MOT of covalent bonding and bonding in complexes.
CO2. Understand the condition of spontaneity and equilibrium and find conducive conditions for different industrial processes.
CO3. Use electrochemical cell to measure pH, $K_{sp}$, equilibrium constant etc., understand working of modern batteries and theories of corrosion.
CO4. Able to write rate law of complex reactions, understand theories of reaction rate and catalysis.
CO5. Identify unsaturation, type of unsaturation, functional groups present in organic molecules and theoretically calculate $\lambda_{net}$.

Prerequisite: NIL

Chemical Bonding:
MO theory to explain bonding in homo and hetero nuclear diatomic molecules, Band theory: band diagrams for conductor, insulator and semiconductors, Bonding in complexes: VBT, CFT, Application of CFT in explaining magnetic moment and colour of complexes.

Chemical Equilibrium and Thermodynamics:
Internal Energy, enthalpy, entropy and free energy, dependence of free energy on temperature and pressure, Gibb’s-Helmholtz equation, conditions of spontaneity and equilibrium, Equilibrium constants $K_p$ and $K_c$. Free energy change and equilibrium constants, Le Chatelier’s Principle and its applications to industrial syntheses, van’t Hoff isotherm and isochore, Clapeyron-Clausius equation, partial molar properties, chemical potential, Gibb’s-Duhem equation.
Electrochemistry:

Conductance, effect of concentration, ionic mobilities- Kohlrausch's law and application, transport number, determination by Hitrof's method, types of electrodes, electrode/Cell potential, Nernst equation and applications: to find electrode/cell potential, equilibrium constant, solubility product and pH, modern batteries: fuel cells (AFCs, PEMFs, SOFCs, MCFCs), Zn-air battery, Li-ion battery, Ni-MH battery), corrosion: mechanism of dry and wet corrosion, types of wet corrosion, prevention.

Chemical Kinetics:

Rate of the reaction and rate law, rate laws of multi-step reactions (steady state approximation), parallel, opposing and consecutive reactions, theory of reaction: collision theory, Lindemann’s modification and absolute reaction theory, catalysis: types, theories, kinetics of enzyme catalysis (Michaeli’s Menten mechanism).

Spectroscopy:

UV-Vis spectroscopy: Beer Lambert’s law, types of transition, concept of auxochrome and chromophore, factors affecting $\lambda_{max}$ and $\Delta\varepsilon$, Woodward-Fieser rules for calculation of $\lambda_{max}$ in diene systems, IR spectroscopy: types of vibration, Hooke’s law, detection of functional groups like C-C, C=C, -OH, -NH$_2$ and -C=O.

Text Books:


Reference Books:


CH-1005 ENVIRONMENTAL SCIENCE Cr - 2

Course Outcome: At the end of the course, the students will be able to:

CO1. Understand different components and composition of environment and importance of EIA.
CO2. Understand different air pollutants and their controlling measures, some important global phenomena.
CO3. Understand different water pollutants, sewage treatment, estimate different water quality parameters.
CO4. Understand different principles of green chemistry, R$_4$M$_4$ principle, Cradle to Grave approach.
CO5. Identify biochemical effects of toxic wastes, different steps in solid waste management.

Prerequisite: NIL

Overview:
Overview on environment, terminologies, components of earth: lithosphere, atmosphere and biosphere, concept of black body radiation and albedo. Importance, scope and principles of EIA.
Air Pollution:

Primary and secondary air pollutants, smog (oxidizing and reducing), important environmental issues: ozone layer depletion, acid rain, green-house effect, controlling measures: electrostatic precipitator, cyclone separator, catalytic converter, scrubbing).

Water Pollution:

Types and sources of water pollutants, sewage treatment: primary, secondary and tertiary treatments, Acid-Base chemistry, pH and buffer, analysis of water quality parameters like DO, BOD, alkalinity, hardness, chloride, fluoride, USEPA and WHO guidelines for drinking water.

Green Chemistry:

Basic principles of green chemistry with examples, matrices to explain greenness, R$^3$M$^4$ model with specific reference to eco-no-burette, life cycle analysis (Cradle to grave approach).

Waste Management:

Classification of solid wastes, toxic and biochemical effects of solid wastes (heavy metals, bio-medical and radioactive wastes), sources and generation, management of solid wastes: collection, segregation, disposal).

Text Books:


Reference Books:

1. Fundamentals of Environment and Ecology, D. De, D. De; 2013, S. Chand Group
5. A Textbook of Environmental Studies, Sashi Chawla; 2012, Mc Graw Hill

MA-1001 MATHEMATICS-I Cr - 4

Course Outcome: At the end of the course, the students will be able to:

CO1. Understand the concept of modeling and formulation of Differential equation of physical problems.
CO2. Apply different methods to solve ODE problems (First order) involving growth-decay, cooling effects and electrical circuits etc.
CO3. Know the geometrical significances of ODEs like orthogonal trajectories.
CO4. Get the concept on different types of roots of higher order ODEs.
CO5. Develop an ability to solve higher order ODEs.
CO6. Use Matrices as a tool of Linear Algebra.
CO7. Apply the knowledge of consistency/inconsistency of a linear system.
CO8. Get the concept of solving vector equations.
Prerequisite : NIL

Ordinary Differential Equations :

Basic concepts and definitions of 1st order differential equations; Formation of differential equations; solution of differential equations: variable separable, homogeneous, equations reducible to homogeneous form, exact differential equation, equations reducible to exact form, linear differential equation, equations reducible to linear form (Bernoulli’s equation); orthogonal trajectories, applications of differential equations.

Linear Differential equations of 2nd and higher order :

Second order linear homogeneous equations with constant coefficients; differential operators; solution of homogeneous equations; Euler-Cauchy equation; linear dependence and independence; Wronskian; Solution of non-homogeneous equations: general solution, complementary function, particular integral; solution by variation of parameters; undetermined coefficients; higher order linear homogeneous equations; applications.

Differential Calculus(Two and Three variables):

Taylor’s Theorem, Maxima and Minima, Lagrange’s multipliers

Matrices, determinants, linear system of equations:

Basic concepts of algebra of matrices; types of matrices; Vector Space, Sub-space, Basis and dimension, linear system of equations; consistency of linear systems; rank of matrix; Gauss elimination; inverse of a matrix by Gauss Jordan method; linear dependence and independence, linear transformation; inverse transformation; applications of matrices; determinants; Cramer’s rule.

Matrix-Eigen value problems:

Eigen values, Eigen vectors, Cayley Hamilton theorem, basis, complex matrices; quadratic form; Hermitian, Skew-Hermitian forms; similar matrices; diagonalization of matrices; transformation of forms to principal axis (conic section).

Text Books:

2. Shanti Narayan and P.K. Mittal, Differential Calculus, S. Chand, reprint 2009

References Books:

Course Outcome: At the end of the course, the students will be able to:

CO1. Get a comprehensive knowledge on Laplace transform and to solve IVPs by using it.
CO2. Understand the concept of power series and solution of ODEs by using power series method.
CO3. Know the power series solution of special type of ODEs such as Legendre and Bessel’s equations.
CO4. Understand the geometrical/physical significance of Vector calculus.
CO5. Develop an ability to solve multiple Integrals.
CO6. Apply Green’s theorem, Gauss Divergence Theorem & Stoke’s Theorem.
CO7. Get the concept of periodic and non periodic functions.
CO8. Know the concept of finding Fourier series, Fourier Integral, Fourier Transform of periodic and non periodic functions.

Prerequisite: Mathematics-I (MA-1001)

Laplace Transforms:
Laplace Transform, Inverse Laplace Transform, Linearity, transform of derivatives and Integrals, Unit Step function, Dirac delta function, Second Shifting theorem, Differentiation and Integration of Transforms, Convolution, Integral Equation, Application to solve differential and integral equations, Systems of differential equations.

Series Solution of Differential Equations:
Power series; radius of convergence, power series method, Frobenious method; Special functions: Gamma function, Beta function; Legendre’s and Bessel’s equations; Legendre’s function, Bessel’s function, orthogonal functions; generating functions.

Fourier series, Integrals and Transforms:
Periodic functions, Even and Odd functions, Fourier series, Half Range Expansion, Fourier Integrals, Fourier sine and cosine transforms, Fourier Transform

Vector Differential Calculus:
Vector and Scalar functions and fields, Derivatives, Gradient of a scalar field, Directional derivative, Divergence of a vector field, Curl of a vector field.

Vector Integral Calculus:
Line integral, Double Integral, Green’s theorem, Surface Integral, Triple Integral, Divergence Theorem for Gauss, Stoke’s Theorem.

Textbooks

Reference books
Course Outcome: At the end of the course, the students will be able to:

CO1. Get the concept of PDEs and comparative study of PDEs and ODEs.
CO2. Understand the Wave and diffusion equations and their solution under different boundary and initial conditions.
CO3. Get the knowledge of classifications of two-dimensional PDEs and transforming them to their normal forms.
CO4. Use the Laplace transform in solving PDEs.
CO5. Develop an ability to solve PDEs under different coordinate systems.
CO6. Apply geometrical representation of complex numbers in Argand Plane and use of complex functions.
CO7. Know Complex differentiation and integration etc.
CO8. Understand the concept of solving real integrations using complex residual integration.

Prerequisite: Mathematics-I (MA-1001) & Mathematics - II (MA-1002)

Partial Differential Equations:
Basic concepts, Solution of PDE by Variable Separable method, Mathematical Modeling of one dimensional Wave equation and its solution, Classification of PDE and transformation into its Normal form, D’Alembert’s solution of Wave equation, Solution of one dimensional Heat equation, Steady state flow of heat in a rectangular bar, Solution of one dimensional heat equation by Fourier Integral, Solution of two dimensional wave equation, Laplace Equation in Polar, Cylindrical and Spherical coordinates and applications. Solution of PDE by use of Laplace Transform.

Complex Analysis:
Complex Numbers and Functions:
Basic concept, Complex functions, Derivatives, Analyticity, Cauchy Riemman equations, Exponential, Trigonometric, hyperbolic, Logarithmic functions, general powers,

Complex integration:
Line integral, Line Integral of independent path, Cauchy’s integral theorem, Cauchy’s integral formula, Derivatives of analytic function. Taylor’s series, Maclaurin’s series, Laurent’s series, Expansion of functions, singularities, Residues, Residue Integration method, Evaluation of Real Integrals;

Mapping:
Conformal mapping and linear fractional transformation(LFT).

Course Outcome: At the end of the course, the students will be able to:

CO1. Know the error analysis in data handling.
CO2. Understand the numerical techniques to solve non-linear algebraic / transcendental equations.
CO3. Use the difference operators and different numerical methods to interpolate and extrapolate from given set of data.
CO4. Understand the applications of numerical differentiations and integrations.
CO5. Approximate the solution of system of linear equations with emphasis on eigen value problems.
CO6. Know the concept of solving numerically the initial and boundary value problems of ODEs.
CO7. Get the knowledge regarding concept of probability and its use in day to day problems.
CO8. Understand the concept of probability distributions, expectation and its applications on real life problems.

Prerequisite: Mathematics-I (MA-1001)

Approximations & Errors:

Approximation of numbers by truncation and rounding-off, Types of errors,

Numerical solution of Non linear equations:


Interpolation & Approximation:

Finite Differences, Operators and Relation between them. Interpolation: Newton's forward and backward difference interpolation, Newton's divided difference interpolation and Lagrange interpolation.
Approximation of functions by best fit straight line, quadratic and exponential curves using Least Square Method.

Numerical Differentiation & Integration:

Numerical differentiation of 1\textsuperscript{st} and 2\textsuperscript{nd} order using difference table. Trapezoidal rule, Simpson's 1/3\textsuperscript{rd} and 3/8\textsuperscript{th} rules, Gauss-Legendre's two points and three points formulae. Error in Numerical Integration.

Numerical Solution to ODE:

Taylor series Method, Euler's Method, Modified Euler's Method, Runge-Kutta Methods of order 2 and 4, reduction of 2\textsuperscript{nd} order ODE to 1\textsuperscript{st} order ODE and its solution by R-K method of order four.

Solution of System of Linear Equations:

LU-factorization (Crout, Doolittle & Cholesky), solutions by Gauss-Seidel and Gauss-Jacobi methods.
Largest eigen value and corresponding eigen vector by Power Method.
Probability Theory:

Introduction to Probability, Random variables and Probability distributions, Mean and Variance of probability distributions, Mathematical expectation, Moments and moment generating function. Binomial and Poisson distributions, Normal distribution.

Text Book:


Reference Books:


MA-2003 DISCRETE MATHEMATICAL STRUCTURE Cr-4

Course Outcome: At the end of the course, the students will be able to:

CO1. Apply the translation of real problems of natural language into mathematical and/or machine languages and develop systems to determine their solutions.

CO2. Get the knowledge of classical logics to understand various soft system methodologies like Artificial intelligence fuzzy expert system, genetic algorithms.

CO3. Get the concept of pattern recognition and define clustering. In addition to that relational data base management system and its operational calculus.

CO4. Understand the method of invariants and well-founded ordering to prove correctness and termination of processes and state machines.

CO5. Know the recurrence relation will be able to derive closed-form and asymptotic expressions from series and recurrences for growth rates of processes. In addition to that modeling and analyzing computational processes using analytic and combinatorial methods.

CO6. Get the concept of Boolean algebra will support them in their subjects like Switching theory, digital circuit design and Sequential machines.

CO7. Apply Graph theory in related areas like Syntactic analysis, Fault detection and diagnosis in computers, Scheduling problems and Minimal-path problems, network flow problems.

CO8. Understand the elementary properties of modular arithmetic their applications in cryptography and hashing algorithms.

Prerequisite: NIL

Logic:

Proposition, Truth values, Connectives, Logical equivalence of composite statement (using truth table & without truth table), Predicates and Quantifiers, Rules of Inference, Methods of Induction.
Set, Relation & Function:


Boolean Algebra:

Lattices and Algebraic system, principles of duality law, Basic properties, Boolean function and Boolean Expressions, DNF & CNF.

Recurrence Relation and their solutions:

Discrete numeric function and their manipulation, Generating Function, Concept of Recurrence Relation with constant coefficients, Solution of Recurrence Relation.(Direct Method and by using generating function).

Graph Theory:

Basic Terminology, Types of Graphs, Group Code, Isomorphic Test, Adjacency & Incident Matrix, Paths, Circuit, shortest path Algorithms (Dijkstra), Tree, Rooted Tree, Binary Tree, spanning tree, cut set, MST Algorithms.(PRIM & KRUSKHAL), Planar Graph

Groups and Rings:

Concept of binary operations, Algebraic structures, Semigroup, monoid, Group, Abelian group with examples. Properties of groups, Cyclic groups and its generator, Sub group, Normal subgroup, cosets, Lagrange’s Theorem, Homomorphism and Isomorphism, ring, field, Integral domain (Definition with examples)

Text Book:

1. Discrete Mathematical Structure, PHI by Kolman, Busby & Ross.

Reference Books:


MA-2004 NUMERICAL METHODS Cr-4

Course Outcome: At the end of the course, the students will be able to:

CO1. Know the error analysis in data handling.
CO2. Understand the numerical techniques to solve non-linear algebraic / transcendental equations.
CO3. Use the difference operators and different numerical methods to interpolate and extrapolate from given set of data.
CO4. Understand the applications of numerical differentiations and integrations.
CO5. Know the concept of solving numerically the initial and boundary value problems of ODEs.
CO6. Solve initial and boundary value problems involving PDEs solved numerically
CO7. Get the knowledge regarding concept of Probability and solution of day to day problems
CO8. Obtain the Knowledge of probability distributions, expectation and its applications on problems
Prerequisite: Mathematics-I (MA-1001)

Approximations & Errors:

Approximation of numbers by truncation and rounding-off, Types of errors,

Numerical solution of Non linear equations:


Interpolation & Approximation:

Finite Differences, Operators and Relation between them. Interpolation: Newton's forward and backward difference interpolation, Newton's divided difference interpolation and Lagrange interpolation.

Numerical Differentiation & Integration:


Numerical Solution to ODE:

Taylor series Method, Euler's Method, Modified Euler's Method, Runge-Kutta Methods of order 2 and 4, reduction of 2nd order ODE to 1st order ODE and its solution by R-K method of order four.

Solution of System of Linear Equations:
Solutions by Gauss-Seidel and Gauss-Jacobi methods.

Numerical Solution to PDE:

Types of Partial differential equations, Finite difference approximations of derivatives, Numerical solution of Laplace equation by five point formula, Numerical solution of Parabolic equations by Schmidt method and Crank-Nicolson method.

Probability Theory:

Introduction to Probability, Random variables and Probability distributions, Mean and Variance of probability distributions, Mathematical expectation, Moments and moment generating function. Binomial and Poisson distributions, Normal distribution.

Text Books:


Reference Books:

HUMANITIES
Course Outcome: At the end of the course, the students will be able to:

CO1. Get a basic idea about that communication is two-way transactional process and know the practical implications and their challenges in the workplace.

CO2. Familiarize with English pronunciation and learn to use neutral accent successfully and communicate ideas effectively.

CO3. Know practical uses of English grammar in technical writing and be able to use grammar correctly and unambiguously.

CO4. Draft different business communication documents like reports, letters, memos and retain a logical flow while writing to get a positive response in the workplace.

CO5. Apply relevant writing formats to develop paragraphs, essays, letters, emails, reports and presentations.

CO6. Summarize & comprehend a large text and technical contents. Address explicit and implicit meaning of a text.

Prerequisite: NIL

UNIT: 1 Communication: Process, Methods of communication and Interpersonal communication

Communication-Definition and Concept., Process of Communication
Elements of Communication, Steps/Phases of Communication
Means/Methods/Mode of Communication
Verbal-Oral, Written
Non Verbal-Sign Language, Body language
Flow of Communication: Formal and Informal
Barriers of Communication-Intrapersonal, interpersonal and organizational barriers
Listening-Definition, difference between hearing and listening, advantages of listening

UNIT II: Business Writing

Paragraph Writing-Techniques and skills
Business letter
Report writing

UNIT III: Basics of Grammar


UNIT IV: Basic Sounds, Vocabulary & Reading Skill

Introduction-Sound & Spelling mismatch; Problem sounds and MTI
Analogy and Sentence Completion
Rules of word formation, Antonyms & Synonyms
Reading Skills
Text Book :

Reference Books:
4. The Oxford Grammar (English ) Sidney Greenbaum, Oxford University Press India. 1 st Edition. 2005
5. Verbal Ability and Reading Comprehension for the CAT. Arun Sharma and Meenakshi Upadhyay, TMH, New Delhi,2007
7. BCOM . Carol M.Lehman, Debbie D.DuFrene and Mala Sinha Cengage Learning, New Delhi

HS - 2002 ENGINEERING ECONOMICS Cr-3

Course Outcome : At the end of the course students will be able to :

CO1. Learn the fundamentals of Engineering Economics.
CO2. Understand and use Economic concepts in making business decisions.
CO3. Use economic information to manage the organization.
CO4. Use economic tools with respect to acceptance or rejection of investment proposals.
CO5. Know the current issues relating to economic environment.

Prerequisite – NIL

UNIT-I : Introduction to Economics and Engineering Economics :


UNIT-II Production and Cost Analysis:


UNIT-III Time Value of Money:


UNIT-IV- Money Banking:

HS - 2004  
PUBLIC FINANCE  
Cr-3

Course Outcome: At the end of the course students will be able to:

CO1. Understand the sources of revenue and heads of expenditure of the different levels of government in the country.
CO2. Analyse the effect of public expenditure and revenue on the overall economy.
CO3. Learn the role and effect of state policies on the economy.
CO4. Know the purpose, effect and areas of budgetary policies.

UNIT-I Introduction:

UNIT-II Public Expenditure:

UNIT-III Public Revenue:

UNIT-IV Public Debt:

Text Books:

Reference Books:
Course Outcome: At the end of the course students will be able to:

CO1. Understand the basics of international trade.
CO2. Know the situation and impact of the BOT and BOP of the country.
CO3. Learn the system of foreign currency transactions and exchange rate determination.
CO4. Know about the existing institutions that regulate the international market.
CO5. Learn about the common policies governing International Trade

UNIT-I International Trade:
The importance of International Trade (with emphasis on its significance in the present era of Globalization, measurement of Gains from Trade and their distribution. Theories of International Trade- Absolute and Comparative cost advantage theories, application of opportunity costs, Heckscher – Ohlin Theorem: its empirical Relevance, Leontif Paradox.

UNIT-II Balance of Trade and Balance of Payment:
Concept of Balance of Trade and Balance of Payments, Causes of Disequilibrium, Measures to correct Disequilibrium (both monetary and non-monetary methods) and their relative merits and demerits. Free Trade vs Protection.

UNIT-III Foreign Exchange:
Demand for and Supply of Foreign exchange, Fixed vs Flexible exchange rate, Rise and Fall of Gold Standard, Theories of exchange rate determination- Mint Parity Theory, Purchasing Power Parity Theory, Balance of Payments Theory.
The Brettonwoods system/IMF.

UNIT-IV Concept of Terms of Trade:
Theories of Terms of Trade, Prebisch and Singer Theory, Economic effects of Tariff on National Income, Terms of Trade and Income Distribution, Effects of Quotas, Effective rate of Protection. Forms of economic co-operation- Theory of Custom Union. Changing structure of India’s foreign trade since Independence, composition and Direction of India’s Foreign Trade, Trends in India’s Balance of Payments, Export Promotion and Import Substitution Strategy, GATT/WTO, TRIPS and TRIMS, FERA and FEMA.

Text Books:

Reference Books:
**Course Outcome:** At the end of the course the students will be able to:

CO1. Know about organisational structure, organisational behaviour and personality development.
CO2. learn about motivational techniques and skill required to work in a group and the process of group decision making.
CO3. Know various leadership styles and the role of leader in achievement of organisational objective.
CO4. learn about the reasons organizational change and its development.

**UNIT-1-Introduction to Organization and Organizational Behaviour:**

Meaning and definition of organization, features and principles of organization, Organizational structures and nature of organizational behavior.

**UNIT-2-Personality:**

Meaning of Personality, Personality Development, Determinants of personality, Application of personality in the organizational level. Motivation-concept of motivation, motivation and behavior, Theories of motivation, Need theory, Hygiene theory, Theory X and Theory Y, Elements of sound motivational system, Motivation in Indian organization.

**UNIT-3-Leadership:**


**UNIT-4-Organizational Change:**

Meaning and Nature of organizational change, Factors of organizational change, Resistance to change, Factors in resistance, Overcoming resistance to change, Organizational Development-Concept, Objectives and process of organization development.

**Text Books:**


**Reference Books:**

1. Organizational Behaviour Dr S.S.Khanka, S.Chand, 2014.
**Course Outcome:** At the end of the course the students will be able to:

- **CO1.** Know the professional and personal qualities of a HR manager.
- **CO2.** Learn different methods of selecting human resources through recruitment, training and performance appraisal system.
- **CO3.** Know how to develop a favourable working environment in an organisation through participation in management and maintain a good industrial relation for benefit of the society.
- **CO4.** Know about consequence of industrial dispute and employee indiscipline of an organization.

**Prerequisite:** NIL

**UNIT-1-Human Resource Management:**
Meaning & Definition, Functions, Scope & Objectives, Qualities of a HR Manager

**UNIT-2-Human Resource Planning:**
Meaning & Definition, Importance of HRP, HRP Process. Barriers of HRP, Factors of sound HRP.


**UNIT-3- Industrial Relations:**
Concept & Meaning, Objective & Importance, Reasons of poor Industrial Relation. Industrial Disputes- Meaning & Definition, Causes of Industrial Dispute, Prevention of Industrial Dispute, Conditions for good Industrial Relation.

**UNIT-4- Workers Participation in Management:**

Employee Discipline-Guidelines for action, Penalties & Punishment, Rewards of Discipline.

**Text Books:**

**Reference Books:**
HS - 3006 ENTREPRENEURSHIP Cr-3

Course outcome: At the end of the course the students will be able to:

CO1. know the contribution of an entrepreneur and role of SSI units in growth and development of socio economic condition of our country.

CO2. Learn market survey, sales promotions and management of working capital through costing and book keeping.

CO3. Know different decision making technique and benefit of personal management system as well as motivational methods of an enterprise.

CO4. Learn how to prepare a project report and knowledge about different tax system of an enterprise.

UNIT-I:

New Industrial Policy of 1991, Meaning and Definition of Entrepreneurship, Incentives and benefits available to SSI Units and New Entrepreneurs. Dearth of entrepreneurial talent in India, Growth of SSI in India. Procedures to start SSI.

UNIT-II:

Market survey and research pricing and techniques, Distribution Channel, Sales promotion activities. Raising Finance and enterprise launching.

UNIT-III:


UNIT-IV:


Text Books:


Reference Books:


HS-3008 MANAGEMENT CONCEPTS AND PRACTICES Cr-3

Course outcome: At the end of the course the students will be able to:

CO1. Learn the critical management functions, principles and analysis of management theories.

CO2. know about marketing strategies as well as implementation of financial techniques in the organisational level.

CO3. Learn about production planning and control and formulation of strategy in organisation.
Prerequisite : NIL

UNIT-1 :


UNIT-II-Marketing:

Identifying Market segments, Market mix, product, price, Distribution and promotion, Advertisement and market research, pricing strategies.

UNIT-III-Finance:

Introduction, Scope & Functions, financial statements, working capital management, Capital budgeting decision.

UNIT-IV-Production:

Production planning and control, systems and procedure of inventory management, Strategy Management : Firm and its environment, process of strategic planning.

Text Books:


Reference Books:

3. Financial Management. I.M.Panday, 2010
CIVIL ENGINEERING
Programme Educational Objectives (PEOs)

Our program will produce graduates to:

PEO-1. Lead a successful career in industry or pursue higher studies or entrepreneurial endeavours.

PEO-2. Offer techno-commercially feasible and socially acceptable solutions to real life engineering problems.

PEO-3. Demonstrate effective communication skill, professional attitude and a desire to learn.

Programme Outcome (POs)

Graduates receiving the Bachelor Degree in Civil Engineering are expected to:

a) Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the conceptualization of engineering models.

b) Identify, formulate, research literature and solve complex engineering problems reaching substantiated conclusions using first principles of mathematics and engineering sciences.

c) Design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.

d) Conduct investigations of complex problems including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.

e) Create, select and apply appropriate techniques, resources, and modern engineering tools, including prediction and modeling, to complex engineering activities, with an understanding of the limitations.

f) Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.

g) Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

h) Demonstrate understanding of the societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to engineering practice.

i) Understand and commit to professional ethics and responsibilities and norms of engineering practice.

j) Understand the impact of engineering solutions in a societal context and demonstrate knowledge of and need for sustainable development.

k) Demonstrate a knowledge and understanding of management and business practices, such as risk and change management, and understand their limitations.

l) Recognize the need for, and have the ability to engage in independent and life-long learning.
Course Outcome: At the end of the course, the students will be able to:

CO1. determine different stress & strain in materials under various loading conditions
CO2. determine critical load of compression members for different support conditions
CO3. determine different stress & strain in cylinders & shells
CO4. select appropriate method to locate failure planes in materials for different loading conditions.

Pre-requisite: Engineering Mechanics (ME-1001)

Simple Stresses and Strains:
Concept of Stress, Stress and Strain in Materials Under Tension, Compression and Shear, Elastic Constants, Relation Between Elastic Constants, Thermal Stress and Strain, Stress & Strain of Composite Bars.

Compound Stresses and Strains:
Two Dimensional Stress System, Principal Planes, Principal Stresses, Mohr’s Stress Circle, Principal Strains, Mohr’s Strain Circle, Principal Stresses Computed From Principal Strains.

Bending Stresses:
Bending Moment and Shear Force Diagram of Determinate Beams, Theory of Simple Bending of Initially Straight Beams.

Shear Stresses in Beams:
Distribution of Normal & Shear Stresses. Shear Center, Shear Flow, Shear Center for Symmetrical sections.

Torsion:
Torsion in Solid & Hollow Circular Shafts, Torque and Power Transmitted by Solid and Hollow Shafts, Strength of Shafts, Combined Bending & Torque, Closed Coiled Helical Springs.

Columns & Struts:
Elastic Instability, Euler Theory-Column with One end Free & Other end Fixed, Column with Both ends Hinged, Column with both ends fixed, Column with one end fixed and the other end Hinged, Eccentrically Loaded Column, Column with Initial Curvature.

Cylinders & Shells:
Stresses & Strains in Thin Cylinders and Thin Spherical Shell under Internal Pressure.

Text Books:

Reference Books:
Course Outcome: At the end of the course, the students will be able to:

CO1. determine various internal forces in beams and frame from bending moment and shear force diagram
CO2. select appropriate method to determine slope and deflection of determinate beams and frames
CO3. determine internal forces in the members of plane & space truss, three hinged arch and cables
CO4. determine absolute maximum internal forces due to rolling or moving loads from Influenced line diagrams.


S.F.D. & B.M.D.:
Definition, type of supports, shears force and bending moment diagram of all determinate beams, frames etc. S.F.D and B.M.D for the structures with internal hinge, Inter-relation between S.F.D and B.M.D. Obtain B.M diagram from S.F diagram.

Slope And Deflection of Beams:
Double Integration method, Maculay’s method, Moment Area method, Conjugate beam method, virtual work (Unit load) method, strain energy method. Castiglione’s theorems of strain energy. Maxwell’s and Betti’s reciprocal theorem.

Analysis of Trusses:
Analysis of forces in members of a simple truss, by joint and section method. Deflection of truss. Williot-Mohr diagram.

Arches & Cables:
Analysis of three hinged parabolic and circular arches for bending moment, normal thrust and radial shear, Analysis of three suspension bridges with their hinged girders.

Influence lines:
Influence lines for determinant beams and Pratt and warren trusses., Influence lines for three hinged arch i.e. for horizontal thrust, bending moment, normal thrust and radial shear.

Rolling loads:
Rolling for simple supported beams, Maximum and absolute maximum values of S.F and B.M due to moving loads.

Text Books:


Reference Books:

Course Outcome: At the end of the course, the students will be able to:

CO1: apply the basic principles of surveying and can carry out the survey in the field for various purposes using chain, compass, plane table and theodolite
CO2: perform leveling and contouring of given ground
CO3: set different types of curves

Pre-requisite: Nil

Introduction to Surveying:
Objectives of Surveying, Primary divisions of Surveying, Classification of Surveying, Principles of Surveying, Units of measurements, Plans and Maps, Introduction to types of scales used in Surveying maps, Introduction to Vernier and Types of Vernier, Error due to Wrong Scales, Types of Mistakes and Errors in Surveying (in brief).

Chaining:
Introduction to chaining, Principle of chain surveying, Methods of measuring distance, Types of Chains and Tapes used in Surveying, Other accessories used in chain surveying, Ranging of a Survey line (Direct & Indirect), Process of measuring distances with chains and tapes, Errors caused by wrong chain length (In length, Area and Volume), Types of errors in chaining and taping, Offsets and types of Offsets, Instruments for measuring right angles, chaining on flat and sloping ground, obstacle in chaining, methods of traversing, Precautions during Chain surveying.

Compass Surveying:
Principle of Compass Surveying, Designation of Bearings used in Compass Surveying, Types of Bearing Systems, Declination of the Magnetic Bearing w.r.t. True Bearing, Types of Compasses used in Compass Surveying, Fore Bearing and Back Bearing, Calculation of included angles from Bearings, Computation of Bearing from Internal Angles, Local attraction, Correction of Bearing for Local attraction, Traversing with Compass, Types of errors in Compass surveying, Plotting the compass traversing survey, Adjustments for closing error in closed traverse surveys, Precautions in Compass surveying.

Plane Table Surveying:
Introduction to Plane Table Surveying, Principle of Plane Table Surveying, Plane table accessories, Setting up of plane table in field, Orientation in plane table, Plane table methods (Radiation, Intersection, Traversing and Resection), Comparison of the methods, Two-Point Problem, Three-Point Problem (Tracing Paper method, Graphical method, Trial and error method, Lehmann’s rule), Adjustments of the Plane table, Errors in Plane tabling, Advantages and Disadvantages in Plane tabling.

Leveling:
Introduction to Leveling, Terminology of terms used in Leveling, Methods of finding elevation, Direct methods for finding levels, Types of Leveling instruments, Leveling staff, Temporary adjustments in leveling instruments, Basic leveling operation in field and terminology, Balancing back sight and fore sight, Reduction of levels, Height of Collimation Method, Rise and Fall Method, Fly leveling, Check leveling, Profile leveling, Cross section leveling, Reciprocal leveling, Correction for Curvature & Refraction, Distance to the Visible horizon, Dip of the Horizon, Errors in leveling, Advantages of leveling.

Contours:
Introduction to Contours, Terminology used in Contour Operations, characteristics of contours, contour interval, Contouring methods, direct and indirect methods of contouring, Interpolation of contours, Preparing contour maps, uses of contour maps.
Theodolite Survey:

Curves:
Types of Horizontal and Vertical Curves, Simple Circular Curve, Elements of a Simple Circular Curve, different methods of setting out-simple circular curves, Compound Curves, transition curves, types of transition curves, Requirements of Vertical Curve, Length of Vertical Curve, Vertical Curves by equation of parabola, Different applications of Curve setting.

Text Books:

Reference Books:
3. "Plane Surveying” by Dr. Alak De, Reprint 2016, S Chand & Company Pvt. Ltd.

CE 2007 CIVIL ENGINEERING MATERIALS & CONSTRUCTION Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. learn about properties of stones, bricks, cement, concrete, timber.
CO2. learn about different types of Foundations and Masonries

Pre-requisite: Nil

Stones:
Classification, composition, characteristics, uses, method of quarrying and dressing.

Bricks:
Brick earth, method of Brick manufacture, testing of bricks, classification.

Cement:
Portland cement:-Classification, Chemical composition, hydration, tests for cement fineness test, normal consistency, setting time, soundness, tensile and compressive strength.

Concrete:
Composition of concrete, W/C ratio, Workability, Compressive and tensile strength, Nominal Mix design, pozzolanic concrete, Light weight and high density concrete, Elasticity, Shrinkage and creep of concrete.
Timber:
Characteristics and suitability for different purposes, Defects and decay seasoning preservation of timber.

Foundation:
Shallow foundation, Deep foundation, Description and types of spread foundation, Description and types of pile foundations, Methods of pile driving, Pile driving formulae (isolated and group of piles), Excavation and timbering of trenches, Well foundations, Caissons, Cofferdams.

Masonry:
Definition of terms; classification of masonry; stone masonry; classification, dressing, joints, maintenance; Brick masonry; Types of bonds, brick laying, structures in brickwork; Partition walls.

Door & Windows:
Criterion of size; types of doors and windows ventilators and fanlights sash and casement windows, skylights and lanterns; fixture and fastenings for doors and windows.

Floors:
Ground flooring, upper flooring, types, preparation, advantages and disadvantages.

Text Books:

Reference Books:
3. “Building Material” by P. C. Verghese, PHI Learning (P) Ltd., New Delhi, 2005

CE-2008 ADVANCED SURVEYING Cr-3

Course Outcome: At the end of the course, the students will be able to:
CO1. prepare a layout plan using Total station instrument.
CO2. calculate area of traverse by using different methods such as triangulation, aerial photogrammetry.
CO3. use RS & GIS to prepare a map of a certain area.

Pre-requisite: Surveying (CE-2005)

Tacheometry:

Total Station and Electronic Distance Measurement:
Introduction to Total Station, Advantages and Disadvantages of Total Station, Measuring Angles, Types of Total Station, Advancement in Total Station Technology, Automatic Target Recognition (ATR), Introduction to EDM, Measurement Principle of EDM instrument, EDM instrument characteristics, Classification of EDM, Errors in Electronic Distance Measurement.
Triangulation:
Introduction, Principle of Triangulation, Purpose of Triangulation Surveys, Classification Triangulation, Layout of Triangulation, Ideal figures for triangulation, Size of triangulation, Well conditioned triangle of a triangulation system, Strength of triangulation figures, Accuracy of triangulation, Routine of triangulation survey, Field work of triangulation, Signals and towers, Classification of signals, Base line measurement, Equipments for base line measurement, Number of Zeros, Types of triangulation stations, Triangulation computations.

Photogrammetry:
Introduction, Types of photogrammetry survey, Aerial photogrammetry survey, Principle of photogrammetry and its limitation, Technical terms used in Aerial surveying, Relation between the Principal point, Plumb point & isocentre of a tilted photograph, Displacement of photo image due to height. Flight planning.

Theory of Errors and Adjustments:
Introduction, Definitions, Weight of the observations, Laws of weights, Assignment of weight-age to the field observations, Adjustment of accidental errors, Method of least squares.

GPS:
Introduction to GPS: Available GPS net works, Limitations and applications of GPS; GPS receivers. Standard, Precise Positioning, Broad casting, GPS Errors, Types of segments (Space, Control, User), spatial data, non spatial data, GPS system of various country, Indian Space program, various satellite orbit and their application, DGPS.

Introductions to remote sensing:
Applications and importance of remote sensing, Basic concepts and fundamentals of remote sensing- elements involved in remote sensing, electromagnetic spectrum, remote sensing terminology and units, over view of Indian Remote sensing satellites and sensors, Energy resources, energy interactions with earth surface features and atmosphere, resolution, visual interpretation techniques, basic elements, converging evidence, interpretation for terrain evaluation, spectral properties of water bodies, introduction to digital data analysis.

Geographic Information System (GIS):
Introduction, GIS definition and terminology, GIS categories, components of GIS, fundamental operations of GIS, A theoretical framework for GIS, Data collection and input overview, data input and output. Keyboard entry and coordinate geometry procedure, manual digitizing and scanning, Raster GIS, Vector GIS - Advantages and disadvantages, Map Projections: Introduction; Scale Factor; Geometry of the sphere and cone; Areas; Surface areas of solids; Types of Map Projections; Orthographic Projection; Conical Projection.

Text Books:
2. "Remote Sensing and GIS" by Basudeb Bhatta, Oxford University Press.

Reference Books:
**Course Outcome:** At the end of the course, the students will be able to:

- CO1. understand the fundamental concepts of fluid mechanics
- CO2. apply the basic equations of fluid statics to determine forces on planar and curved surfaces submerged in a static fluid; to manometers: to the determination of buoyancy and stability
- CO3. understand the concept of fluid kinematics, stream functions, velocity potentials and Laplace equation.
- CO4. use Euler’s and Bernoulli’s equations and the conservation of mass to determine velocities, pressures and accelerations for fluids
- CO5. apply the concepts of laminar flow
- CO6. perform dimensional analysis for problems in fluid mechanics.

**Pre-requisite:** Engineering Mechanics (ME-1001)

**Introduction:**
Properties of Fluids, Concept of Shear Stress in Fluids, Newtonian, Non Newtonian & Ideal Fluids.

**Fluid-Statics:**
Pressure at a Point, Pascal’s Law, Pressure Head and Piezometric Head, Measurement or Pressure (Manometers), Pressure on Plane & Curved Surfaces, Buoyancy & Floating Bodies, Stability of Floating Bodies, Metacentre.

**Fluid Kinematics:**

**Fluid Dynamics:**

**Laminar Flow:**

**Dimensional Analysis & Model Analysis:**
Dimensions, Physical Quantities In Fluid Flow, Dimensionally Homogeneous Equations, Buckingham’s Π Theorem And Model Studies.

**Textbooks:**

**Reference Books:**
CE-2014 FLUID MECHANICS-II Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. understand the concepts of laminar and turbulent boundary layer
CO2. determine minor and major head losses for flows through pipes and design simple pipe systems to deliver fluids under specific conditions
CO3. solve problems for uniform gradually varied and rapidly varied flow in open channel.


Boundary Layer Theory:
Laminar & Turbulent boundary layer, momentum equation for Boundary layer, hydrodynamically smooth & rough surfaces.

Pipe flow:
Darcy-Weisbach formula, Laminar flow in pipes, velocity distribution & resistance to flow, resistance to flow in turbulent flow, Moody’s diagram.

Pipe flow problem:
Energy losses in transition, pipe fittings & valves, problems on siphons, pipes in series and parallel, branching of pipes, pipe networks.

Flow in open channels:

Text Books:

Reference Books:
Course Outcome: At the end of the course, the students will be able to:

CO1. identify the current trends of transportation
CO2. characterize pavement materials and develop the acceptance criteria
CO3. analyze and design the highway geometric elements
CO4. determine stress condition and design of pavements
CO5. design traffic infrastructure based on given situation
CO6. select feasible airport site, decide runway orientation, design geometric elements of runway and taxiway, and decide runway length and airport lighting.

Pre-requisite: Nil

Introduction:
Definition of Transportation Engineering, Role of transportation, different modes of transportation and their merits and demerits, scope of highway engineering.

Highway development in India:
Jayakar Committee, Central Road Fund, Indian Roads Congress, Central Road Research Institute, Motor vehicle act, Highway Research board, First twenty year road plan, Second twenty year road plan, Third twenty year road plan.

Classification of roads:
Classification of roads by various road plans, classification of urban roads, Road pattern.

Highway alignment and Engineering surveys:
Requirements, factors controlling the highway alignment, Drawings & Reports, New Highway Project, Map study, reconnaissance survey, preliminary survey, final location and detail surveys.

Highway Geometric Design:
Importance of geometric design, design control and criteria, Highway cross section element, Typical cross section of road, Sight distance, SSD, OSD, ISD, Design of horizontal alignment, Superelevation, Attainment of super elevation, Widening of pavement on horizontal curve, Horizontal transition curve, Set-back distance on horizontal curves, Curve resistance, Design of vertical alignment, Grade compensation, Summit curve and Valley curve.

Highway Materials:
Significance of subgrade soil, CBR test, desirable properties of road aggregate, Test for road aggregate, Bituminous materials, Bitumen, Tar, types of bitumen, Test on bitumen, Marshall Method of Bituminous Mix Design.

Pavement Design:

Traffic Engineering:
Scope of traffic engineering, Traffic characteristics, Traffic studies, Traffic volume study, Speed studies, Origin and Destination (O&D) study, Traffic flow characteristics, Traffic capacity study, Parking study, Accident studies, Level of Service, Passenger Car Unit (PCU), Relationship between Speed, Travel Time, Volume, Density and Capacity, Regulatory sign, Informatory signs, Traffic Signals, Rotary intersection, Mini Roundabout.

Road Drainage:
Significance of highway drainage, Requirements of highway drainage, Surface drainage, Cross drainage, Sub-Surface drainage, Road construction in water-logged area.
**Highway maintenance:**
Introduction, causes of pavement failures, failure in flexible pavement and rigid pavement, maintenance of flexible and rigid pavement.

**Introduction to Airport Engineering & Aircraft Characteristics:**

**Airport Planning:**
Airport Master Plan- FAA & ICAO Recommendations, Regional Planning, Data Required Before Site Selection, Airport Site Selection, Site Surveys & Drawings, Estimation of Future Air Traffic.

**Terminal Area & Airport Layout:**
Airport Classification, Terminal Area, Building & Building Area- Functions, Site Location, Requirements, Planning Considerations, Noise Control, Aprons- Gate Positions & Parking System, Hangers, Typical Airport Layout.

**Airport Obstructions:**
Zoning Laws, Classification of Obstructions, Approach Zone, Turning Zone

**Runway Design:**
Runway Orientation, Cross wind Component & Wind Coverage, Wind Rose, Basic Runway Length, Correction for Elevation, Temperature & Gradient, Runway Geometric Design Standards.

**Taxiway Design:**

**Visual Aids & Air Traffic Control:**

**Airport Drainage:**
Characteristics & Requirements of Airport Drainage, Design Data, Surface, Sub-surface & Subgrade Drainage Design.

**Text Books:**

**Reference Books:**

**Highway Engineering**
CE-2018        DESIGN OF CONCRETE STRUCTURES-I                Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1: determine strength of reinforced concrete beams and slabs at various support conditions as per Limit state
design
CO2: design reinforced concrete beams and slabs at various support conditions for different loadings as per
Limit state design
CO3: design staircases for different support conditions as per Limit state design

& Structural Analysis-I (CE-2004)

Introduction:
Materials, Basic properties of concrete and reinforcement.

Basic working stress and limit state design concepts.

Analysis & Design of R. C. Beams:
Analysis of singly-doubly reinforced sections, flanged sections.
Design of simply supported and continuous beam subjected to flexure, shear and torsion by limit state
methods.

Design of Slabs:
Design of one-way and two-way slab (simply supported and continuous) by limit state methods.

Design of staircases:
Different components of Staircase, Design Of dog-legged staircase.

Text Books:
New Delhi 2003

Reference Books:
Delhi 2002
New Delhi.
Course Outcome: At the end of the course, the students will be able to:

CO1. estimate the water demand for a particular area.
CO2. design different types of water intake structures based on water source and select proper type of pump for conveyance of water.
CO3. categorize and measure the physical, chemical and biological parameters responsible for water pollution.
CO4. design various units of a water treatment plant.
CO5. identify the parameters responsible for air pollution and their control strategies.
CO6. identify the parameters responsible for noise pollution and their preventive measures.

Pre-requisite: Nil

Water Supply Engineering:
General requirement for water supply, sources of water supply, Estimation of water demand. Intake structures, pumping and transportation of water. Physical, chemical and biological characteristics of water and their significance, Water quality criteria, Water borne diseases.

Engineered systems for water treatment:
Aeration, sedimentation, softening, coagulation, filtration, ion exchange, and disinfection. General description of water distribution system.

Air Pollution:
Types of pollutants, their sources and impacts, air pollution meteorology, air pollution control, air quality standards and limits.

Noise Pollution:
Impacts of noise, permissible limits of noise pollution, measurement of noise and control of noise pollution.

Text Books:

Reference Books:
Course Outcome: At the end of the course, the students will be able to:

CO1: determine the degree of static and kinematic indeterminacy of various types of structures and selection of method of analysis
CO2: determine the internal force components using Slope deflection method, Moment distribution method, Kani’s method, Strain energy method, Consistent deformation method and theorem of three moments.
CO3: determine the internal force components using suitable method in two hinged arches and two hinged suspension cable bridges.

Pre-requisites: Solid Mechanics (CE-2003), Structural Analysis -1 (CE-2004)

Redundancy:
Degree of static and kinematic indeterminacy plane and space trusses and frames.

Analysis by classical methods:
Analysis of fixed beams, propped cantilever beam by consistent deformation method. Continues beams by Theorem of three moments
Analysis of beams and frames by, Slope deflection method, Moment distribution method, Kani’s method and Strain energy method.
Analysis of two hinged arches and fixed arches.
Suspension bridges with two hinged girder.

Text Books:

Reference Books:
3. Indeterminate structural Analysis by J.S. Kenney Oxford &IBH Publishing Co Pvt Ltd , New Delhi,

Course Outcome: At the end of the course, the students will be able to:

CO1. design different types of reinforced concrete compression members and isolated footings as per Limit state design
CO2. design various types of piles and pile caps
CO3. design different components of water tank, water tank supporting structures
CO4. understand pre-stressing systems and determine the pre-stressing force required in a beam
CO5. evaluate different types of losses in pre-stress.
Pre-requisites: Solid Mechanics (CE-2003), Structural Analysis-I (CE-2004), Structural Analysis-II (CE-3001), Design of Concrete Structure-I (CE-2018)

Design of column:
Design of short and long columns with axial and eccentric loading

Design of Footing:
Design of isolated & combined column footing (Only slab type).

Design of pile:
Design of piles and pile caps (pile cap for 4 & 3 pile).

Design of water tank:
Design of circular water tank with flexible base and rigid base.

Introduction to pre-stressed concrete:
Introduction to pre-stressing systems, analysis of beam sections at transfer and service loads and losses in pre-stressing.

Text Books:

Reference Books:
1. "Design of Concrete Structures" by U. Pillai & D. Menon, Tata Mcgraw Hill publishing company ltd., New Delhi, 2003
5. “Pre-stressed Concrete”, by N. Krishna Raju, Tata McGraw Hill publishing company ltd, New Delhi

CE-3007 DESIGN OF STEEL STRUCTURES Cr-4

Course Outcome: At the end of the course, the students will able to;

CO1. understand different rolled steel structural members and their connections
CO2. design different types of connections (bolted & welded) as per Limit state design
CO3. design different types of rolled steel structural members for axial and bending load as per Limit state design
CO4. design plate girders as per Limit state design.
CO5. design beam-column and appropriate column bases for steel columns as per Limit state design.

Pre-requisites: Solid mechanics (CE-2003), Structural Analysis-I (CE-2004)

Introduction:
Properties of structural steel, IS rolled section.
Plastic analysis:
Plastic analysis of beams and frames.

Connections:
Simple and moment resistant bolted and welded connections.

Tension members:
Design of tension members.

Compression members:
Design of compression members, single angle, column with cover plate, lacerings and battens.

Beams:
Design of laterally supported and unsupported beam.

Beam-column:
Design of beam-column.

Column bases:
Design of slab base, gusseted base, and grillage footing

Text Books:

Reference Books:
1. "Design of Steel Structures by Limit State Method as per IS 800-2007" by S. S. Bhavikatti, 2nd edition, I.K International publishing house pvt. Ltd.

CE-3008    ENVIRONMENTAL ENGINEERING–II    Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. identify the physical, chemical and biological characteristics of sewage.
CO2. estimate sewage and storm water discharge and thereby design sewer pipeline and storm water drain.
CO3. design modern and low cost wastewater treatment plants.
CO4. assess the impact of sewage discharge on land and water bodies.
CO5. list the various appurtenances used in sewerage system.
CO6. characterize solid wastes and methods of their collection and transportation.
CO7. manage solid wastes using different techniques.

Pre-requisite: Environmental Engineering – I (CE-2019)

Wastewater Engineering:
Physical, chemical and biological characteristics of sewage. Generation and collection of wastewater, sanitary, storm and combined sewerage systems, Quantities of sanitary wastes and storm water. Design of sewerage system.

Treatment of sewage:
Sewer Appurtenances:  
Manholes, Drop manholes, Lamps holes, street inlets, catch basins, flushing tanks, storm water regulators, grease and oil-traps, inverted siphons.

Municipal Solid Waste Management:  
Characteristics, generation, collection and transportation of solid wastes, engineered systems for solid waste management (reuse, recycle, energy recovery, treatment and disposal.

Text Books:  

Reference Books:  

CE-3009 WATER RESOURCES ENGINEERING-I Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. check the consistency of rainfall data and calculate the probability of rainfall over a given return period.
CO2. determine the evaporation, evapo-transpiration and rate of infiltration.
CO3. apply the concept of various stream flow measurement methods and derive unit hydrograph, synthetic and instantaneous unit hydrograph.
CO4: describe irrigation types and methods and determine water requirement of crops.
CO5. classify the canals, design irrigation channels and apply the concept of Kennedy and Lacey theory, design Canal Fall & Cross Drainage Work.

Pre-requisite: Nil

Introduction:  
Hydrologic cycle, Water-Budget Equation and Applications in Engineering

Precipitation:  
Forms and weather systems for precipitation, Characteristics of precipitation in India, Measurement, preparation & presentation of rainfall data, mean precipitation, DAD Curves and Frequency of point rainfall
**Abstractions from Precipitation:**
Different types of abstractions, Evaporation, Infiltration-process, measurement, infiltration capacity and indices.

**Stream flow Measurement:**
Measurement of stage, velocity, area-velocity method, Stage-discharge relationship

**Runoff:**
Catchment characteristics, yield, flow duration curve, flow mass curve and sequent peak algorithm, Curve Number Method

**Hydrograph:**
Components, Base flow, effective rainfall, Unit hydrograph- application and Derivation, Method of superposition and S-curve.

**Irrigation:**
Definition, necessity, Benefits & ill effects of irrigation, types of irrigation & methods of irrigation

**Water Requirements of Crops:**

**Canal Irrigation systems:**
Classification of canals, Alignment, Different types of canals, Distribution system, Design of stable channels in India, Regime Channel, Kennedy’s Theory, Use of Garret’s diagram, Lacey’s theory, Design procedure of irrigation channels, different types of lining and its construction.

**Canal Falls:**
Necessity. Location, Elementary concept of different types of canal falls. Design of a Trapezoidal notch fall.

**Cross drainage works:**
Type of cross drainage works, Design consideration of Cross Drainage Work (Aqueduct & Syphon Aqueduct)

**Text Books:**
2. "Irrigation Engineering & Hydraulic Structures" by S.K. Garg, Khanna Publishers

**Reference Books:**
Course Outcome: At the end of the course, the students will be able to:

CO1. study flood frequency by using Gumbel and Log Pearson type III Method.
CO2. explain the concept of hydrologic flood routing.
CO3. identify the sites for construction of reservoirs and dams.
CO4. determine the forces acting on gravity dam and design of gravity dam.
CO5. describe the types, causes of failure and criteria for safe design of earthen dam

Pre-requisite: Water Resources Engineering-I (CE-3009)

Flood:
Methods of estimation, Flood frequency studies (Gumbel’s method, Log Pearson type III method), Design flood, Risk and reliability.

Flood Routing:
Basic equation, Hydrologic storage routing-Modified Pul’s and Goodrich method, Hydrologic channel routing-Muskingham method of channel routing.

Diversion Head works:
Concept of weir & barrage, Layout of diversion heads works, Theory of seepage, concept of Blight’s creep theory, Lanes Weighted creep theory, Khosla’a theory on permeable foundation. Design of weir on permeable foundations.

Reservoirs:
Preliminary concept of reservoir planning, types of reservoirs, selection of site, Silting of reservoirs.

Dams:
Classification, Investigation, Site selection, economical height of dam.

Gravity dams:
Forces acting on gravity dam, structural stability of gravity dam, Elementary profile of a Gravity dam, High & Low gravity dam, Concept of design of gravity dam, Construction of Galleries, joints, foundation treatment of gravity dam.

Earth Dams:
Types of earth dams, causes of failure of earth dams, criteria for safe design of earth dams, determination of phreatic line and flow net, measures to control seepage through earth dams and their foundations.

Spillways:
Types and Description, Design Aspects of Ogee of spillways.

Text Books:

Reference Books:
Course Outcome: At the end of the course, the students will be able to:

CO1. identify the soil types and classify based on index properties.
CO2. evaluate the capillarity and permeability characteristics of soil strata.
CO3. determine the seepage pressure in soil due to ground water using graphical method.
CO4. determine effective stress under various conditions to lead failures of hydraulic structures by piping and remedial measures.
CO5. determine various shear strength parameters of soil.
CO6. evaluate the compaction methods and field compaction control.
CO7. determine the long term settlement of foundations based on consolidation theory.

Pre-requisite: Nil

Introduction and Classification:
Definition of soil, origin & formation of soil, General types of soil and soil deposits, Cohesive and cohesion less soils. Basic definitions, Relationship & inter-relationships. Index properties of soils & their determination. Classification base on grain size and plasticity characteristics.

Permeability of soils:
Darcy’s law and its range of validity, Discharge velocity, Seepage velocity Laboratory determination of Co-efficient of permeability (K):-constant head permeability, Falling head permeability. Indirect determination of K, Factors affecting permeability, Permeability of stratified soils, Co-efficient in an inclined direction.

Effective stress principle:

Seepage analysis:
Laplace’s equation,Stream and Potential Functions, flow net, characteristics of flow net, graphical method, flow net for anisotropic soils, flow net in non-homogeneous soil mass, uses of flow net.

Shear strength:
Basic concept, Mohr-coulomb-failure criteria. Methods of determination of shear strength parameters: Shear tests-Direct shear test, Triaxial compression test, Unconfined compression test, Vane shear test; advantage and disadvantage of direct shear and triaxial compression test, advantages of unconfined compression test and vane shear test.

Compaction of Soils:

Consolidations of Soils:
Introduction, Principles of consolidation, soil spring analogy, consolidation characteristics of laterally confined soil, pressure void ratio diagram, Normally consolidated and over consolidated soils, Estimation of reconsolidation pressure, Terzaghi’s theory of one dimensional consolidation, Laboratory consolidation test, Determination of coefficient of consolidation, Consolidation settlement.
Text Books:

Reference Books:

CE-3013 CONSTRUCTION PLANNING AND MANAGEMENT Cr-3

Course Outcome: At the end of the course, the students will be able to:
CO1. identify different aspects of DPR preparation.
CO2. optimize the cost and time of a Project by using CPM & PERT Techniques.
CO3. optimize resources in a project.
CO4. describe material procurement method and control for a project.

Pre-requisite: Nil

Construction Management:

Contracts:

Construction equipment:
Selection of construction equipment, Cost of owning and operating, Engineering fundamentals of equipment, Excavating & transporting equipments, Hauling & conveying equipments.

Text Books:
2. "Construction Project Management" by Kumar Neeraj Jha, Pearson Education

Reference Books:
1. "Basics of Construction Management" by Ajay Kumar Singhal, Skill Enhancement Academy
5. "Construction Management & Planning", by B. Sengupta & H. Guha, TMH Education (P) Ltd, New Delhi

CE-3014 GEOTECHNICAL ENGINEERING-II Cr-3

Course Outcome : At the end of the course, the students will be able to:

CO1. determine the vertical stress distribution on horizontal and vertical plane below the ground surface due to various shapes of footings.
CO2. evaluate the bearing capacity of shallow foundations founded in soil.
CO3. select type of pile foundations based on the soil type and its geotechnical design.
CO4. identify type of earth pressures behind retaining structures.
CO5. identify failure mechanisms of cuttings and embankment using slope stability analysis.
CO6. select appropriate soil exploration methods in geotechnical engineering.

Pre-requisite: Geotechnical Engineering-I (CE-3011)

Bearing Capacity of Shallow Foundations:
Introduction, Rankine’s analysis for cohesion less soils, Terzaghi’s bearing capacity equation, Factors influencing bearing capacity of soil including effect of water table, size of footings and eccentricity of loading, plate load test, Selection of type of foundations, Depth of foundation, Floating Foundation

Pile Foundations:
Classification of piles, Load carrying capacity of single piles by static and dynamic formulae (Hilley’s and Engineering News formula) Group action of piles, Negative skin friction.

Earth Pressure and Retaining Structures:
Active & passive earth pressure, Rankine’s theory for active and passive earth pressure, Coulomb’s theory Pressure against solid retaining walls without and with uniformly distributed load surcharge, Effect of submergence.

Stability of Slopes:
Stability of infinite slopes, Swedish, slice method and friction circle method of analysis, stability of homogeneous finite earth slopes without surcharge with steady seepage and under sudden drawdown condition.

Site Investigations:
Methods of exploration, Preservation, standard penetration test and static cone penetration test.
Text Book:

Reference Books:

CE 3021
ADVANCED SOLID MECHANICS

Course Outcome: At the end of the course, the students will be able to:

CO1. understand different theories of failure
CO2. determine stress at any point in cross section of unsymmetrical bending
CO3. analyze curved beams and thin walled cylinders
CO4. determine stresses in beams due to thermal loading

Pre-requisites: Solid Mechanics (CE-2003), Structural analysis I (CE-2004)

Theories of failures:
Maximum principal stress theory, Maximum shearing stress theory, Maximum strain theory, Total strain energy theory, Maximum distortion energy theory, Octahedral shear stress theory.

Unsymmetrical bending:
Symmetrical and unsymmetrical bending, Stress at any point in cross section, Determination of stress in beams with unsymmetrical section.

Flexural and Shear Centre:
Shear centre for symmetrical and unsymmetrical section.

Thick Walled Cylinders:
Lame’s theory of thick walled cylinders.

Thermal Analysis:
Thermo-elastic stress and strain relation, Equation of equilibrium, Stresses in beams due to thermal loading.

Text Books:

Reference Books
Course Outcome: At the end of the course, the students will be able to:

CO1. identify different types of concrete and its properties.
CO2. determine strength and durability of concrete.
CO3. design concrete mixes for the given conditions.
CO4. select types of admixture and special concrete for given condition.

Pre-requisite: Civil Engineering Materials & Construction (CE-2007)

Concrete Materials:
Types of material, cement types, testing of materials.

Concrete:
Workability, Factors affecting workability, type of tests.

Strength of concrete:
Water cement ratio, gain of strength with age, effect of maximum size of aggregate, relationship between compressive and tensile strength, high strength concrete, high performance concrete.

Elasticity, shrinkage and creep of concrete.

Durability of concrete:
Permeability, carbonation, sulphate attack, alkali-aggregate reaction, chloride attack.

Concrete Mix design:
Concept & types, example.

Destructive and non destructive testing of hardened concrete.

Admixtures

Special Concrete:
Lightweight Concrete. High density concrete. Hot weather and cold weather concreting, Polymer concrete, Fibre reinforced concrete, Self compacting concrete.

Text Books:

Reference Books:
Course Outcome: At the end of the course, the students will be able to:

CO1. acquire the knowledge of the most important rocks and minerals
CO2. understand the relationship between rocks and engineering
CO3. understand weathering as they influence civil engineering works
CO4. understand mass movement as they influence civil engineering works
CO5. understand the role of geology in the design and construction process of underground opening in rocks.
CO6. apply geology concepts and approaches on rock engineering projects
CO7. identify and classify soil and rock using basic geological classification system.

Pre-requisite: Nil

General Geology:
Branches and scope of geology, Earth, its position in the solar systems, surface features and internal structure, work of natural agencies like lakes, oceans, atmosphere, wind, streams, sea, glacier, earth movements. Types of weathering, mountains and mountain building.

Mineralogy:
Definition of crystal and a mineral, the study of the physical properties and occurrence of quartz, Feldspar, Mica, Kyanitie, calcite, tale, corundum, gypsum, fluorite, biotite, mus, covite, graphite, realgar, magnetite, limonite, pyrite, galena, barite dolomite, garnet, tourmaline, chalcopyrite, opal, topaz, autite, hornblende, epidate, kaolinite, diamond.

Petrology:
Formation and classification of rocks into three types, igneous, sedimentary and metamorphic rocks, description of physical properties for constructional purposes of granite, pegmatite, dolerite, gabbzo, basalt, sandstone, conglomerate, breccias, limestone, shale, schist, marble, quartzite, khondalite, slate, gneiss, and esite, stratigraphy of India(a general idea), principles of correlation, fossils, their preservation and significance.

Structural geology:
strike and dip, out crops, volcanoes, overlaps, inliers and outliers, types classification of folds, faults, joints, unconformities, surface mapping, identification of potential zones of weakness or failure, analysis using stereonetes.

Earthquakes and landslides:
Classification, causes and effects of earthquakes and landslides, seismic curve, seismographs, seismograms, accelograms, seismic problems of India, seismic zones of India, remedial measures to prevent damage for engineering structures, case histories.

Geological investigation:
Interpretation of geological maps, use of aerial maps in geological surveying, geophysical methods as applied to civil engineering for subsurface analysis (Electrical and seismic methods).

Geology of dams and reservoirs:
Types of dams, requirements of dam site, preliminary and detailed geological investigations for a dam site, important international and Indian examples of failures of dams and their causes, factors affecting the seepage and leakage of the reservoirs and the remedial measures, silting of reservoirs.

Rock mechanics and tunneling:
Purposes of tunneling and geological problems connected with tunneling, geological considerations in road alignment, roads in complicated regions problems after road construction, geology of bridge sites.
CE 3029 ENVIRONMENTAL IMPACT ASSESSMENT & AUDITING Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. identify the roles of EIA and environmental audits;
CO2. prepare an EIA Report required to evaluate the environmental sustainability of any project;
CO3. conduct an environmental audit and evaluate its result.

Pre-requisite: Nil

Evolution of EIA; EIA at project; Regional and policy levels; Strategic EIA; EIA process; Screening and scoping criteria; Rapid and comprehensive EIA.

Specialized areas like environmental health impact assessment; Environmental risk analysis; Economic valuation methods; Cost-benefit analysis; Expert system and GIS applications; Uncertainties; Practical applications of EIA; EIA methodologies; Baseline data collection; Prediction and assessment of impacts on physical, biological and socio-economic environment.

Environmental management plan; Post project monitoring, EIA report and EIS; Review process.
Case studies on project, regional and sectoral EIA; Legislative and environmental clearance procedures in India and other countries, Sating criteria; CRZ; Public participation.
Resettlement and rehabilitation. Environmental auditing.

Text Books:


Reference books:


CE 3031 RAILWAYS ENGINEERING Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. explain & design permanent waterway
CO2. perform geometric design of railway track
CO3. design signaling system.
Pre-requisite: Transportation Engineering (CE-2016)

Introduction to Railway Engineering:
History of Railway Lines, Role of Indian Railways, Development of Railways in India, Classification of Railway Line (by tonnage, gauge length, speed on railway line).

Alignment of Railway Lines: Ideal requirements of Alignment, Factors affecting alignment, Preliminary surveys and Engineering surveys on Alignment.

Permanent Way:
Introduction to Permanent Way of a railway line, Requirements of Ideal Permanent Way, Cross sections, Forces acting on track, Coning of wheels and its Advantages and Disadvantages, Functions of rail, Defects in rail, Creep of rail, Theories on Creep, Measurement and Prevention of Creep, Sleeper, Types of Sleepers, Functions of Sleeper, Sleeper Density, Fastenings and Joints, Requirements of Ideal Rail Joints, Requirements of Ideal Fastening, Types of Fasteners and Joints, Fish Plates, Elastic Fastening, Types of Elastic Fastening, Criteria for determining length of rails, Ballast, Functions of Ballast, Characteristics of Good Ballast, Minimum depth of Ballast Cushion, Sub-grade and Formation, Slopes of Formation.

Geometrical Design of Railway Tracks:

Rolling Stock:
Types of traction, Locomotives and other rolling stock, Resistance due to friction, Wave action, Wind resistance, Curvature Stresses, Stresses at Starting and Stopping, Tractive effort of Locomotive, Hauling Power of Locomotive.

Railway Stations and Yards:

Points & Crossings:
Necessity of point and crossings, turnout, left hand turnouts and right hand turnouts, point of switches and its component parts, crossings and its component parts, number of crossing and angle of crossing.

Signaling and inter locking:
Objects of signaling, classification and types of signals, centralized traffic control system (CTC), automatic train control system (ATC), track circuiting. Necessity and functions of interlocking, methods of interlocking, mechanical device for interlocking

Track Drainage:
Sources Of Moisture In Railway Track, Significance & Requirements Of Track Drainage, Drainage Systems, Cross Drainage.

Safety in Railways:
Railway Accidents & Derailments- Classification, Causes & Prevention, Duties Of Railway Staff In Serious Accidents, Emergency Restoration Of Railway Traffic.

Administration & Modern Developments In Railways:
Indian Railway Administration & Railway Expenses, Rates & Fares, Modernization of Track, Traction, High & Super High Speeds, Miscellaneous Developments
Text Books:

Reference Books:

CE 3033 GROUND WATER HYDROLOGY Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. explain groundwater concept and construction of shallow and deep well.
CO2. analyze well hydraulics for steady and unsteady flow in aquifer.
CO3. identify modern methods of groundwater exploration.
CO4. explain the concept of ground water pollution and management.

Pre-requisite: Nil

Hydrologic cycle, Water balance, Occurrence of ground water: Origin, geological formations as aquifers, type of aquifers, groundwater basins, springs.

Darcy’s Law, validity of Darcy’s Law permeability, laboratory and field measurement of permeability, groundwater Flow lines.

Well Hydraulics, steady flow to a well, steady radial flow to a well in confined aquifer and unconfined aquifer, unsteady radial flow into a confined aquifer, Non equilibrium Theis equation, Theis method of solution, multiple well system.

Methods of constructions of deep and shallow wells: The percussion (or cable tool) method of drilling, Direct circulation hydraulic rotary method, Down the hole hammer method, well logs-receptivity logging, testing of wells for yield.

Surface and Subsurface investigations of groundwater, Geophysical exploration, Electrical resistivity method, aerial photo interpretation, remote sensing applications to ground water exploration, test drilling.

Artificial recharge by water spreading, through pits and shaft, recharge through other methods.

Groundwater management: Concepts of Basin management, Equation of hydrologic equilibrium, groundwater basin investigations, conjunctive use of surface and groundwater.

Text Books:

Reference Books:
Course Outcome: At the end of the course, the students will be able to:

CO1. acquire fundamental knowledge on effect of hydrodynamic force on various types of vanes
CO2. understand hydro-electric power stations
CO3. understand the concepts of the working and design aspects of hydraulic machines like turbines and pumps
CO4. design various components of pumps and turbines
CO5. understand the working principle of miscellaneous hydraulic machines like press, accumulator, crane etc.


Impact of Jets:
Force exerted by the jet on Stationary Vertical plate, Moving plates, Series of Vanes, Radial curved vanes.

Turbines:

Centrifugal Pumps:
Parts of Centrifugal Pump, Work Done by the Centrifugal Pump on water, Head and efficiency of Centrifugal Pump, Multistage Centrifugal Pumps, Specific Speed, Priming, Characteristic curves of Centrifugal Pumps, cavitations, suction lift, net positive suction head.

Reciprocating Pumps:
Parts Of Reciprocating Pump, Working of Reciprocating Pump, Slip of Reciprocating Pump, Classification, Variation of velocity and Acceleration in the suction and delivery pipe due acceleration of the piston, effect of variation of velocity on friction in the suction and delivery pipe, Indicator diagram, air vessels, Comparison between centrifugal and reciprocating Pumps.

Fluid System:

Text Books:

Reference Books:
**Course Outcome:** At the end of the course, the students will be able to:

CO1. analyze & identify the engineering characteristics of pavement materials & to adapt ideal material that will fit engineering requirements of road works
CO2. explain the principles & factors affecting pavement design
CO3. design of flexible and rigid pavements using IRC, AASHTO and other important methods of design
CO4. optimally design pavement formation width components like carriageway, shoulder, drainage etc. and inspect performance of composite theoretically.

**Pre-requisite:** Transportation Engineering (CE-2016)

**Stresses in Flexible Pavements:**
Types of component parts of pavements, highway and airport pavements, materials used in pavement, layered system concepts, stress solution for one, two and three layered systems, fundamentals of design concepts, introduction to analysis using KENLAYER.

**Stresses in Rigid Pavements:**
Westergaard’s theory and assumptions, stresses due to curling, stresses and deflections due to loading, frictional stresses, stresses in dowel bars and tie bars, introduction to stress analysis using KENSLAB.

**Factors Affecting Pavement Design:**
Variable considered in pavement design, classification of axle types, standard and legal axle loads, tyre pressure, contact pressure, ESWL, EWLF and EAL concepts, traffic analysis: AADT, growth factor, lane distribution factor, directional distribution factor and vehicle damage factor.

**Design of Flexible Pavements:**
IRC method of flexible pavement design, Asphalt Institute’s methods with HMA and other base combinations, AASHTO method of flexible pavement design, design of flexible pavement shoulders.

**Design of Rigid Pavements:**
IRC methods of rigid pavement design, AASHTO method of rigid pavement design, design of rigid pavement shoulders.

**Design of Pavement Drainage:**

**Text Book:**
1. Pavement Analysis and Design” by Y. H. Huang, Dorling Kindersley (India) Pvt. Ltd., New Delhi, India

**Reference Books:**
2. “Specifications for Roads and Bridge Works”, Ministry of Road Transport and Highways, Indian Road Congress, New Delhi, India.
Course Outcome: At the end of the course, the students will be able to:

CO1. identify properties of aggregate and bituminous binders used in pavement.
CO2. Design and evaluate bituminous mixes for non stabilized and stabilized roads.
CO3. explain cement concrete, semi rigid, non conventional and new pavement materials.
CO4. evaluate different modern testing.

Pre-requisite: Nil

Introduction:
Types and Component Parts of Pavements, Highway and Airport Pavements, Materials used in Pavements.

Soil Properties:
Basic Soil Properties Relevant to Pavement Applications, Resilient Modulus, and Modulus Of Sub-Grade Reaction, Testing of Subgrade, Soil Stabilization.

Conventional aggregates:
Source, Physical Properties of Aggregates, Preparation, Grading and Blending, Testing and Their Evaluation.

Bitumen & Bituminous binders:
Basic Properties of Bitumen, Polymer and Rubber Modified Bitumen, Testing and Applications.

Bituminous mixes:

Cement Concrete Pavement Materials:
Materials for Cement Concrete and Semi-Rigid Pavements, Design of Mixes for Stabilized Roads.

Flexible And Rigid Pavement Distresses:
Distresses in Pavements, Distress Survey, Pavement Maintenance other than overlay, Fog spray, Slurry seal and micro surfacing, Treatments of cracks and joints in Rigid pavement, Mud Jacking.

Non-conventional and new pavement materials:

Text Books:

Reference Books:
6. Relevant IRC, ASTM and AASHTO codes and specifications.
CE 3041 TRAFFIC ENGINEERING AND TRANSPORTATION PLANNING Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. identify the different aspects of traffic engineering
CO2. determine traffic RU characteristics at various sections of road
CO3. design traffic facilities
CO4. explain the concept of transportation planning
CO5. explain the economic evaluation of transportation plan.

Perquisite: Transportation Engineering (CE-2016)

Traffic Engineering:
Traffic Engineering-Definition, Functions & Importance; Road User Characteristics, Human Factors Governing Road User Behavior, Vehicle Characteristics, Slow Moving Traffic Characteristics In Indian Conditions.

Traffic Engineering Studies:

Highway capacity analysis:
Cases of different types of highways, Highway capacity; Design of Intersection; Parking types; Off street parking; Facilities.

Traffic control devices:
Channelization, rotary and Traffic signals, Traffic Signs and Road marking, Road Accidents.

Transportation Planning:
Brief ideas about urban and regional transportation systems; Components of transportation system planning, Planning Surveys, Trip generation and distribution, Traffic assignment and modal split, Optimal scheduling, Computer applications in Traffic Engineering & Transportation Planning.

Text Books:

Reference Books:

CE 3070 FUNDAMENTALS OF PROJECT MANAGEMENT Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. apply concepts to address specific management needs at the individual, team, division and/or organizational level
CO2. formulate strategies allowing organizations to achieve strategic goals
CO3. apply team-building skills
CO4. investigate complex business problems to propose project-based solutions
CO5. manage creative teams and project processes effectively and efficiently.
Pre-requisite: Nil

Introduction:
What is Project and Project Management, Role of a Project Manager, The Project Life Cycle, Characteristics of the Project Life Cycle, Project Phases.

Project Management Process:

Project Management Knowledge Areas:

Text Book:

Reference Book:

CE 3072 BIOREMEDIATION Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. understand the fundamentals of microbial bioremediation and its feasibility as well as significance over conventional treatment technologies.
CO2. analyze & identify the various aspects of bioremediation like biodegradation of contaminants and pollutants, bioconversion including the genetic aspects of contaminant degradation.
CO3. design of bioremediation systems or methods for soil, liquid and slurry phase remediation.
CO4. optimally design hybrid need based remedial systems for better desired output.

Pre-requisite: Nil

Bioremediation Principles:
Introduction about Bioremediation, Current Bioremediation Practices and its Application to Green Environment.

Bioremediation Systems and Processes:
Solid, Liquid and Slurry phase bioremediation.

Factors influencing bioremediation:
Environmental, Physical and Chemical factors Influencing Bioremediation Process.

Genetics of Bioremediation:
Genetic responses of microorganisms to the presence of pollutants: Plasmid coded inducible degradative enzymes; Microbial transformation reactions: Aerobic and Anaerobic Biotransformation.

Applications of Bioremediation:
Application of genetically engineered microorganisms for hazardous waste management; Microbial detoxification of specialty chemicals (insecticides, herbicides, fungicides, polychlorinated biphenyls, heavy metals); Microbial cleaning of gases: biofiltration and bioscrubbing.

In-situ Bioremediation:
Current advances on in-situ bioremediation practices, Laboratory stage bio-treatability studies for bioremediation; Management of bioremediation projects
Text Books:

Reference Books:

CE 3074 CONSTRUCTION MATERIALS & SPECIFICATIONS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. know the various type of construction materials used for construction purpose.
CO2. know and understand the necessities of specifications of the materials with respect to quality and quantity for a construction work.
CO3. know the engineering specifications containing detailed description of all workmanship and materials for a complete project in accordance with plan and drawings.
CO4. know the specifications regarding the quality of workmanship to be achieved during construction.

Pre-requisite: Nil

Bricks:
Classification, Methods of brick manufacture, Testing of bricks.

Cement:
Classification, Chemical composition, Cement manufacturing process, Tests on cement

Aggregates:
Fine and coarse aggregates, Gradation of sand, Tests on aggregates

Concrete:
Composition of concrete, W/C ratio, Nominal mix design, pozzolanic concrete, Light weight and high density concrete, Tests on concrete

Bituminous materials:
Manufacturing of Bitumen, Tests on bitumen, Grades of bitumen.

Geosynthetics:
Geo textiles, geogrids, geonets, geomembrane, geosynthetic clay liner, geocells, geo composites, Pre fabricated vertical drains, Applications of geosynthetic materials.

Reinforcement and Structural Steel:
Steel manufacturing process, Types of reinforcement steel and application, Grades of structural steel, Various types of standard sections.

Non structural materials:
Text Book:

Reference Books:
3 “Building Material” by P. C. Verghese, PHI Learning (P) Ltd., New Delhi, 2005

CE 3076 TROPICAL HYDROLOGY & WATER RESOURCES Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. check the consistency of rainfall data and calculate the probability of rainfall over a given return period.
CO2. determine the evaporation evapo-transpiration and rate of infiltration.
CO3. apply the concept of various stream flow measurement methods and derive unit hydrograph, synthetic and instantaneous unit hydrograph.
CO4. determine flood discharge using probability distribution functions
CO5. analyze flood routing in reservoir and channel

Pre-requisite: Nil

Introduction:
Hydrologic cycle, Water-Budget Equation and Applications in Engineering.

Precipitation:
Forms and weather systems for precipitation, Characteristics of precipitation in India, Measurement, preparation & presentation of rainfall data, mean precipitation, DAD Curves and Frequency of point rainfall.

Abstractions from precipitation:
Evaporation, Evapotranspiration, Infiltration-process, measurement, infiltration capacity and indices.

Stream flow Measurement:
Measurement of stage, velocity, area-velocity method, Stage-discharge relationship.

Runoff:
Catchment characteristics, yield, flow duration curve, flow mass curve and sequent peak algorithm.

Hydrograph:
Components, Base flow, effective rainfall, Unit hydrograph- application and Derivation, Method of superposition and S-curve,

Flood:
Methods of estimation, Flood frequency studies (Gumbel’s method, Log Pearson type III method), Design flood, Risk and reliability.

Flood Routing:
Basic equation, Hydrologic storage routing-Modified Pul’s and Goodrich method, Hydrologic channel routing-Muskingham method of channel routing, hydraulic flood routing.

Flood Control works:
Flood flows, types of flood control works.
**Erosion & Reservoir Sedimentation:**
Erosion process, Estimation, Channel Erosion, Reservoir Sedimentation, Trap Efficiency, Density Current, Life of reservoir.

**Text Books:**


**Reference Book:**


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**CE 4020 PAVEMENT MANAGEMENT SYSTEMS Cr-3**

**Course Outcome:** At the end of the course, the students will be able to:

- CO1. evaluate the various aspects of pavement management
- CO2. evaluate pavement roughness
- CO3. understand various techniques of rehabilitation of pavement

**Pre-requisite: Transportation Engineering (CE-2016)**

**Introduction:**
Importance of Pavement Management Systems (PMS), Components of PMS and their activities; Application of PMS, Pavement Investment Planning, Analysis, Evaluation & Selection of Pavement Design Strategies, Major steps in implementing PMS- Inputs; Design, Construction and Maintenance; Rehabilitation and Maintenance Management Systems, Preventive Maintenance, Recent developments in PMS.

**Evaluation of pavements:**

**Pavement roughness:**
Measurement of profile, tolerance standards in quality control, waves and deformations, Measurement of rebound deflection, roughness index, Effect of traffic, fuel, chemicals and environmental conditions, Recent techniques for measuring road roughness.

**Pavement rehabilitation:**
Pavement rehabilitation techniques: Overlay- types, design & construction procedures; Economics of overlays; Recycling of flexible and rigid pavements.

**Pavement distress & maintenance:**
Distresses in Pavements, Distress Survey, Pavement Maintenance other than overlay, Fog spray, Slurry seal and micro surfacing, Treatments of cracks and joints in Rigid pavement, Mud Jacking.
Text Book:
1. "Pavement Evaluation and Maintenance Management System"; R Srinivasa Kumar, Universities Press (India)

References Books:
6. "Deterioration and Maintenance of Pavements", Derek E. Pearson, ICE Publishing
8. Relevant AASHTO/ IRC and other Codes and Specifications

CE 4027 ADVANCED STEEL DESIGN Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. design and detailing of gantry girder and roof truss using limit state method
CO2. design of steel member using cold formed light gauge steel
CO3. design and detailing of power transmission tower, steel chimney and water tank using working state method.

Pre-requisite: Design of Steel Structure (CE- 3007)

Design of Gantry girder.
Design of cold formed light gauge steel beams and columns.
Design of roof truss.
Design of power transmission tower
Design of water tank with staging.
Design of self supported steel chimney.

Text Book:

Reference Books:
Course Outcome: At the end of the course, the students will be able to:

CO1. explain causes of different natural disasters.
CO2. identify appropriate rehabilitation and retrofitting technique for structures.
CO3. identify different management techniques during disasters.

Pre-requisite: Nil

Cyclones: Formation, Cyclonic precipitation, anti-cyclones.
Flood: Flood and its estimation, Flood warning, Flood protection measures.
Earthquake:
Causes of earthquake, plate tectonics, seismic zoning map, Characteristics of strong ground motions & attenuation, damage assessment
Rehabilitation and retrofitting of structures
Environmental disaster: Impact assessment studies, computation and preparedness.
Disaster management: Developing appropriate technology for disaster mitigation, Role of management teams, importance of awareness, alertness and preparedness camp

Text Book:

Reference books:

Course Outcome: At the end of the course, the students will be able to:

CO1. understand basic theory of vibrations of Single Degree of Freedom systems
CO2. analyse and design problems related to machine foundations
CO3. determine the stiffness and damping constants of different types of foundations
CO4. determine the response of machine foundations under the effect of different types of dynamic loading.

Pre-requisites: Geotechnical Engineering I (CE-3011), Geotechnical Engineering II (CE-3014)

Vibration of elementary Systems:

Dynamics of soil-foundation System:
Types of machine foundation, design criteria, dynamic loads, physical modeling and response analysis, Barken’s approach, Ford & Haddow’s analysis, Hammer foundation, I. S. Codes.
**Dynamic soil testing techniques:**
Cyclic plate load test, block vibration test, shear modulus test, geophysical methods, Resonance -column test, Two & three borehole techniques, Model tests using centrifuge and shake table, recent developments.

**Vibration isolation and control:**
Vibration transmitted through soil media, active and passive isolation, vibration isolation – rigid foundation and flexible foundation, method of isolation, properties of material and media used for isolation, vibration control of existing machine, foundation isolation by barriers.

**Guidelines for design and construction of machine foundation:**
Data required for design of reciprocating, impact and rotary type machines, guidelines for the design of different type machines, construction guidelines, guidelines for providing vibration absorbers.

**Text & Reference Book**

**CE 4032 STRUCTURAL ANALYSIS-III Cr-3**

**Course Outcome:** At the end of the course, the students will be able to:
CO1. apply the concept of energy theorems to determine the internal forces in structure.
CO2. determine absolute maximum internal forces due to rolling or moving loads of indeterminate structures from Influenced line Diagrams by Muller-Breslau principle.
CO3. perform plastic analysis of frame structure.
CO4. determine the internal forces in rigid joined plane frame, continuous beam, pin joined plane frame by flexibility and stiffness matrix methods.

**Pre-requisites:** Structural Analysis I (CE-2004), Structural Analysis II (CE-3001)

**Energy theorems:**
Total potential Energy, Complimentary Energy, Simple examples.

**Influence Line Diagrams for redundant structures:**
Muller-Breslau Principle, Influence lines for bending moment, Shear force and reaction components for single redundancy.

**Plastic Analysis:**
Stress-strain relation for mild steel, rigid plastic theory, Behavior of fixed beam, Evaluation of fully plastic moments for double and mono symmetric sections, Upper bound and lower bound theorems, Application of upper bound theorems for beams and frames, Combinations of mechanisms with simple examples, Load interaction diagram, Characteristics of yield surface.

**Matrix Analysis:**
Direct flexibility and stiffness methods, Applicable to redundant beams and portal frames.

**Text Books**
2. “Matrix Analysis”, by Pandit & Gupta, TMH Education, New Delhi
Course Outcome: At the end of the course, the students will be able to:

CO1: analyze single degree of freedom (SDOF) system for damped and undamped free vibration systems
CO2: analyze single degree of freedom system for damped and undamped forced vibration for harmonic, periodic, impulse and general dynamic loads
CO3: analyze multi degree of freedom (MDOF) system for damped and undamped free vibration systems
CO4: analyze Free and Forced vibration of distributed mass system of Beam

Pre-requisites: Solid Mechanics (CE-2003), Structural Analysis-I (CE-2004)

Single degree of freedom system:
Equation of motion, Damped and undamped free vibration, Response to harmonic, Periodic, impulse load and general dynamic load, Duhamel’s integral

Multi degrees of freedom system:
Equation of motion, Free vibration analysis, Dynamic response and modal analysis.

Free and Forced vibration of distributed mass system:
Beam.

Text Book:

Reference Books:
Pre-requisites: Geotechnical Engineering- I (CE-3011), Geotechnical Engineering II (CE-3014)

Introduction:

Drainage methods:
Well point systems, deep well drainage, vacuum dewatering system, design of dewatering system – field permeability tests, dewatering by electro osmosis. Preloading, sand drains, wick drains- Thermal methods case studies

Chemical stabilization:

Grouting:

Earth Reinforcement:
Mechanism and concept- stress strain relationship of reinforced soil-design theories and stability analysis of retaining wall-tie back analysis-coherent gravity analysis- application areas of earth reinforcement.

Geotextiles:
Soil reinforcement with geotextiles- classification- concepts geotextiles as separators, filters, and drainage media-damage and durability of geotextiles.

Text Books:

Reference Books:

CE 4051 FLOOD AND DROUGHT ESTIMATION AND MANAGEMENT Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1: learn about various estimation methods of flood
CO2: learn about different methods of flood control, monitoring and forecasting
CO3: learn about drought, drought assessment and monitoring
Pre-requisites: Water Resources Engineering I (CE-3009), Water Resources Engineering II (CE-3010)

Flood Estimation:
Estimation of design flood- Empirical methods, envelope curve method, unit hydrograph method, flood estimation in small watersheds, urban catchment and influence of urban drainage.

Flood Control and Management:
Detailed study of various methods of flood control- flood plain identification, flood disaster monitoring and mitigation procedures, various methods of forecasting data, communication and warning, flood fighting.

Drought Classification:
Importance, definition-NCA classification, direct and indirect losses.

Drought Estimation:
Drought severity assessment, methods in meteorological, hydrological and agricultural aspects.

Drought Monitoring:
Supply and demand oriented measures, drought prone areas programme (DPAP), short term and long-term strategies, drought management.

Text Books

2. "Engineering Hydrology" by K. Subhrmanya, TMH Education Pvt. Ltd, New Delhi

Reference Books:


CE 4053 SOLID AND HAZARDOUS WASTE MANAGEMENT Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1: classify solid wastes and understand the functional elements of solid waste management
CO2: understand the aspects of waste generation and its effects on public health and environment
CO3: identify the strategies for waste collection, storage, transport and disposal
CO4: select proper waste processing technique
CO5: identify proper ways of source reduction, product recycling and recovery of biological conversion products
CO6: explain various incineration technologies, estimate the energy generation potential of wastes and assess the environmental impacts of incineration
CO7: identify and classify hazardous wastes and select proper strategy for managing and treating them
CO8: understand the concepts of Integrated Waste Management

Pre-requisite: Environmental Engineering – II (CE-3008)

Introduction to Solid and Hazardous waste management:
Classification of solid waste – source-based and type-based. Functional elements of solid waste management.
**Waste Generation aspects:**
Waste generation and composition, Waste characteristics, Effects on public health and environment.

**Waste collection, storage, transport and disposal:**
Collection components, storage devices, collection operation, Transfer station, Waste collection system design, disposal options – sanitary landfill, landfill gas emission, leachate formation.

**Waste Processing techniques:**
Mechanical volume and size reduction, component separation, drying and dewatering.

**Source reduction, product recycling and recovery of biological conversion products:**
Basics of source reduction, Elements of recycling – source separation, drop-off, curbside programme, storage and collection of recyclables etc., Composting, Biogasification.

**Incineration and energy recovery:**
Incineration technologies, Energy recovery, Air emission and its control.

**Hazardous waste (HW):**

**Integrated Waste Management (IWM):**
Characteristics of IWM, Planning for IWM, Implementation of IWM, Benefits of IWM. Introduction to life cycle assessment tool and its application in IWM.

**Text Books:**

**Reference Books:**
1. "Solid Waste Management in Developing Countries", by A.D. Bhide, Nagpur publications
3. "Hazardous Waste Management" by Lagrega, Buckingham & Evans, McGraw Hill International

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**CE 4057 DRAINAGE ENGINEERING AND DESIGN Cr-3**

**Course Outcome:** At the end of the course, the students will be able to:

**CO1:** understand, plan and design drainage of agricultural land

**CO2:** understand, plan and design urban drainage system.

**Pre-requisite:** Nil

**Drainage of Agricultural Land:**
Nature and extent of Drainage Problems; drainage Investigation; Steady and transient state drainage equations; Design, alignment, construction and maintenance of surface and subsurface drainage systems; Design, construction and maintenance of mole drains; Guideline for the selection of envelope materials for subsurface drain; Design, construction and maintenance of well drains; Drainage machineries.
Urban Drainage:
Introduction; Approaches to urban drainage – piped or natural systems, types of piped system, urban water system; Storm water – introduction, runoff generation, overland flow and storm water quality; System components and layout of urban drainage system – introduction, building drainage, system components and design; Hydraulics of urban drainage, Storm sewers, Structural design and construction – types of construction, site investigation, open-trench construction, tunneling and trenchless methods; Storm water management.

Text Books

Reference Book:

CE 4059 REINFORCED CONCRETE REPAIRS & MAINTENANCE Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1: understand condition Survey, Evaluation and Assessment of Damage detection methods concrete structures
CO2: perform repair analysis and design using different materials and methodologies
CO3: understand various methods of protection of concrete structures and rebar corrosion
CO4: understand maintenance of concrete structures

Pre-requisite: Nil

Introduction:

Condition Survey, Evaluation and Assessment of Damage:
Diagnostic methods and analysis. Destructive, Semi destructive and Non-Destructive methods including Core test, Carbonation test, Petrography, Corrosion Analysis, Cover meter test, Rebound Hammer test, Ultrasonic Pulse Velocity test, Crack measurement techniques, Concrete Endoscopy and Thermal imaging, Pull-off test and Pull-out test etc.

Materials and Methodology of Repairs:

Protection of Concrete Structures:
Protective materials and their properties for moisture barrier systems, Above-grade and below grade waterproofing of concrete structures. Systems like integral, crystalline, coatings, membranes etc., Thermal protection coatings

Rebar Corrosion Protection:
Methods of Corrosion protection. Corrosion inhibitors, Corrosion resistant steels, Cathodic Protection, Pre-packaged zinc sacrificial anode, Snap-on zinc mesh anode CP system.
Maintenance of concrete structures:

Text & Reference Books:
1. "Concrete Repair and Maintenance", by Peter H. Emmons & Gajanan M. Sabnis, Galgotia Publication.
2. "Repairs and Rehabilitation", by Compilation from Indian Concrete Journal-ACC Publication.
4. "Concrete Repair Association", by CSIRO and Standards Australia.

CE 4061 EARTHQUAKE ENGINEERING

Course Outcome: At the end of the course, the students will be able to:

CO1: identify the parameters of earthquake and seismic zones of India
CO2: determine dynamics responses of free vibration and forced vibration (un-damped & damped) for single degree of freedom systems
CO3: Construct response spectra and select proper value for design from given dynamic properties
CO4: determine dynamics responses of un-damped free vibration for multi degree of freedom systems
CO5: Use standard earthquake codes for design of structure

Pre-requisite: Nil

Single degree freedom system:
Free and forced vibration

Multi degree freedom systems:
Free vibrations of un-damped systems, Determination of frequencies by Rayleigh’s method and Stodola method, Un-damped and damped free vibrations with viscous damping, Vibration isolation, Response spectra, India seismic zoning map.

Earthquake resistant design of RC multi-storeyed buildings and masonry buildings as per provision in IS code:

India seismic zoning map

Seismic retrofitting of RC and masonry buildings

Text Book:
Reference Books:


CE 4062 WATER RESOURCES SYSTEM ANALYSIS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. develop a simulation model related to water resources planning.
CO2. explain reservoir operation, planning and management of water resources projects.
CO3. explain economics for hydro-systems, water pricing and allocation policies.

Pre-requisites: Water Resources Engineering I (CE-3009), Water Resources Engineering II (CE-3010)

Objective of water resources development, economic analysis and discounting techniques.
Conditions of project optimality, graphic optimization techniques for multipurpose projects.

Analytical optimization techniques for water resources projected by linear programming, non-linear programming and dynamic programming, optimization by simulation, mathematical models for large scale multipurpose projects, different case studies.

Stochastic optimization techniques, water quality subsystems.

Optimum operation model for reservoir systems by incremental dynamic programming, sequencing of multipurpose project.

Text Books


Reference Books:


CE 4063 FINITE ELEMENT METHOD IN GEO-MECHANICS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. understand the importance of numerical modeling in geotechnical engineering
CO2. solve linear and non-linear systems of equations
CO3. learn finite element formulation, discretization and meshing
CO4. model soil response
CO5. model soil by considering compressibility, yielding, hysteresis
Pre-requisite: Nil

Introduction:

One and Two Dimensional Problems:
Detail formulation including shape functions, stress strain relations, strain displacement relations and derivation of stiffness matrices using energy approach, Assembling of element matrices, application of displacement boundary conditions, Numerical solution of one dimensional problems using bar, truss, beam elements and frames. Derivation of shape function using Lagrange’s interpolation, Pascal’s triangle, Convergence criteria, Finite Element modelling of two dimensional problems using Constant strain Triangle(CST) elements, Stress strain relations for isotropic and orthotropic materials, Four nodded rectangular elements, axi-symmetric solids subjected to axi-symmetric loading.

Isoparametric Elements:
Natural coordinates, iso-parametric elements, four nodes, eight node elements, Numerical integration, order of integration

Plate Bending:
Bending of plates, rectangular elements, triangular elements and quadrilateral elements, Concept of 3D modelling

Text Books:

Reference Books:

CE 4065 INFRASTRUCTURE PLANNING  Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. understand the fundamental characteristics of infrastructure.
CO2. understand past and contemporary challenges and trends in the theories and practice of mega infrastructure planning, appraisal and delivery
CO3. acquire basic knowledge of the international, national and regional policies and legislative frameworks, plus market contexts that surround mega infrastructure development
CO4. understand the critical issues concerning sustainable infrastructure investment at all scales.
CO5. apply innovative methods and techniques to infrastructure planning, appraisal and monitoring.

Pre-requisite: Construction Planning and Management (CE-3013)

Definitions of infrastructure; Typical infrastructure planning steps; Planning and appraisal of major infrastructure projects. Screening of project ideas; Life cycle analysis; Multi-criteria analysis for comparison of infrastructure alternatives. Procurement strategies; Scheduling and management of planning activities.
Economic Analysis: Concepts and Applications, Principles of methodologies for economic analysis of public works, Social welfare function, indifference curves and tradeoffs, Demand curves and price elasticities; Benefit-cost ratio and internal rate of return; Shadow pricing; Accounting for risk and uncertainty.

Financial Evaluation: Time value of money, Investment criteria, Project cash flows – elements and basic principles of estimation, Financial estimates and projections, Cost of capital, Rate of return; Project risk analysis; Political and social perspectives of infrastructure planning; Case studies.

Text Books:


Reference Books:


CE 4067 OFFSHORE GEOTECHNICAL ENGINEERING Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. learn about equipment and standard soil investigation methods used in offshore constructions
CO2. Understand geotechnical problems related to offshore oil exploration and production
CO3. evaluate procedures relevant for foundations, piles and anchors subjected to cyclic loading

Pre-requisites: Geotechnical Engineering I (CE-3011), Geotechnical Engineering II (CE-3014)

Classification; Consolidation and shear strength characteristics of marine sediments; Planning and site exploration of offshore drilling, sampling, laboratory testing, in-situ testing methods and geophysical methods.
Current design practice of pile-supported and gravity offshore structures.
Dynamic analysis of offshore structures.
Anchor design, breakout resistance analysis and geotechnical aspects of offshore pipe line and cable design.

Text & Reference Books:

3. Ramakrishna, T V, Marine and Offshore Engineering, Mahip Distributor Delhi
CE 4069  COST EFFECTIVE HOUSING  Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. classify the population based on income
CO2. identify the need and problems of lower income and economically weaker section regarding shelter
CO3. identify different low cost materials and use them to build a low cost house.

Pre-requisite: Nil

Income based classification of population. High, Middle, Low Income group and economically weaker section.

Basic shelter issues in India. Mindset of low income group and economically weaker section people. Problems associated with this group with relation to land, living condition and dwelling standards; Recommendation of housing and urban development corporation.

Traditional materials and techniques (rammed earth, sun dried bricks, wood, bamboo, jute); Alternate and developed methods / materials of construction: pressed soil blocks, use of stabilized soil, soil cement blocks, fly ash brick, by-product gypsum, foundation, arch foundation, walling- rat trap bond, roofing- filler slabs. Precast blocks and their use.

Laurie Baker’s experiments in low cost housing. ; Modular constructions. Experimental observations/findings of CBRI.

Use of cost effective technologies (CECT) in building constructions, stub foundation, Rat trap bond (walls), brick arches (alternates to lintels) filler slab (roof). Use of Ferro cement.

Cost effective housing for natural disaster mitigation.

Text books:
2. International Association for Earthquake Engg. Guidelines for Earthquake Resistant Non-Engineered Construction.

Reference books:

CE 4070  GLOBAL WARMING & CLIMATE CHANGE  Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. understand the importance of global warming
CO2. model and apply the techniques of ‘measuring’ the Earth’s temperature
CO3. assess the ‘best predictions’ of current climate models
CO4. understand the concept of mitigation measures against global warming
CO5. explain the factors forcing climate change and the extent of anthropogenic influence.
Pre-requisite: Nil

Earth’s Climate System:

Atmosphere and its Components:

Impacts Of Climate Change:
Causes of Climate change, Change of Temperature in the environment, Melting of ice Pole, Sea level rise, Impacts of Climate change on various sectors, Agriculture, Forestry and Ecosystem, Water Resources, Human Health, industry, Settlement and Society, Methods and Scenarios, Projected Impacts for different regions, Uncertainties in the Projected Impacts of Climate Change, Risk of Irreversible Changes.

Observed changes and its causes:
Climate change and Carbon credits, CDM, Initiatives in India-Kyoto Protocol, Intergovernmental Panel on Climate change, Climate Sensitivity and Feedbacks, The Montreal Protocol, UNFCCC, IPCC, Evidences on changes in Climate and Environment on a Global scale and in India.

Climate change and mitigation measures:

Textbook:

References:

CE 4071  BASIC TRANSPORTATION ENGINEERING  Cr-3

Course Outcome: At the end of the course, the students will be able to:
CO1. understand highway system & design
CO2. understand railway and airport system
CO3. understand other modes of transportation engineering

Pre-requisite: Nil

Highway Engineering:
Introduction to Transportation Systems, Road Development in India, Highway Engineering – Classification of Roads, Highway Planning - Road cross section - camber, gradient, Super elevation - Sight distance - Horizontal and Vertical curve, Highway Materials- Soil & Soil properties, Bitumen and bituminous mixes – sources, composition, characterization, various forms - Tests on bitumen- Aggregate test, mix design - Types of pavement - pavement
construction and maintenance, Traffic engineering- various studies, Level of Service, Intersections, Road signs, markings & signals, Highway Parking

**Railway Engineering:**
Introduction, Development & Administration of Indian Railway, Railway surveying, Rolling Stock & track resistances, Tractive power & Tractive resistances, Permanent way, Railway gauges, Sleepers, Ballast, Track design, Stations & yards, Station Equipments, Signalling, High speed Trains, Train Accidents- Causes & Prevention.

**Airport Engineering:**

**Tunnel Engineering:**
Introduction-Advantages, disadvantages, economics & selection, Classification of tunnels, Design of shape & size of tunnels, Components of Tunnel, Methods of tunneling, Pre cautions, Tunnel Lining & drainage.

**Docks & Harbor Engineering:**
Introduction, Classification & Requirements of ports, harbor, docks, Maintenance of ports & harbours, advantages of docks, Transit shed & warehouse, Tides, wind & waves, Different components of docks, Navigational aids, Breakwater.

**Text Books:**

**Reference Books:**

**CE 4072 GREEN BUILDING Cr-3**

**Course Outcome:** At the end of the course, the students will be able to:

CO1. understand necessity and role of green buildings & regarding Indian green building council
CO2. design green buildings considering water, site and material parameters
CO3. understand passive solar design
CO4. handle construction and maintenance of green buildings

**Pre-requisite:** Nil

**Introduction To Green Buildings:**
Green Buildings, Global warming, requirement of Green Building, Benefits of Green Buildings, Requisites for Constructing a Green Building, sustainable construction focus point: site, water, energy, material, indoor air quality, construction procedures.
Indian Green Building Council:
Introduction to IGBC green homes, Benefits of IGBC, IGBC green home rating system, introduction to USGBC, LEED rating system, procedure to get IGBC certification.

Green Building Design Site issues:
Site analysis and design, site development and layout, Water issues: watershed protection, drainage of concentrated Runoff, water efficiency and conservation, rain water harvesting, water reclamation. Sustainable materials: Reduce / Reuse / Recycle, Natural Sources, concrete, masonry, metals, wood and plastic, finishes.

Passive Solar Design:
Passive solar design, Day lighting, Building envelope, Renewable energy, Construction Process And Maintenance Of Green Building
Environmental construction guidelines, building operations and maintenance.

Indoor Environmental Quality:
Significance, design principle, ventilation control, occupant activity control, significance of acoustics.

Economics Of Green Homes:
Economics of green buildings, Selecting environmentally and economically balanced building materials, Project cost, Income and expenses.

Text Books:
3. IGBC Green homes rating system Version 1.0 – A bridged reference guide

Reference Books:
2. Green Building Handbook, Volume 1, Tom Woolley, Sam Kimmins, Paul Harrison and Rob Harrison; E & FN Spon, an imprint of Thomson Science & Professional

CE 4073 FUNDAMENTALS OF RCC DESIGN Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. know the different properties, types & test of cement.
CO2. know the different gradation of coarse aggregate, test of fine & coarse aggregate, types.
CO3. know the manufacturing process & different grades of steel.
CO4. know the different behavior of concrete.
CO5. know about the concept of stress and strain.
CO6. understand basic design concepts and to be able to design simple beams & columns.

Pre-requisite: Nil

Materials for Concrete: Cement:
Physical and chemical properties of cement, Types of cements and their use, Tests on cement.

Fine aggregates and coarse aggregates:
Gradation of fine aggregate, Tests on sand, Tests on coarse aggregates Steel: Steel manufacturing process, grades of steel.
Concrete:
Composition of concrete, W/C ratio, Workability, Compressive and tensile strength, Nominal Mix design, Elasticity, Shrinkage and creep of concrete

Concept of Stress and strain: Simple stresses and strains:
Materials under tension, compression and shear stresses, Elastic constants.

Bending Stresses & Shear Stresses in Beams:
Bending Moment and Shear Force Diagram of Determinate Beams, Theory of Simple Bending of Initially Straight Beams.

Basic Design Concept:
Basic working stress and limit state design concepts. Design of singly-doubly reinforced sections Design of columns.

CE 4074 ENVIRONMENTAL CHEMISTRY Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. demonstrate knowledge of chemical principles of various fundamental environmental phenomena and processes in air, land and water
CO2. apply the principles of green chemistry for a sustainable future.

Pre-requisite: Nil

Introduction to environmental chemistry; Global biogeochemical cycles.
Atmospheric chemistry: gases, particulate matter; Air pollution and its health effects; Climate change.
Soil chemistry - Physico-chemical properties of soil, Classification of soils and their characteristics, Major nutrients of soil, Biofertiliser and their types, Significance of C:N ratio.
Water chemistry - Physico-chemical properties of water and their significances.
Green Chemistry for Sustainable Future: Reagents, Media, Special Importance of Solvents, Role of Catalyst, Biological Alternatives, Biopolymers, Principles and Application of Green Chemistry.

Text Books:


Reference Books:
CE 4075  FUNDAMENTALS OF SOIL PHYSICS  Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. understand soil basic relationship
CO2. understand soil-water relationship
CO3. understand soil-plant-water relationship

Pre-requisite: Nil

Introduction & Basic Relationships:
Soil Physics And Soil Physical Characteristics , Water Properties In Relation To Porous Media.

The Solid Phase:
Particle Sizes, Shapes, And Specific Surface , Clay, The Colloidal Component, Soil Structure and Aggregation.

The Liquid Phase:
Water Content And Potential, Water Flow In Saturated Soil, Water Flow In Unsaturated Soil, Solute Movement And Soil Salinity.

The Field Water Cycle:
Water Entry Into Soil, Surface Runoff And Water Erosion, Redistribution And Retention Of Soil Moisture, Groundwater Drainage And Pollution, Evaporation From Bare Soil And Wind Erosion.

Soil–Plant–Water Relations:
Plant Uptake Of Soil Moisture, Water Balance And Energy Balance In The Field Irrigation And Water-Use Efficiency).

Text Book:

"Fundamentals of Soil Physics" by Daniel Hillel, Academic Press.

CE 4077  EARTH & EARTH RETAINING STRUCTURES  Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. describe potential applications for Earth Retaining Structures (ERS)
CO2. select a technically appropriate and cost-effective ERS
CO3. select appropriate material properties, soil design parameters, and earth pressure diagrams
CO4. perform design analysis and prepare conceptual designs

Pre-requisites: Geotechnical Engineering I (CE-3011), Geotechnical Engineering II (CE-3014)

Earth and Rock Fill Dam:
Choice of types, material, foundation, requirement of safety of earth dams, seepage analysis.

Mechanically Stabilized Earth retaining walls:
General considerations, backfill and reinforced materials, construction details, design method, stability.

Soil nailing:
applications, advantages, limitations, methods of soil nailing, case histories, analysis and design.
**Reinforced Soil:**
Introduction, basic components, strength characteristics, soil-reinforcement interface friction.

**Reinforced Earth wall:**
Stability analysis, construction procedure, drainage, design Procedure.

**Foundation on Reinforced Soil Bed:**
Pressure ratio, analysis of strip, isolated, square and rectangular footing on reinforced soil bed, ultimate bearing capacity of footing on reinforced earth slab. Fiber reinforced soil.

**Text & Reference Books:**


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**CE 6102 CONSTRUCTION ENGINEERING PRACTICES Cr-3**

**Course Outcome:** At the end of the course, the students will be able to:

CO1. explain concreting in different environment and design the formwork.
CO2. explain Fabrication and erection of structures by special construction methodology.
CO3. explain construction of special structures.

**Pre-requisites:** Civil Engineering Materials & Construction (CE-2007), Concrete technology (CE-3023)

Concrete construction methods; form work design and scaffolding, slip form and other moving forms, pumping of concrete and grouting, mass concreting (roller compacted concrete), ready mixed concrete.

Various methods of placing and handling concrete, Accelerated curing, hot and cold weather concreting, under water concreting, pre-stressing.

Steel and composites construction methods; Fabrication and erection of structures including heavy structures, Prefab construction, industrialized construction, Modular coordination.

Special construction methods, Construction in Marine environments, high rise construction, Bridge construction including segmental construction.

Incremental construction and push launching techniques, River valley projects.

**Text Books:**


**Reference Books:**

2. “Guide for Concrete Formwork”, American Concrete Institute. Box No 19150, Detroit, Michigan-48219.
Course Outcome: At the end of the course, the students will be able to:

CO1. prepare balance sheet of construction accounting
CO2. choose best alternatives for financial investments and assess financial health of organization in a given environment
CO3. explain the depreciation, taxation and inflation of any construction project
CO4. explain the cost elements associated with the contract bidding and tendering
CO5. understand capital budgeting and working capital management parameters, risks, financial ratios, international finance.

Pre-requisite: Engineering Economics (HS-2002)

Construction accounting, Profit & Loss, Balance sheet, Income statement, Ratio analysis, Depreciation and amortization, Engineering economics, time value of money, discounted cash flow, NPV, ROR, PI, comparison, incremental rate of return, benefit-cost analysis, replacement analysis, break even analysis, risks and uncertainty.

Management decision in capital budgeting, taxation and inflation.

Work pricing, cost elements of contract bidding and award, revision due to unforeseen causes, escalation. Turnkey activities, project appraisal and project yield, working capital management finance. International finance. Budgeting and budgetary control, Performance budgeting appraisal through financial statements. Practical problems and case studies, project cash flow.

Text Books:

Reference Books:
6. "Industrial Engg and Management" by Dr. O.P. Khanna, Khanna Publisher - 2008.

Course Outcome: At the end of the course, the students will be able to:

CO1. determine the prestressing force required in beam for a prestressing systems
CO2. compute losses and deflections of prestressed concrete members
CO3. compute Flexural Strength & Torsional Resistance of Prestressed Concrete Members
CO4. design End Blocks of a post tensioned prestressed concrete member
CO5. design continuous prestressed concrete beams
CO6. design prestressed concrete pipes, mast and railway sleepers.

**Pre-requisites: Structural Analysis-I (CE-2004), Design of Concrete Structures-I (CE-2018)**

Different systems of prestressing, Characteristics of concrete and steel, Other suitable materials, Losses in prestress.

Analysis and design of section for flexure, shear and torsion. Design of compressive member. Limit state design as per IS code. Introduction to Partial prestressing.

Stress distribution in end-block of post tensioned section: Magnel’s method, Guyen’s method, Rowe’s method and IS code method.

Deflection of prestressed structures- short term as well as long term deflections of uncracked and cracked members.

Indeterminate structures- Principles of design of prismatic continuous beams of two and three equal, unequal spans with variable moments of inertia.

Composite construction of prestressed and in-situ concrete.

Design of special structures- Circular tanks, Pipes, Mast, and Railway sleepers.

**Text & Reference Book**

1. “Prestressed Concrete”, by N. Krishna Raju, TMH, New Delhi.

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**CE 6106 CONSTRUCTION METHODS & EQUIPMENTS Cr-3**

**Course Outcome:** At the end of the course, the students will be able to:

CO1. prepare owning and operating cost (rate analysis) of any construction equipment.
CO2. select appropriate construction equipments for different purpose and environments.
CO3. explain the output/ production of equipments.

**Pre-requisite: Construction Planning and Management (CE-3013)**

**Construction Equipments:**
Factors affecting selection of equipment, Owning and Operating Cost.

**Construction Equipment fundamentals:**
Analysis of production output and costs of Excavating Equipments, Characteristics and performances of equipment for Earth moving.

Deep excavation support systems:
Diaphragm wall, sheet piling, secant pile, contiguous pile, strutting, ground anchors.

Text Book:

Reference Books:
4. “Heavy Construction”, by Vazirani & Chandolu, Khanna Publisher Delhi.

CE 6134 PROJECT QUALITY AND SAFETY MANAGEMENT Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. identify different techniques of quality control and select the appropriate one for given conditions.
CO2. explain safety and various parameters of safety construction.
CO3. manage accident/injuries during construction according to safety standards.

Pre-requisite: Nil

Introduction to quality planning and control of quality during design of structures, Quantitative techniques in quality control, Quality assurance during construction.

Inspection of materials and machinery in process inspection and test, Preparation of quality manuals, check list and inspection report, Establishing quality assurance system.

Quality standards/ codes in design and construction, Concept and philosophy of total quality management (TQM), Training in quality and quality management systems (ISO-9000).

Concept of safety, Factors affecting safety, Physiological, Psychological and Technological, Planning for safety provisions, Structural safety, Safety consideration during construction, demolition and during use of equipment.

Management of accidents/ injuries and provision of first aid, Provisional aspect of safety, Site management with regard to safety recommendations.

Training for safety awareness and implementation, Formulation of safety manuals, safety legislation, standards/ codes with regard to construction, Quality vs. Safety. Case studies.
Text book:


References Books:


CE 6136 BUILDING SERVICES PLANNING Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. explain urban planning.
CO2. explain Functional planning of buildings.
CO3. determine Fire rating of building construction.
CO4. prepare the layout plan of lift & escalator in building as per fire safety rules.

Pre-requisite: Building Drawing (CE-2081)

Components of urban forms and their planning.
Concepts of neighborhood unit, Street system and layout in a neighborhood, Functional planning of buildings.
Optimization of space; Spatial Synthesis graphical techniques, heuristic procedures, formulation of linear and non-linear optimization problem.
Space requirements and relationships for typical buildings, like residential offices, hospitals, etc. Standard fire, fire resistance.
Classification of buildings, means of escape, alarms, Engineering services in a building as a systems, Lifts, escalators, cold and hot water systems, waster water systems, and electrical systems.

Text Book:


Reference Books:

Course Outcome: At the end of the course, the students will be able to:

CO1. understand different structural strengthening and retrofitting methods of columns, beams, walls, footings and slabs, piers of concrete structures
CO2. understand specialized repair methods of structures
CO3. understand retrofitting by composite materials
CO4. understand seismic retrofitting and post-repair maintenance of structures

Pre-requisite: Nil

Introduction:
Need for strengthening due to various reasons such as ageing, natural calamities, increase of load, change of function and design, construction errors.

Structural Strengthening:
Strengthening and retrofitting of columns, beams, walls, footings and slabs, piers of concrete structures by jacketing, external post-tensioning, replacing or adding reinforcement, plate bonding, textile reinforced concrete.

Specialized Repairs:
Electro chemical repair using re-alkalization and chloride extraction techniques, Specialized repairs for chemical disruption, fire, marine exposure etc, Repair of damaged structures of water retaining structures, hydraulic structures, Pavements and Runways, Tunnels, Bridges, Piers and Flyovers, Parking Garages, Underwater repair, Masonry Repair, Repair and Restoration of Heritage Structures

Retrofitting by composite materials:

Seismic Retrofitting:
Seismic strengthening of existing RC structures, Use of FRP for retrofitting of damaged structures.

Post-Repair Maintenance of Structures:
Protection & Maintenance schedule against environmental distress to all those structures. Special cares in repair and rehabilitation of heritage structures

Text & Reference Book:
1. “Concrete Repair and Maintenance”, Peter H. Emmons & Gajanan M. Sabnis, Galgotia Publication.
CE 6142 CONTRACT LAWS & REGULATIONS Cr-3

Course Outcome: At the end of the course, the students will be able to:

- CO1. perform estimate and costing of any civil work
- CO2. understand tendering & contractual procedures
- CO3. understand arbitration and conciliation
- CO4. understand claim settlement and dispute resolution

Pre-requisite: Nil

Project cost estimation, rate analysis, overhead charges.

Bidding models and bidding strategies, Qualification of bidders, Owner's and contractor's estimate.

Tendering and contractual procedures.


Text & Reference Book:

1. "Construction Equipment and Job Planning" by S. V. Deodhar, Khanna Publisher, Delhi

CE 6206 FINITE ELEMENT METHOD Cr-3

Course Outcome: At the end of the course, the students will be able to:

- CO1. understand the fundamentals of finite element method
- CO2. derive and know various types of finite elements and its application
- CO3. analyze various structures using finite element method
- CO4. apply finite element method to structural and geotechnical engineering
- CO5. develop computer program for finite elements
- CO6. use commercial finite element software for engineering solutions.

Fundamentals of finite element:
Equations of Equilibrium, Elements, Degrees of freedom, Stiffness matrices, Different steps involved in finite element analysis, Finite Element modeling, Shape functions, Strain displacement relations, Constitutive relations, Boundary Conditions, Loading type, Solution technique, Convergence criteria.

Formulation Techniques:
Variation methods, Galerkin method, Weighted residual methods.

One Dimensional Element: Truss element and beam element

Two dimensional Elements :
Constant strain triangular element and rectangular element.

Three dimensional Element :
Tetrahedral element.

Text Books:-

Reference books:

CE 6235 SOIL-STRUCTURE INTERACTION Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. understand various theories applicable to soil structure interaction
CO2. determine Contact pressure and settlement under foundations
CO3. determine earth pressure on different retaining structures
CO4. understand the theories and application methods for modelling soil structure interaction for various typical field situations.

Pre-requisites: Geotechnical Engineering-I (CE-3011), Geotechnical Engineering-II (CE-3014)

Soil-Foundation Interaction:
Introduction to soil-foundation interaction problems, Soil behaviour, Foundation behaviour, Interface behaviour, Scope of soil foundation interaction analysis, soil response models, Winkler, Elastic continuum, Two parameter elastic models, Elastic plastic behaviour, Time dependent behavior.

Beam on Elastic Foundation:
Elastic Analysis of Pile:

Elastic analysis of single pile, Theoretical solutions for settlement and load distributions, Analysis of pile group, Interaction analysis, Load distribution in groups with rigid cap. Load deflection prediction for laterally loaded piles, Subgrade reaction and elastic analysis

Text Book:

2. "Elastic Analysis of Soil-Foundation Interaction" by Selvadurai, A. P. S Elsevier

Reference Books:

2. "Design Analysis of Beams, Circular Plates and Cylindrical Tanks on Elastic Foundation" by E.S.Melersk.
3. "Beams of Elastic Foundation” by M.Hetenyi, University Michigan Press 1946

CE 6238 COMPOSITE STRUCTURES Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1: know the classifications of composite material and its applications.
CO2: know the method of manufacturing processes of composite
CO3: know macro and micro-mechanics of composite material.
CO4: learn the failure theories of composite material.
CO5: design a laminate based on the application

Pre-requisites : Civil Engineering Materials & Construction (CE-2007)

Introduction to composite materials: .
Definition,Isotropy, Orthotropy and Anisotropy, Lamina, Laminate, Advantages and limitations, Classification and characteristics of Composite materials, Mechanical behaviour of composite material, Manufacture of laminated fiber reinforced composite material

Macromechanical behavior of lamina:
Stress strain relations for anisotropic materials, Stress strain relations for a lamina of arbitrary orientation, Interlaminar stresses.

Micromechanical behaviour of lamina: .
Volume and mass fraction, Density and void content, Evaluation of elastic moduli: Mechanics of material approach to stiffness

Macromechanical behavior of laminate:
Classical lamination theory: Lamina stress-strain behavior, Stress and strain variation in laminate, Resultant laminate forces and moments, Special cases of laminate stiffnesses.

Strength criterion for an orthotropic lamina: .
Maximum stress failure criterion, Maximum strain failure criterion, Tsai-Hill failure criterion, Tsai-Wu failure criterion, Hoffman failure criterion

Bending of laminated plate:
Assumptions, Equilibrium equation, Solution technique.

Introduction to the design of composite structures:
Design requirements, Material selection and Con figuration selection.
Text Books:

Reference Books:

CE 6239 ADVANCED FOUNDATION ENGINEERING Cr-3

Course outcome: At the end of the course, the students will be able to:

CO1: determine the soil parameters for foundations subjected to dynamic loads and its control measures
CO2: assess the liquefaction potential of soil strata under earthquake condition
CO3: identify the swelling potential of cohesive soil and its effect on the building, measures to prevent the swelling using various ground improvement and design methods
CO4: identify the ground improvement techniques to make the soil suitable for the construction of structures.

Pre-requisites: Geotechnical Engineering-I (CE-3011) and Geotechnical Engineering-II (CE-3014)

Machine Foundations:

Liquefaction of foundation soils under earthquakes:
Introduction, Liquefaction Phenomenon, Effect of Liquefaction on Build environment, Factors Affecting Liquefaction, Assessment of Susceptibility of a Soil to Liquefaction, Prevention of Liquefaction.

Foundations on Expansive soils:

Foundation Soil Improvement:
Stabilization of soil with granular skeleton, chemical, cement, lime, ash, slag & bitumen, Thermal stabilization, Electrical stabilization, Vibration methods of ground improvement, Drainage methods of ground improvement, Pre-compression and vertical drains, Grouting and injection, Reinforced earth, Use of geotextile & modern materials Ground anchors & soil nails

Text Books:

Reference Books:
CE 6241  
**DESIGN OF BRIDGES**  
Cr-3

**Course Outcome:** At the end of the course, the students will be able to:

**CO1:** select appropriate site and design of slab, beam-slab, plate girder and composite Bridge, sub-structure for bridges, bearings, foundations for bridges.

**CO2:** explain the concept of bridge vibration.

**Pre-requisites:** Structural Analysis-I (CE-2004), Structural Analysis-II (CE-3001), Design of Concrete Structures-I (CE-2018), Design of Steel Structure (CE-3007)

Introduction, historical review, engineering and aesthetic requirements in bridge design. Introduction to bridge codes. Economic evaluation of a bridge project, Loading standard, IRC specification, Impact factor.

Site investigation and planning: Scour - factors affecting and evaluation.

**Bridge foundations:**
Open, pile, well and caisson. Piers, abutments and approach structures-reinforced earth structure; Superstructure - analysis and design of right, skew and curved slabs.

**Girder bridges:**

Various types of bearings and their design.

Pre-stressed concrete bridges and steel bridges Fabrication, Launching & creation. Design and construction of construction joints (use of relevant codes of practice are permitted in the examination).

**Text & Reference Books:**

4. “Design of Bridges”, N. Krishna Raju, Oxford and IBH.
**Course Outcome:** At the end of the course, the students will be able to:

CO1: analyze uniform flow calculations in open channels
CO2: solve problems on dynamics of gradually and spatially varied flow
CO3: analyze rapidly varied flow calculations in open channels
CO4: determine the parameters of unsteady flow.


Uniform flow, determination of roughness coefficients and the factors affecting the roughness, computation of uniform flow, flood discharge, determination of normal depth and velocity, flow in composite roughness; Design of channels for uniform flow in non-erodible and erodible with grassed channels.

Dynamics of Gradually varied flow and classification of flow profile, methods of computation, Dynamics of spatially varied flow - analysis of flow profile and computation by method of numerical integration. Rapidly varied flow, classification, flow over spillway, Hydraulic Jump, types with characteristics of jump, the surface profile and location of the jump, jumps as energy decapitator, rapidly varied flow through non-prismatic channels.

Unsteady flow, dynamics of gradually varied unsteady flow, solution of unsteady flow equations, rapidly varied unsteady flow, positive and negative surges, flood routing, principle and methods of flood routing.

**Text Books:**


**Reference Books:**


**Course Outcome:** At the end of the course, the students will be able to:

CO1. conduct the satellite based remote sensing survey
CO2. create thematic maps and its integration for a functional use like hydrological data, crop pattern study
CO3. develop confidence of use on the multi-spectral electromagnetic spectrum
CO4. understand and use the various raster and vector data for strategic GIS applications.

**Pre-requisite:** Nil

**Introduction to Remote Sensing system:**
Data acquisition and processing, Applications, Multi concept in remote sensing.

**Physical Basis of Remote Sensing:**
EMR nature, definition, nomenclature and radiation laws. Interaction in atmosphere-nature, its effects in various
Wave-length regions, atmospheric windows; Interaction at ground surface soils Geometric basis of interaction.

**Resolution:**
Spectral, spatial, radiometric and temporal; IFOV, FOV, GRE; geometric characteristics of scanners, V/H and S/N ratio; Data products from various air and space borne sensors-aerial photographs, LiDAR, Landsat, SPOT, IRS, ERS, IKONOS etc.

**Image Interpretation:**
Elements of interpretation; digital image processing and interpretation, Field verification.

**Geographical Information systems:**
Components of GIS-data acquisition, spatial and attribute data, pre-processing, storage and management; data structures raster and vector data.

**GIS analysis functions:**
Errors and corrections; data presentation and generation of thematic maps.

**Text books:**

**Reference Books:**

**CE 6332 RIVER ENGINEERING & SEDIMENT TRANSPORT**

**Course Outcome:** At the end of the course, the students will be able to:

- CO1. learn about river morphology in respect of engineering, sediment and river regulation systems
- CO2. understand analytical and numerical modeling of river morphology and sediment transport
- CO3. learn about design of stable channels and river engineering works
- CO4. understand sediment transport measurement, sedimentation in reservoirs and its computational methods

**Pre-requisites:** Water Resources Engineering-I (CE-3009), Water Resources Engineering-II (CE-3010)


Sediment Sources and Sediment Characteristics: Initiation of Motion of Sediment Transport, Mode of Sediment Transport, Estimation of Sediment Transport and Alluvial Roughness: (Flow Regimes and Bed Forms, Sediment Transport Formulas for Bed Load and Total Load, Suspended Load Formula, Alluvial Channel Roughness.)


Sedimentation in Reservoirs: Distribution of Sediment Deposition in Reservoirs, Erosion of Sediment Deposits in Reservoirs, Computation of Sedimentation Volume in Reservoirs, Sedimentation Distribution in Reservoirs.

Text Book:


CE 6339 ADVANCED IRRIGATION ENGINEERING Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1: understand and identify different types & methods of irrigation
CO2: design different surface & sub-surface irrigation methods
CO3: use different types of flow measurement instruments
CO4: design drainage system.

Pre-requisite: Water Resources Engineering-I (CE-3009)

Introduction, objectives of irrigation, type of irrigation and suitability, selection of irrigation method

Irrigation requirement, water balance, soil water relationships, water storage zone, Flow of moisture through root zone, soil physical and chemical properties.

Crop evaporative and drainage requirements, irrigation efficiency and uniformity, Surface irrigation systems, types of surface systems, basin irrigation, border irrigation, furrow irrigation, sprinkler irrigation.

Field measurement techniques, flow measurement, flumes, weirs, irrigation events, advance, wetting, depletion and recession phases.

Infiltration, infiltrometer, ponding methods, soil water, tensiometers, neutron probe, time domain reflectometer, evapotranspiration, crop coefficient, leaf area index, evapotranspiration estimation.

Fundamentals of surface irrigation hydraulics, continuity equation, momentum equation, Hydrodynamic model, zero inertia model and kinematic wave model.

Drainage principles, need for drainage, steady state equations, Hooghoudt, Kirkham, Dagan and Ernst equations. Salt balance, water and salt balance of the root zone, salt equilibrium equation and leaching requirement, leaching efficiency.
CE 6342     WATER POWER ENGINEERING                 Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1: design different components of hydroelectric scheme effectively and economically

CO2: explain the construction process of hydropower development project


Concept of water power Engineering, Different heads such as Gross head, Effective head, Design head, rated head, critical head, classifications of water power plants based on hydraulic characteristics, topography, head, capacity of plant, load etc. Major hydrotlectric schemes in India.

Planning a site selection of hydropower projects according to availability of Quantity and head of water, estimating of power potential using Mass curve and flow duration curves Economics of water power plants load factor, capacity factor, load curve, effect of pondage on flow duration curve. Estimation of unit cost of hydro power and comparison with unit cost of stream power station, General planning of hydropower projects.

Various types of intake structures. Penstocks of steel pipes economic diameter, number of penstocks wall thickness of steel penstocks, shell theory of design, welded and riveted steel pipes, Accessories of penstocks. Expansion joints anchor blocks and pipe supports. Tunnels. Dimensions and shape economic size of tunnel Tunnel lining.

Theory of water hammer, Arithmetic integration and graphical method of analysis, surge tanks and types of surge tanks theory of simple surge tank and design, Mathematical treatment f water surface oscillations including friction. Pressure relief valves stability of surge tank. Thoma formula, Balancing reservoir and fore bays Pressure.

Selection of type of turbines according to head & specific speed, various types casing of turbines. Determination of their shapes, main relative dimension of runner. Draft tube, its functions, draft tube theory. In take conduits, Preliminary power house dimensioning, general arrangement of power house.

Text Books


Reference Books:


CE 6431     SOIL EXPLORATION AND FIELD TEST                 Cr-3
**Course Outcome:** At the end of the course, the students will be able to:

CO1: identify sources of subsurface information  
CO2: report relevant field reconnaissance information for soil investigation  
CO3: perform all the relevant laboratory and field test on soil  
CO4: prepare log soil samples and prepare bore-hole logs for civil engineering projects.

**Pre-requisites: Geotechnical Engineering-I (CE-3011), Geotechnical Engineering-II (CE-3014)**

**General principles of exploration:**  
Methods of exploration; Boring: Different types of borings.

**Sampling methods:**  
Surface sampling, sampling from boreholes and core boring in soils; Boring and sampling records.  

**Soil profile:**  
Pore pressure measuring devices for laboratory and field use; Earth pressure cells.

**Vibration-meters:**  
Pickups and generators for vibration study of machine foundations; Load measuring devices; Settlement measurements in field.

**Text & Reference Book**

**CE 6436  
TUNNEL ENGINEERING  
Cr-3**

**Course Outcome:** At the end of the course, the students will be able to:

CO1: investigate tunnel work  
CO2: design tunnels  
CO3: understand and decide tunnel amenities

**Pre-requisites: Geotechnical Engineering-I (CE-3011), Geotechnical Engineering-II (CE-3014), Design of Concrete Structures-I (CE-2018), Design of Concrete Structures-II (CE-3006)**

Site investigations, Geotechnical Considerations of tunneling.  
Design of Tunnels.  
Construction & Excavation methods, soft ground tunnels, Rock tunnels.  
Micro tunneling techniques, Tunnel support design.  
Ventilation of tunnels, tunnel utilities, safety aspects.

**Text & Reference Book**

**CE 6437  
GEOSYNTHETICS & REINFORCED EARTH STRUCTURES  
Cr-3**
Course Outcome: At the end of the course, the students will be able to:

CO1: develop an understanding of the fundamental concepts that govern the behavior of soils reinforced with geosynthetics
CO2: provide design guidance for allowable tensile strength, vertical reinforcement spacing, length of reinforcement, drainage, seismic loading issues, and different facing systems
CO3: design geosynthetic-reinforced steep slopes and walls.

Pre-requisites: Geotechnical Engineering-I (CE-3011), Geotechnical Engineering-II (CE-3014)

Historical background; Principles, concepts and mechanism of reinforced earth.
Design consideration for reinforced earth and reinforced soil structures.
Geosynthetics-their composition, manufacture, properties, functions, testing and applications in reinforced earth structures.
Design of reinforced soil structures like retaining walls, embankments, foundation beds etc.; Designing for Separation, Filtration, Drainage and Roadway Applications; Designing for Landfill Liners and Barrier Applications; Case histories of applications.

Text Books:

Reference Books:
Koerner, R.M, "Designing with Geosynthetics", Prentice Hall, 1993

CE 6446 GEOTECHNICAL EARTHQUAKE ENGINEERING Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1: understand seismic design concepts and current practices for shallow and deep foundations, slopes and retaining walls to enable them to plan and direct the construction activity appropriately
CO2: understand the soil dynamic testing procedure and methodology of seismic design
CO3: understand design methodology and the interpretation in the seismic codes while designing foundations, slopes and retaining walls.

Pre-requisites: Geotechnical Engineering-I (CE-3011), Geotechnical Engineering-II (CE-3014)
Introduction to Geotechnical Earthquake Engineering. Seismology and Earthquakes, Strong Ground Motion: Parameters and Estimation.

Seismic Hazard Analysis: Deterministic and Probabilistic Analyses, Wave Propagation: 1D and 3D

Dynamic Soil Properties: Lab and Field Determination. Ground Response Analysis. Local Site Effects and Design Ground Motions.

Liquefaction;

Performance-based Earthquake Geotechnics – An Introduction, Usage of Softwares.

Text Books:


Reference Books:

COMPUTER SCIENCE

&

ENGINEERING
Program Educational Objectives (PEOs)

1. To lead a successful career in industry or pursue higher studies or entrepreneurial endeavors.
2. To offer techno-commercially feasible and socially acceptable solutions to real life engineering problems.
3. To demonstrate effective communication skill, professional attitude and a desire to learn.

Program Outcomes (POs)

a) Ability to apply knowledge of mathematics, science, engineering, computing to solve complex problems.
b) Ability to identify, analyze and solve complex software and hardware engineering problems.
c) Ability to design, implement and evaluate various computer based systems to meet the needs of the society by considering public health, safety, cultural, societal and environmental issues.
d) Ability to design & conduct experiments and interpret data.
e) Ability to use techniques, skills and modern engineering and IT tools to various relevant engineering practices.
f) Ability to examine and understand the impact of societal, health, safety, legal and cultural concerns at local, national and international levels relevant to engineering practices.
g) Ability to recognize the sustainability and environmental impact of the computer-based engineering solutions.
h) Ability to follow prescribed norms, responsibilities and ethics in engineering practices.
i) Ability to work effectively as an individual and in a team.
j) Ability to communicate effectively through oral, written and pictorial means with engineering community and the society at large.
k) Ability to recognize the need for and to engage in life-long learning.
l) Ability to understand and apply engineering & management principles in executing projects.
Course Outcome: At the end of the course, the students will be able to:

CO1. Understand the basic terminology used in C programming.
CO2. Write, compile and debug programs written in C.
CO3. Use different data types in a C program.
CO4. Design programs using decision structures, loops and functions.
CO5. Explain the difference between call by value and call by reference.
CO6. Understand the dynamics of memory by using pointers.
CO7. Create/update basic data files.

Prerequisite: NIL

Introduction to Computer and Programming:

Basic concepts of computer organization, CPU, Memory, I/O devices, Number Systems, Evolution of programming languages, structured programming, Compilation process, source code, object code, executable code, Operating systems, interpreters, linkers, loaders, Algorithms, flow charts, pseudo-code

Program Constructs:

Character set, Identifiers, Keywords, Data Types, Constant and Variables, Operators: Precedence and associativity, Expressions, Statements, Input and Output functions, Control structures: Branching & Looping.

Functions:

Library and User defined functions, Formal and Actual parameters, function prototypes, Parameter passing: Call-by-value, Call-by-reference, Recursion, Storage Classes.

Arrays and Strings:

One dimensional Array, Multidimensional Array and their applications, String Manipulation.

Pointers:

Pointer variable, Pointer Arithmetic, passing parameters by reference, pointer to pointer, pointers to functions, dynamic memory allocation.

Structures, Unions:

Structures, Unions, pointer to structure & pointer to union, linked list.

File Handling:

Declaration of file pointer, opening and closing files, Working with text and binary files.

Additional Features:

Command line arguments, bit wise operators, enumerated data types, type casting, macros, Preprocessor directives.

Text Books:

Reference Books:


CS-2001 DATA STRUCTURES & ALGORITHMS Cr-4

Course Outcome: At the end of the course, the students will be able to:

CO1. Understand the concepts of data structure, data type and array data structure.
CO2. Analyze algorithms and determine their time complexity.
CO3. Implement linked list data structure to solve various problems.
CO4. Understand and apply various data structure such as stacks, queues, trees and graphs to solve various computing problems using C-programming language.
CO5. Implement and know when to apply standard algorithms for searching and sorting.
CO6. Effectively choose the data structure that efficiently model the information in a problem.

Prerequisite: Programming in C (CS-1001)

Introduction
Structures and Unions, Pointers, Dynamic Memory Allocation, Algorithm Specification, Space and Time Complexity

Arrays
Arrays, Abstract Data Type, Dynamically Allocated Arrays, Polynomials, Two-dimensional Array, Address Calculation, Matrix Addition and Multiplication, Sparse Matrix

Linked List
Singly Linked Lists and Chains, Representing Chains in C, Polynomials, Sparse Matrix, Doubly Linked Lists, Circular & Header Linked lists,

Stacks and Queues
Stacks, Stacks using Dynamic Arrays and Linked List, Queues, Queue using Linked List, Circular Queues using Dynamic Arrays, Evaluation of Expressions, Priority Queue, Dequeue

Trees
Introduction, Binary Trees, Binary Tree Traversals, Threaded Binary Trees, Binary Search Trees, AVL Trees, m-way Search Trees, B-Trees, B+-Trees, Tree Operation, Forests,

Graphs
The Graph ADT, Graph Representation, Graph Operation-DFS, BFS

Sorting:
Insertion Sort, Quick Sort, Merge Sort, Heap Sort, Bubble Sort, Selection sort, Radix sort
Searching:
Linear Search, Binary Search, Static Hashing, Dynamic Hashing

Text Books:
1. Data Structures, Schaum’s OutLines, Seymour Lipschutz, TATA McGRAW HILL

Reference Books:

CS-2004 DATABASE MANAGEMENT SYSTEMS Cr-4

Course Outcome: At the end of the course, the students will be able to:

CO1. Master the basic concepts and understand the applications of database systems.
CO2. Construct an Entity-Relationship (E-R) model from specifications and to perform the transformation of the conceptual model into corresponding logical data structures.
CO3. Understand the basic database storage structures and access techniques.
CO4. Distinguish between good and bad database design, apply data normalization principles, and be aware of the impact of data redundancy on database integrity and maintainability.
CO5. Construct queries and maintain a simple database using SQL.
CO6. Apply database transaction management and database recovery.

Prerequisite: NIL

Introduction
General introduction to database systems; Database - DBMS Definition, approaches to building a database, data models, three-schema architecture of a database, challenges in building a DBMS, various components of a DBMS.

Relational Data Model:
Concept of relations and its characteristics, schema-instance, integrity constraints, E/R Model - Conceptual data modelling - motivation, entities, entity types, various types of attributes, relationships, relationship types, E/R diagram notation,

Extended E/R Model, Converting the database specification in E/R and Extended E/R notation to the relational schema. Data Storage and Indexes - file organizations, primary, secondary index structures, hash-based indexing, dynamic hashing techniques, multi-level indexes, B+ trees.

Relational Query Language:
Relational Algebra operators: selection, projection, cross product, various types of joins, division, example queries, tuple relation calculus, domain relational calculus. Introduction to SQL, Data definition in SQL, Table, Key and Foreign key definitions, Data manipulation in SQL. Nested queries, Notion of aggregation, PL/SQL.
Relational Database Design:

Dependencies and Normal forms - Importance of a good schema design, problems encountered with bad schema designs, motivation for normal forms, dependency theory - functional dependencies, Armstrong's axioms for FD's, closure of a set of FD's, minimal covers, definitions of 1NF, 2NF, 3NF and BCNF, decompositions and desirable properties of them, algorithms for 3NF and BCNF normalization, multi-valued dependencies and 4NF, join dependencies and definition of 5NF.

Transaction Processing:

Concepts of transaction processing, ACID properties, concurrency control, locking based protocols, recovery and logging methods.

Text Books:

1. Database System Concepts by Silberschatz, Korth & Sudarshan (McGraw-Hill Education)
2. Fundamentals of Database System By Elmasari & Navathe- Pearson Education

Reference Book

1. Database Management Systems by RamaKrishna & Gehrke (McGraw-Hill Education)
2. Fundamentals of Relational Database management Systems by Sumathi & Esakkirajan, Springer

CS-2006 COMPUTER ORGANIZATION AND ARCHITECTURE Cr- 4

Course Outcome: At the end of the course, the students will be able to:

CO1. Understand how computer hardware has evolved to meet the needs of multiprocessing systems, Instruction Set Architecture: Instruction format, types, various addressing modes.
CO2. Understand the basic components and design of the CPU: the ALU and control unit.
CO3. Understand the memory organization: SRAM, DRAM, concepts on cache memory, Memory Interleaving, Associative memory, Virtual memory organization.

Prerequisite : NIL

Basic Structure of Computers:


Basic Processing Unit:

Arithmetic:
Design of fast adders, Multiplication of Positive Numbers, Signed Operand Multiplication, Fast Multiplication, Integer Division, Floating-point Numbers and Operations.

Memory System:
Basic Concepts, Semiconductor RAM Memories, Read Only Memories, Speed, Size, and Cost, memory module design, Cache Memories – Mapping Functions, Replacement Algorithms, Memory interleaving, Memory Performance Considerations Virtual Memories.

Input/Output Organization:
Basic Input and Output Operations, Accessing I/O Devices, Interrupts – Interrupt Hardware, Enabling and Disabling Interrupts, Handling Multiple Devices, Controlling Device Requests, Exceptions, Direct Memory Access. Interface Circuits, Standard I/O Interfaces – PCI Bus, SCSI Bus, USB, Flynn’s Classification, RISC vs CISC

Text Books:

CS-2008           DESIGN & ANALYSIS OF ALGORITHMS                  Cr-4

Course Outcome: At the end of the course, the students will be able to:

CO1. Use different computational models, order notation and various complexity measures (e.g., running time, disk space) to analyze the complexity/performance of different algorithms.
CO2. Describe, apply and analyze the complexity of certain divide and conquer, greedy, and dynamic programming algorithms.
CO3. Understand the techniques used for designing fundamental graph theory algorithms and apply them to solve other related problems.
CO4. Identify and analyze criteria and specifications appropriate to new problems, and choose the appropriate algorithmic design technique for their solution.
CO5. Understand the classes P, NP, and NP-Complete and be able to prove that a certain problem is NP-Complete.

Prerequisite: Data Structure & Algorithms (CS-2001)

Introduction:
Algorithm Design paradigms- motivation, concept of algorithmic efficiency, run time analysis of algorithms, Asymptotic Notations.

Divide and conquer:
Structure of divide-and-conquer algorithms, max-min problem, Binary search, quick sort, randomized quick sort, merge sort, Analysis of divide and conquer run time recurrence relations.
Greedy Method:
Overview of the greedy paradigm, knapsack problem, Optimal storage on tapes, Job sequencing with deadlines, Activity selection problem, minimum cost spanning tree, Single source shortest path, Huffman’s code.

Dynamic programming:
Overview, difference between dynamic programming and divide and conquer, Applications: 0/1 knapsack, Shortest path in graph, Matrix chain multiplication, Traveling salesman Problem, longest Common subsequence.

Graph searching and Traversal:
Overview, Traversal methods (depth first and breadth first search)

Back tracking:
Overview, 8-queen problem, sum of subset, and Knapsack problem

Brach and bound:
LC searching Bounding, FIFO branch and bound, LC branch and bound application: 0/1 Knapsack problem, Traveling Salesman Problem

Computational Complexity:
Complexity measures, Polynomial Vs non-polynomial time complexity; NP-hard and NP complete classes, examples, Approximation Algorithm for travelling sales person problem.

Text Books:
4. Algorithm Design:Foundation, Analysis&Internet examples By Michael T.Goodrich, Roberto Tamassia , John Wiley & Sons

CS-3002 COMPILER DESIGN Cr 4

Course Outcome: At the end of the course, the students will be able to

CO1. Describe the design of a compiler and the phases of program translation from source code to executable code and the files produced by these phases.
CO2. Explain lexical analysis phase and its underlying formal models such as finite state automata, push-down automata and their connection to language definition through regular expressions and grammars.
CO3. Explain the syntax analysis phase and identify the similarities and differences among various parsing techniques and grammar transformation techniques.
CO4. Formal attributed grammars for specifying the syntax and semantics of programming languages.
CO5. Identify the effectiveness of optimization and explain the differences between machine-dependent and machine-independent translation.
Prerequisite: Programming in C (CS-1001), Object Oriented Programming (IT-1002), Formal Language and Automata (CS-3003)

Overview of Compilation:
Introduction to Compiler, Phases of Compilation, Grouping of Phases.

Lexical Analysis:
Role of Lexical Analyzer, Input Buffering, Specification of Tokens, Finite state machines and regular expressions and their applications to lexical analysis.

Syntax Analysis:
Context-free grammars, Top-down Parsing – Backtracking, LL(1), recursive descent parsing, Predictive parsing, Bottom-up parsing – Shift Reduce parsing, LR and LALR parsing, Error recovery in parsing, handling ambiguous grammar.

Semantic analysis:
Intermediate forms of source Programs – abstract syntax tree, polish notation and three address codes. Attributed grammars, Syntax directed translation, Conversion of popular Programming languages language Constructs into Intermediate code forms, Type checker.

Symbol Tables:
Symbol table format, organization for block structures languages, hashing, tree structures representation of scope information.

Code optimization:
Consideration for Optimization, Scope of Optimization, local optimization, loop optimization, frequency reduction, folding, DAG representation.

Data flow analysis:
Flow graph, data flow equation, global optimization, redundant sub expression elimination, Induction variable elements, Live variable analysis, Copy propagation.

Object code generation:
Object code forms, machine dependent code optimization, register allocation and assignment generic code generation algorithms, DAG for register allocation.

Text Books:

Reference Book
1. lex & yacc – John R. Levine, Tony Mason, Doug Brown, O’reilly
2. Engineering a Compiler, by Cooper & Linda, Elsevier.
Course Outcome: At the end of the course, the students will be able to:

CO1. Apply a number of proof techniques to theorems in language design.
CO2. Present the theory of finite automata, as the first step towards learning advanced topics, such as compiler design.
CO3. Understand the equivalence between Context-Free Grammars and Non-deterministic Pushdown Automata.
CO4. Develop an understanding of computation through Turing Machines.
CO5. Develop a clear understanding of the Chomsky hierarchy for language classes.

Prerequisites: Data Structure & Algorithms (CS-2001) and Discrete Mathematics (MA-2003)

Regular Languages:

Basic Concepts, Deterministic Finite Automata, Non-deterministic Finite Automata, Equivalence of DFA and NFA, Minimization of number of states in a DFA, Regular Expressions, Equivalence of Regular Expressions and Finite State Automata, Closure Properties of Regular Languages, Pumping Lemma for Regular Languages, Myhill-Nerode Theorem, Identification of some non-Regular languages, Decision Problems on Regular Languages, Regular grammars: right linear and left linear grammars, Equivalence of regular languages and regular grammars.

Context-Free Languages:


Turing Machines and other relevant Topics:

Turing Machines, Turing Machines as Language Accepters, Church-Turing Thesis, Models of Turing Machines -- Multiple Tape, Multiple Tracks, Non-determinism, etc., Equivalence of TM Models, Recursive and Recursively Enumerable languages, Chomsky Hierarchy of Formal Languages, Computability and Decidability, Halting Problem, Undecidability of the Halting Problem, Examples of some other undecidable problems.

Text Books:

1. An Introduction to Formal Languages and Automata, Peter Linz, Jones & Bartlett Publishers

Reference Books:

1. Introduction to Automata Theory Languages and Computation, J.E. Hopcroft, R Motwani and J.D. Ullman, Pearson Education.
3. The Theory of Computation, Bernard M. Moret, Pearson Education
5. Theory of Computer Science, K. L. P Mishra and Chandrasekharan, PHI
6. Introduction to Automata Theory, Formal Languages and Computation, Kamala Krithivasan and R. Rama, Pearson Education
Course Outcome: At the end of the course, the students will be able to:

CO1. Understand the concepts of computer graphics H/W
CO2. Analyze algorithms and their implementation
CO3. Understand and apply various multimedia techniques
CO4. Implement and know when to apply multimedia techniques standards for use.

Prerequisites: Programming in C (CS-1001) and Mathematics - 1 (MA-1001)

Introduction:


Two Dimensional Graphics:

Two dimensional output primitives, Different forms of line drawing algorithms, Circle generating algorithms, Ellipse generating algorithm, Filled area primitives.

Two Dimensional Geometric Transformations:

Translation, Scaling, Rotation, Reflection, Shear, Homogeneous coordinates, Composite transformations

Two Dimensional Viewing:

Window to view port transformations, Line clipping: Cohen Sutherland algorithm; Polygon clipping: Sutherland-Hodgeman algorithm, Projections: Parallel and Perspective projections

3D Geometric Transformations:

Translation, Scaling, Rotation in space

Three Dimensional Graphics:


Illumination model and surface rendering:

Basic illumination models, Goraud shading, Phong shading

Color Models:
RGB, CMY and HSV models

Animation.

Text Books:

Reference Books:
Course Outcome: At the end of the course, the students will be able to:

CO1. The main objective of this course is to provide students with an understanding and appreciation of the fundamental issues and tradeoffs involved in the design and evaluation of modern computers.

CO2. Through programming and analysis assignments students will build, in stages, a timing simulator for a simplified out-of-order multiple-issue microprocessor in order to examine the impact of various architectural techniques.

Prerequisite: Computer Organization and Architecture (CS-2006)

Introduction:

Review of basic computer architecture, quantitative techniques in computer design, measuring and reporting performance. CISC and RISC processors.

Pipelining:

Basic concepts, instruction and arithmetic pipeline, data hazards, control hazards, and structural hazards, techniques for handling hazards. Exception handling. Pipeline optimization techniques. Compiler techniques for improving performance.

Hierarchical memory technology:

Inclusion, Coherence and locality properties; Cache memory organizations, Techniques for reducing cache misses; Virtual memory organization, mapping and management techniques, memory replacement policies.

Instruction-level parallelism:

Basic concepts, techniques for increasing ILP, superscalar, super-pipelined and VLIW processor architectures. Array and vector processors.

Multiprocessor architecture:


Text Books:


References Books:

Course Outcome: At the end of the course, the students will be able to:

CO1. Understand the difference between different types of modern operating systems, virtual machines and their structure of implementation and applications.
CO2. Understand the difference between process & thread, issues of scheduling of user-level processes / threads and their issues & use of locks, semaphores, monitors for synchronizing multiprogramming with multithreaded systems and implement them in multithreaded programs.
CO3. Understand the concepts of deadlock in operating systems and how they can be managed / avoided and implement them in multiprogramming system.
CO4. Understand the design and management concepts along with issues and challenges of main memory, virtual memory and file system.
CO5. Understand the types of I/O management, disk scheduling, protection and security problems faced by operating systems and how to minimize these problems.

Prerequisite: Data Structure & Algorithms (CS-2001)

Introduction:

Operating system and functions, Evolution of operating system, Batch, Interactive, Time Sharing, Real Time System, Multi-Threading System.

Operating System Structure:

System Components, System structure, Operating System Services.

Concurrent Processes:


CPU Scheduling:

Scheduling Concept, Performance Criteria Scheduling Algorithm, Evolution, Multiprocessor Scheduling.

Deadlock:

System Model, Deadlock Characterization, Prevention, Avoidance and Detection, Recovery from deadlock combined approach.

Memory Management:

Resident monitor, Multiprogramming with fixed partition, Multiprogramming with variable partition, Multiple base register, Paging, Segmentation, Virtual memory concept, Demand paging, Performance, Page replacement algorithms, Allocation of frames, Thrashing.

I/O Management & Disk Scheduling:

I/O devices and organization of I/O function, I/O Buffering, DISK I/O, Operating System Design Issues.
File System:

Operating system Protection & Security:
Introduction to distributed operating system, Case Studies - The UNIX operating system

Text Books:

Reference Book
2. An introduction to operating system, Dietel, Addition Wesley
3. Operating system design and implementation, Tannenbaum, PHI

CS-3022 PARALLEL AND DISTRIBUTED COMPUTING Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. To learn how to design parallel programs and how to evaluate their execution.
CO2. To understand the characteristics, the benefits and the limitations of parallel systems and distributed infrastructures.
CO3. To expose students to writing code in different parallel programming environments
CO4. Build experience with interdisciplinary teamwork

Prerequisites: Operating Systems (CS-3009)& High Performance Computer Architecture(CS-3007)

Introduction to parallel computing:
Motivation, scope and issues.

Parallel Programming Platforms:

Principles of parallel Algorithm Design:
Preliminaries, Decomposition Techniques, Characteristics of Tasks and Interactions, Mapping Techniques for load Balancing, Methods for containing interaction overheads, Parallel Algorithm Models.

Basic Communication Operations:
One-to-All Broadcast and All-to-One Reduction, All-to-All Broadcast and reduction All-Reduce and Prefix sum operations, scatter and Gather, All-to-All personalized communication, circular shift, improving the speed of some communication operation.

Analytical Modeling of Parallel Programs:
Performance Metrics for Parallel systems, Effect of Granularity of Performance, scalability of parallel system, Minimum Execution Time and Minimum Cost-optimal execution Time, Asymptotic Analysis of parallel Programs, other scalability Metrics.
Programming Using the message passing Paradigm:

Principle of Message – Passing Programming, Send and receive Operations, The message passing Interface, Topologies and Embedding, Overlapping communication with computation, collective communication and computation Operations, Groups and Communicators. Dense Matrix Algorithm

Sorting:
Bubble Sort and its variants, Quick Sort.

Graph Algorithms:
Minimum Spanning Tree (Prim’s Algorithm) shortest path (Dijkstra’s Algorithm)

Text Books:

Reference Books:
2. Designing and Building Parallel Programs, I.Foster. Addison-Wesley.
3. Parallel programming in c with MPI and Open MP, M.J. Quinn, TMH.

CS-3026 DISTRIBUTED DATABASE SYSTEMS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. To know the design and system issues related to distributed database systems.
CO2. To learn the usage of different design strategies for distributed databases.
CO3. To study and implement the query processing techniques and algorithms as well as transaction management and concurrency control concepts used in such systems and in real world applications.
CO4. To know the Design and implementation issues related to multi-database systems (MDBS) and applications as well.

Prerequisite: Data Base Management Systems (CS-2004)

Introduction:
Overview of DDS, Features of Distributed versus Centralized Databases, why Distributed Databases Overview of FQL (of RDBMS) and DDBMS.

Levels of Distribution Transparency:

Distributed Databases Design:
Distributed Design Issues, Fragmentation, and Allocation of fragments.

Translation of Global Queries to Fragment Queries:
Equivalence Transformations for queries, Transforming Global Queries into Fragment Queries, Distributed Grouping and Aggregate functions Evaluations and Parametric Queries.
**Optimization of Access Strategies:**
The Framework for Query Optimization, Join Queries and General Queries

**Distributed Transaction Management:**
Issues for Transaction Management, Supporting Atomicity of Distributed Transaction, Concurrency Control for Distributed Transaction and Architectural Aspects of Distributed Transaction.

**Concurrency Control:**
Foundation of Distributed Concurrency Control, Distributed Deadlocks, Concurrency Control based Timestamps and Optimistic Methods Distributed Concurrency Control.

**Distributed DBMS Reliability:**
Basic concepts, Non blocking Commitment Protocols, Reliability and Concurrency Control, Determining a Consistent View of the Network, Detection and Resolution of Inconsistency and Checkpoints and Cold Restart.

**Distributed Databases Administration:**
Catalog Management in Distributed Databases and Authorizations and Protections

**Multi-database Systems (MDBS):**

**Text Books:**

**Reference Books:**

**CS-3028 ARTIFICIAL INTELLIGENCE Cr-3**

**Course Outcome:** At the end of the course, the students will be able to:

CO1. Understand the modern view of AI as the study of agents that receive percepts from the environment and perform actions.
CO2. Demonstrate awareness of the major challenges facing AI and the complex of typical problems within the field.
CO3. Exhibit strong familiarity with a number of important AI techniques, including in particular search, knowledge representation, planning and constraint management.
CO4. Assess critically the techniques presented and to apply them to real world problems.
Prerequisite: Data Structures & Algorithms (CS-2001)

Introduction:

Overview; Foundation; History; The State of Art.

Intelligent Agents:

Agents and environment; Rationality; The nature of environment; The structure of agents.

Solving Problems by Searching:

Problem-solving agents; Well defined problems & solutions; Formulating problems; Searching for solution; Uninformed search strategies: (BFS, DFS, DLS, IDDFS, Bidirectional Search)

Informed Search and Exploration:

Informed search strategies; Heuristic functions; On-line search agents and unknown environment.

Constraint Satisfaction Problems:

Constraint satisfaction problems; Backtracking search for CSPs; Local search for CSPs.

Adversial search:

Games; Optimal decisions in games; Alpha-Beta pruning.

Logical Agents:

Knowledge-based agents; The wumpus world as an example world; Logic: Propositional logic Reasoning patterns in propositional logic.

First-order Logic:

Syntax and semantics of first-order logic; Use of first-order logic.

Text Books:


Reference Books:

Course Outcome: At the end of the course, the students will be able to:

CO1. Identify and describe soft computing techniques and their roles in building intelligent machines.
CO2. Recognize the feasibility of applying a soft computing methodology for a particular problem.
CO3. Apply fuzzy logic and reasoning to handle uncertainty and solve engineering problems.
CO4. Apply genetic algorithms to optimization problems.
CO5. Apply neural networks to pattern classification problems.
CO6. Evaluate and compare solutions by various soft computing approaches for a given problem.

Prerequisite: NIL

Introduction to Neura Fuzzy And Soft Computing:

Fuzzy Set Theory:

Optimization:

Neural Networks:

Neuro Fuzzy Modelling:

Text Books:

Reference Books:
Course Outcome: At the end of the course, the students will be able to:

CO1. Identify the need for big data analytics for a domain
CO2. Hands on R tool.
CO3. Use Hadoop, Map Reduce Framework
CO4. Apply big data for a give problem
CO5. Suggest areas to apply big data to increase business outcome
CO6. Contextually integrate and correlate large amounts of information automatically to gain faster insights

Prerequisite: Data Base Management System (CS-2004)

Introduction to Big Data:


Big data technology foundations:


Big data tools:


Data analysis through


Frameworks and visualization:


Text Books:

Reference Books:

4. Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data by EMC Education Services (Editor), Wiley, 2014
7. Big Data For Dummies, Judith Hurwitz, Alan Nugent, Fern Halper, Marcia Kaufman, Wiley 2013

CS-3034 SERVICE ORIENTED ARCHITECTURE Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Demonstrate an understanding of software oriented architectures.
CO2. Demonstrate an understanding of the service composition..
CO3. Demonstrate an ability to manage a modern medium scale software development project using SOA principles.
CO4. Demonstrate an understanding of the principles linking business processes, process oriented architectures and service oriented architectures.
CO5. Demonstrate and ability to implement a service oriented application.

Prerequisite: Software Engineering (IT-3003)

Introduction to SOA, Evolution of SOA:

Fundamental of SOA; Common Characteristics of contemporary SOA; Common tangible benefits of SOA; An SOA timeline (from XML to Web services to SOA); The continuing evolution of SOA (Standards organizations and Contributing vendors); The roots of SOA (comparing SOA to Past architectures).

Web Services and Primitive SOA:

The Web services framework; Services (as Web services); Service descriptions with WSDL; Messaging with SOAP.

Web Services and Contemporary SOA:

Message exchange patterns; Service activity; Coordination; Atomic Transactions; Business activities; Orchestration; Choreography, Addressing; Reliable messaging; Correlation; Polices; Metadata exchange; Security; Notification and eventing.

Principles of Service – Orientation:

Services-orientation and the enterprise; Anatomy of a service-oriented architecture; Common Principles of
Service-orientation; Service orientation principles interrelate; Service-orientation and object-orientation; Native Web service support for service-orientation principles.

**Service Layers:**

Service-orientation and contemporary SOA; Service layer abstraction; Application service layer, Business service layer, Orchestration service layer; Agnostic services; Service layer configuration scenarios.

**Business Process Design:**

WS-BPEL language basics; WSCoordination overview; Service-oriented business process design; WSAddressing language basics; WS-ReliableMessaging language basics.

**SOA Platforms:**

SOA platform basics; SOA support in J2EE; SOA support in .NET; Integration considerations.

**Text Books:**


**Reference Book:**

1. Understanding SOA with Web Services, Eric Newcomer, Greg Lomow, Pearson Education.

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**CS-3040 DATA STRUCTURES USING C Cr-3**

**Course Outcome:** At the end of the course, the students will be able to:

- CO1. Understand the concepts of data structure, data type and array data structure.
- CO2. Analyze algorithms and determine their time complexity.
- CO3. Implement linked list data structure to solve various problems.
- CO4. Understand and apply various data structure such as stacks, queues, trees and graphs to solve various computing problems using C-programming language.
- CO5. Implement and know when to apply standard algorithms for searching and sorting.
- CO6. Effectively choose the data structure that efficiently model the information in a problem

**Prerequisite: Programming in C (CS-1001)**

**Introduction**

Structures and Unions, Pointers, Dynamic Memory Allocation, Algorithm Specification, Space and Time Complexity

**Arrays**

Arrays, Abstract Data Type, Dynamically Allocated Arrays, Polynomials, Two-dimensional Array, Address Calculation, Matrix Addition and Multiplication, Sparse Matrix
Linked List

Singly Linked Lists and Chains, Representing Chains in C, Polynomials, Sparse Matrix, Doubly Linked Lists, Circular & Header Linked lists,

Stacks and Queues

Stacks, Stacks using Dynamic Arrays and Linked List, Queues, Queue using Linked List, Circular Queues using Dynamic Arrays, Evaluation of Expressions

Trees

Introduction, Binary Trees, Binary Tree Traversals, Threaded Binary Trees, Binary Search Trees, AVL Trees, m-way Search Trees, B-Trees, B+-Trees, Tree Operation, Forests, Tree vs. Graph

Sorting :

Insertion Sort, Quick Sort, Merge Sort, Heap Sort, Bubble Sort, Selection sort

Searching : Linear Search, Binary Search

Text Books:

1. Data Structures, Schaum’s OutLines, Seymour Lipschutz, TATA McGRAW HILL

Reference Books:


CS-3042 COMPUTER ORGANIZATION Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Understand how computer hardware has evolved to meet the needs of multiprocessing systems.
CO2. Instruction Set Architecture: Instruction format, types, various addressing modes.
CO3. Understand the basic components and design of the CPU: the ALU and control unit.
CO4. Understand the memory organization: SRAM, DRAM, concepts on cache memory, Memory.
CO5. Interleaving, Associative memory, Virtual memory organization.
CO6. Understand the parallelism both in terms of a single processor and multiple processors.

Prerequisite: NIL

Introduction :

Functional units, Basic operational concepts, Bus structures, Performance and metrics, Instructions and instruction sequencing, Hardware – Software Interface, Instruction set architecture, Addressing modes, RISC & CISC. ALU design, Fixed-point arithmetic: Addition, Subtraction, Multiplication and Division.
Basic Processing Unit

Fundamental concepts, Execution of a complete instruction, Single and Multiple bus organization, Hardwired control & Micro programmed control unit.

Pipelining

Basic concepts, Flynn’s Classification, Types of different hazards, Performance considerations.

Memory System


I/o Organization

Programmed I/O, DMA control and Interrupt based I/O, Serial transmission, Synchronization, Bus arbitration techniques, Bus architectures.

Text Books:


Reference Books:


CS-3044 RELATIONAL DATABASE MANAGEMENT SYSTEM Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Master the basic concepts and understand the applications of database systems.
CO2. Construct an Entity-Relationship (E-R) model from specifications and to perform the transformation of the conceptual model into corresponding logical data structures.
CO3. Understand the basic database storage structures and access techniques.
CO4. Distinguish between good and bad database design, apply data normalization principles, and be aware of the impact of data redundancy on database integrity and maintainability.
CO5. Construct queries and maintain a simple database using SQL.
CO6. Apply database transaction management and database recovery.

Prerequisite: NIL

Introduction:

Introduction to Database Systems; Database – DBMS Definition, Approaches to building Database, Data Models, Three – Level Data Abstraction, Various components of DBMS.
Relational Data Model:

Relational Query Language:
Relational Algebra Operators: Selection, Projection, Cross product, Types of joins, Division. Introduction to SQL, Data definition in SQL, Table, Primary key and Foreignkey definitions, Data manipulation in SQL. Nested queries, Notion of aggregation.

Relational Database Design:
Dependencies and Normal forms – Importance of a good schema design, Problems encountered with bad schema designs, Motivation for normal forms, Dependency theory – functional dependencies, Armstrong's axioms for FD's, closure of a set of FD's, Minimal covers, 1NF, 2NF, 3NF and BCNF, Denormalization.

Transaction Processing:
Introduction to transaction, ACID property, Serializability, Concurrency control protocol.

Text Books:
1. Database System Concepts by Silberschatz, Korth & Sudarshan (McGraw-Hill Education)
2. Fundamentals of Database System By Elmasari & Navathe- Pearson Education

Reference Book
1. Database Management Systems by RamaKrishna & Gehrke (McGraw-Hill Education)

CS-4024 DISTRIBUTED OPERATING SYSTEMS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Understand difference between DOS and COS along with distributed computing environment structure, components and their implementation with applications.
CO2. Understand Synchronization, absence of global clock, Lamport’s logical clock, distributed mutual exclusion and their issues for synchronizing multiprogramming systems and their implementation.
CO3. Understand the concepts of deadlock in distributed systems and how they can be managed/avoided and implement them in hierarchical, distributed and centralize multiprogramming system.
CO4. Understand different processor failure, byzantine agreement protocol, issue and implementation of distributed shared memory with distributed load sharing in multiprocessor systems.
CO5. Understand election algorithm, implementation of file system and remote procedure call in distributed computing systems.
CO6. Understand failure, recovery and fault tolerance implementation in distributed systems.
Prerequisite: Operating Systems (CS-3009)

Introduction:

Issues in Distributed Systems:
Characterization of distributed systems, Design goals, Communication and computer networks, Distributed processing, Distributed operating systems, Client Server Communications, Remote Procedure calls, File Service, Name Service, Distributed transactions and concurrency control, fault tolerance and security.

Distributed Algorithms:
Synchronization & Coordination, Distributed Algorithms.

Advance Issue:
Special topics in distributed operating systems.

Text Books:

CS-4025 MICROPROCESSORS Cr-3

Course Outcome: At the end of the course, the students will be able to;

CO1. Understand the architecture and organization of microprocessor along with instruction coding formats.
CO2. Understand, write structured and well-commented programs in assembly language and in a higher-level language with an ability to test and debug them in the laboratory.
CO3. Understand the memory and addressing concepts for interfacing I/O devices to the microprocessor.
CO4. Understand software/hardware interrupts and further write programs to perform I/O using handshaking and interrupts.
CO5. Understanding of digital interfacing and system connections.

Prerequisite: Digital Electronics (EC-2011)

Introduction:
Overview of Microcomputer Structure and Operation, Microprocessor Evolution and Types, 8086 Internal Architecture. 8086 Instruction Description and Assembler Directives, 8086 Family Assembler Language Programming – Instruction Templates, MOV Instruction Coding Format and Examples, MOV Instruction Coding Examples, Writing Programs for use with an Assembler, Assembly Language Program Development Tools

Implementing Standard Program Structures in 8086 Assembly Language:
Simple Sequence Programs, Jumps, Flags, and Conditional Jumps, If-Then, If-Then-Else, and Multiple If-Then-Else Programs, While-Do Programs, Repeat-Until Programs, Instruction Timing and Delay Loops

Strings, Procedures, and Macros:
The 8086 String Instructions, Writing and Using Procedures, Writing and Using Assembler Macros
8086 System Connections Timing:

A Basic 8086 Microcomputer System, Addressing Memory and Ports in Microcomputer Systems, 8086 and 8088 Addressing and Address Decoding, How the 8088 Microprocessor Accesses Memory and Ports, 8086 Timing Parameters

8086 Interrupts and Interrupt Applications:

8086 Interrupts and Interrupt Responses, Hardware Interrupt Applications, 8259A Priority Interrupt Controller, Software Interrupt Applications

Digital Interfacing:

Programmable Parallel Ports and Handshake Input/output, Methods of Data Transfer, Implementing Handshake Data Transfer, 8255A Internal Block Diagram and System Connections, 8255A Operational Modes and Initialization, Constructing and Sending 8255A Control Words

Text Books:


Reference Book

2. The Intel Microprocessors, Barry B. Brey, Pearson/PHI 2006. 7th Edition
5. 8086 microprocessor & Architecture by Liu, Gibson; PHI.

CS-4027 REAL TIME SYSTEMS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Distinguish a real-time system from other systems
CO2. Identify the functions of operating system
CO3. Evaluate the need for real-time operating system
CO4. Implement the real-time operating system principles

Prerequisite: Operating Systems (CS-3009)

Introduction:

Real-Time systems, applications of Real-Time systems, basic model of Real-Time systems, characteristics of Real-Time systems, types of Real-Time systems: hard, firm, soft, timing constraints, modeling timing constraints.

Real-Time task scheduling:

Fault-tolerant:
Fault-tolerant scheduling of tasks, clocks in distributed Real-Time systems, Commercial Real-Time Operating Systems, timers, UNIX and Windows as RT OS, POSIX, PSOS, VRTX, QNX, RT Linux, other RT OS, benchmarking RT OS, RT communications, QoS framework, models.

Real-Time Communication:
Real-Time Communication in a LAN, IEEE 802.4, RETHER, Communication over Packet Switched Networks, Routing algorithms, RSVP, rate control, RT databases, Applications, characteristics of temporal data, Concurrency control, Commercial RT databases.

Text Books:

Reference Books:

CS-4029 EMBEDDED SYSTEMS Cr-3

Course Outcome: At the end of the course, the students will be able to;

CO1. Describe the differences between the general computing system and the embedded system, also recognize the classification of embedded systems.
CO2. Become aware of the architecture of the ATOM processor and its programming aspects (assembly Level)
CO3. Become aware of interrupts, hyper threading and software optimization.
CO4. Design real time embedded systems using the concepts of RTOS.
CO5. Analyze various examples of embedded systems based on ATOM processor.

Prerequisite: Computer Organization and Architecture (CS-2006)

Embedded Computing:

The 8051 Architecture:
Introduction, 8051 Micro controller Hardware, Input/Output Ports and Circuits, External Memory, Counter and Timers, Serial data Input/Output, Interrupts.

Basic Assembly Language Programming Concepts:
Applications:
Interfacing with Keyboards, Displays, D/A and A/D Conversions, Multiple Interrupts, Serial Data Communication.

Introduction to Real-Time Operating Systems:
Tasks and Task States, Tasks and Data, Semaphores, and Shared Data; Message Queues, Mailboxes and Pipes, Timer, Functions, Events, Memory Management, Interrupt Routines in an RTOS Environment

Basic Design Using a Real-Time Operating System:
Principles, Semaphores and Queues, Hard Real-Time Scheduling Considerations, Saving Memory and Power, An example RTOS like uC-OS (Open Source); Embedded Software Development Tools: Host and Target machines, Linker/Locators for Embedded Software, Getting Embedded, Software into the Target System.

Basic Design Using a Real-Time Operating System:

Introduction to advanced architectures:
ARM and SHARC, Processor and memory organization and Instruction level parallelism; Networked embedded systems: Bus protocols, I2C bus and CAN bus; Internet-Enabled Systems, Design Example-Elevator Controller.

Text Books:
1. An Embedded Software Primer, David E. Simon, Pearson Education.

Reference Books:
1. Embedding system building blocks, Labrosse, via CMP publishers.
2. Embedded Systems, Raj Kamal, TMH.
3. Micro Controllers, Ajay V Deshmukhi, TMH.
5. Microcontrollers, Raj Kamal, Pearson Education.

CS-4031 SOFTWARE TESTING Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Students who complete this course will be able to test software in structured, organized ways.
CO2. Programmers will learn effective, practical ways to design and automate high quality tests during unit and integration testing.
CO3. System testers will learn how to efficiently design effective tests. Students will learn how to apply theory in practical ways to design tests based on test criteria.

Prerequisites: Software Engineering (IT-3003)& Object Oriented System Design(IT-3004)

Testing Methodology
Software Testing Terminology and Methodology


Testing Techniques

Dynamic Testing:
Black Box Testing Techniques, Boundary Value Analysis, Boundary value checking, Equivalence Class Testing, Identification of Equivalence classes, State Table based Testing, Finite State Machine, State table based testing, Decision Table based Testing, Cause Effect Graphing based Testing, Error Guessing

White Box Testing:
Need of White box testing, Logic Coverage Criteria, Basis Path Testing, Control Flow Graph, Flowgraph notations of different programming constructs, Path Testing, Terminology, Cyclomatic Complexity, Formulae based on Cyclomatic complexity, Guidelines for Basis Path Testing, Applications of Path Testing, Graph Matrices Graph Matrix, Connection Matrix, Loop Testing, Data Flow Testing, Static Data flow testing, Dynamic Data flow testing, Mutation Testing, Mutation Testing Process.

Static Testing

Regression Testing

Managing the Test Process

Test Automation

Testing for Specialized Environment
Text Books:


Reference Book:

1. Foundation of Software Testing, Aditya P Mathur, Pearson Education
2. Software Testing and Analysis Process Principles and Techniques, Mauro Pezze, Michal Young, Willey India

CS-4037 HUMAN COMPUTER INTERACTION Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Explain the human components functions regarding interaction with computer
CO2. Explain Computer components functions regarding interaction with human
CO3. Demonstrate Understanding of Interaction between the human and computer components.
CO4. Use Paradigms
CO5. Implement Interaction design basics
CO6. Use HCI in the software process
CO7. Apply Design rules
CO8. Produce Implementation supports
CO9. Use Evaluation techniques

Prerequisite: Artificial Intelligence (CS-3028)

Fundamental to HCI:

Importance of the user interface-definition, importance of good design, brief history. Characteristics of graphical & web user interfaces-GUI and WUI. User interface design process. Knowing the client-understanding how people interact, important human characteristics and human considerations. Principles of good screen design-human considerations in screen design. Develop system menus & navigation schemes-structures, functions, content, formatting, phrasing, choices and graphical menus.

Windows Management:

Select the proper kinds of windows-characteristics, components, presentation styles, types, management, organizing functions, operations. Device based controls-characteristics, selection. Screen based controls- operable, text entry/read-only, selection, combination entry/selection, and other operable controls, presentation controls, selection of proper controls. Write clear Text & Messages.

GUI Issues:


Interaction Design:

Principles of Interfaces Design:

Text books:

Reference Books:
2. Interaction Design: Beyond Human-Computer Interaction, Second Edition by Jenny Preece et al., John Wiley & Sons Ltd.

CS-4041 PATTERN RECOGNITION Cr-3

Course Outcome: At the end of the course, the students will be able to :
CO1. Apply basic principles and practices of Computer Science and Engineering to productively engage in research.
CO2. Design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, ethical, manufacturability, and sustainability.
CO3. Identify, analyze, formulate, and solve engineering problems.
CO4. Use the techniques, skills, and modern engineering tools necessary for engineering practice.

Prerequisite: Data Structure & Algorithms (CS-2001)

Pattern Classifier

Unsupervised Classification
Clustering for unsupervised learning and classification - Clustering concept - C-means algorithm – Hierarchical clustering procedures - Graph theoretic approach to pattern clustering - Validity of clustering solutions.

Structural Pattern Recognition
Elements of formal grammars - String generation as pattern description - Recognition of syntactic description - Parsing - Stochastic grammars and applications - Graph based structural representation.

Feature Extraction and Selection

Recent Advances

Text Books:

Reference Book
INFORMATION TECHNOLOGY
Program Educational Objectives (PEOs):

The Program Educational Objectives (PEOs) of B.Tech Program in Computer Science Engineering are established and are listed as follows:

PEO-1. To lead a successful career in industry or pursue higher studies or entrepreneurial endeavors.

PEO-2. To offer techno-commercially feasible and socially acceptable solutions to real life engineering problems.

PEO-3. To demonstrate effective communication skill, professional attitude and a desire to learn.

Program Outcomes (POs):

Ability to apply knowledge of computing, mathematics, science and engineering fundamentals appropriate to the discipline.

(a) Ability to analyze a problem, and identify and formulate the computing requirements appropriate to its solution.

(b) Ability to design, implement, and evaluate a computer-based system, process, component, or program to meet desired needs with appropriate consideration for public health and safety, cultural, societal and environmental considerations.

(c) Ability to design and conduct experiments, as well as to analyze and interpret data.

(d) Ability to use current techniques, skills, and modern tools necessary for computing practice.

(e) Ability to analyze the local and global impact of computing on individuals, organizations, and society.

(f) Knowledge of contemporary issues.

(g) Understanding of professional, ethical, legal, security and social issues and responsibilities.

(h) Ability to function effectively individually and on teams, including diverse and multidisciplinary, to accomplish a common goal.

(i) Ability to communicate effectively with a range of audiences.

(j) Recognition of the need for and an ability to engage in continuing professional development.

(k) Understanding of engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects.
Course Outcome: At the end of the course, the students will be able to:

CO1. Differentiate between structures oriented programming and object oriented programming.
CO2. Use object oriented programming language like C++ and associated libraries to develop object oriented programs.
CO3. Understand and apply various object oriented features like inheritance, data abstraction, encapsulation and polymorphism to solve various computing problems using C++ language.
CO4. Apply concepts of operator-overloading, constructors and destructors.
CO5. Apply exception handling and use built-in classes from STL.

Prerequisite: Programming in C (CS-1001)

Object oriented paradigm:
Evolution of programming paradigm, structured versus object-oriented development, Introduction to Object oriented programming concepts: Objects, classes, encapsulation and abstraction, inheritance, polymorphism, dynamic binding, message passing.

Moving from C to C++:
Introduction to C++, streams based I/O, name space, scope resolution operator (::), variable declaration at the point of use, variable aliases-reference variables, strict type checking, parameter passing by reference, inline function, function overloading, default arguments.

Object and Classes:
Specifying and using classes, access specifies: private, public, functions and data members, default arguments, function overloading, friend functions, static members.
Objects: memory considerations for objects, new and delete operators.

Constructors - default constructor, parameterized constructor, constructor with dynamic allocation, copy constructor, destructors.

Operator overloading - overloading through friend and member functions: Binary operators: arithmetic, relational, assignment, insertion, extraction: Unary operators: unary minus, post and pre-increment, post and pre-decrement, Conversion functions: class to basic, basic to class, class to class.

Inheritance:
Derived and base classes, Class hierarchies, public, private, and protected derivations, constructors in derived classes, destructors in derived classes, constructors invocation and data members initialization in derived classes, classes within classes, virtual base class.

Polymorphism:
Pointer to objects, pointer to derived class object, this pointer, run time and compile time polymorphism, virtual functions, pure virtual functions, abstract class, virtual destructor.

Files and Streams:
Introduction to file handling, hierarchy of file stream classes, opening and closing of files, file modes, file pointers and their manipulators, sequential access, random access.
Exception handling and Templates:

Introduction to exception handling, throw point outside try, Multiple catch, Catch-all, throwing objects. Introduction to templates, class templates, function templates

Text Book:


Reference Books


IT-2003 WEB TECHNOLOGY Cr-4

Course Outcome: At the end of the course, the students will be able to:

CO1. Design good web pages using different tags, tables, forms, frames and style sheets supported by HTML.
CO2. Implement, compile, test and run Java programs, comprising more than one class, to address a particular software problem.
CO3. Demonstrate the ability to employ various types of selection statements and iteration statements in a Java program.
CO4. Be able to leverage the object-oriented features of Java language using abstract class and interface.
CO5. Be able to handle errors in the program using exception handling techniques of Java.
CO6. Design applets as per the requirements with event handling facility.

Prerequisite: Object Oriented Programming (IT-1002)

Web Development:

HTML, Structure, Tags, Lists, Table, Link and it's types ,Images, Form, Frame, Style sheets and it's type

Introduction to Java:

Java and Java applications, Java Virtual Machine(JVM), Java Runtime Environment(JRE)Java Development Kit(JDK,) Byte code, Java characteristics, Object oriented Programming, Simple java programs, Data types, Operators, Expressions, control statements, Selection statements, Iteration statements, Jump statements

Classes, Inheritance :

Classes in java, Declaring a class, Creating instances of class, Constructors, Argument Passing, use of static keyword, Inner class. Method overloading, Inheritance, use of super keyword ,Method overriding, Abstract class, Dynamic method dispatch, use of final keyword

Interface, Package:

Package, Acesss control mechanism, Interface, Dynamic Method look up
Exception Handling:

Java Exception Handling Mechanism, try, catch, throw, throws and finally, Exception types, Built in Exceptions: checked and unchecked exceptions, User defined Exceptions

String Handling:

String and String Buffer, Constructors, String operations : character extractions, String comparisons, searching strings, modifying a string. To String() and valueOf() methods, String Buffer operations

Java I/O Stream:

I/O basics, Byte stream, Character stream, Reading console input, Writing console output, Reading and writing files

Java Utility package:

Collection overview, Collection interfaces, Collection classes: ArrayList, LinkedList, Accessing a collection using iterator and for-Each statement

Applet:

Applet class, Applet architecture, Applet Skeleton, Life cycle methods, setForeground() and setBackground() methods, Using the status window, HTML Applet tag, Passing parameters to an applet, getCodebase() and getDocumentbase() methods.

Event Handling and AWT:

Delegation Event Model, Event classes, Sources of Events, Event Listener interfaces, Event handling using adapter class, Inner and anonymous class, AWT classes: Label, Button, TextField etc.

Text Books :


Reference Book :

2. Core Java-An Integrated Approach, Dr. R. Nageswara Rao, Dreamtech 2015

IT-3001 COMPUTER NETWORKS Cr- 4

Course Outcome: At the end of the course, the students will be able to :

CO1. Understand different models used for study of computer networks and ability to identify different designs.
CO2. Understand how information transforms while moving through network and understand different technologies used to improve efficiency of communication.
CO3. Understand how to preserve the integrity of data communication on network.
CO4. Design and engineer routes to create interconnect of nodes.
CO5. Understand working of World Wide Web and electronic mail technologies.

Prerequisite: NIL

Introduction:

Internet, Protocol, Network edge, Packet and circuit switching, Performance of network, Protocol layers and service model
Application Layer:

Architecture and principles of network applications, Web and HTTP, FTP and Email, DNS, P2P Applications

Transport Layer:

Introduction, Multiplexing and de multiplexing of data, Connection less transport, Principles of reliable data transfer, Go-back-to-N, Selective repeat, Connection oriented transport, Principles of congestion control, TCP congestion control

Routing Algorithms:

Link state, Distance vector, Hierarchical routing, RIP, BGP, Broadcast and multicast routing

Link Layer:

Error detection and correction, Multiple access links and protocols, Switched local area networks, Ethernet, VLAN, MPLS, and Data centre networking, 802.11 MAC

Open Area Research:

Introduction to Data centre networking, software defined networking.

Text Books:


Reference Books:


IT-3002 DATA ANALYTICS Cr-4

Course Outcome: At the end of the course, the students will be able to:

CO1. Identify the need for data analytics for different domains
CO2. Performing analysis of data using R tool.
CO3. Use of Hadoop, Map Reduce Framework
CO4. Apply big data analytics for a give problem
CO5. Suggest areas to apply big data to increase business outcome
CO6. Contextually integrate and correlate large amounts of information automatically to gain faster insights

Prerequisite: Data Base Management System (CS-2004)

Introduction to Big Data:

Data analysis:


Big data technology foundations & mining data streams:


Frequent itemsets and clustering:


Frameworks and visualization:


Text Books:


References:

5. Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data by EMC Education Services (Editor), Wiley, 2014
8. Big Data For Dummies, Judith Hurwitz, Alan Nugent, Fern Halper, Marcia Kaufman, Wiley 2013
Course Outcome: At the end of the course, the students will be able to:

CO1. Gather and specify requirements of the software projects.
CO2. Analyze software requirements with existing tools.
CO3. Differentiate different testing methodologies.
CO4. Understand and apply the basic project management practices in real life projects.
CO5. Work in a team as well as independently on software projects.

Prerequisite: Programming Knowledge

Software Process Models:


Software Requirements Engineering:


Software Project Management:

Responsibilities of a Software project manager, project planning, Metrics for project size estimation, Project estimation techniques, Empirical estimation techniques, COCOMO models, Scheduling, Organization & team structure, Staffing, Risk management, Software configuration management.

Structured Analysis & Design:

Overview of design process: High-level and detailed design, Cohesion and coupling, Modularity and layering, Function-Oriented software design: Structured Analysis using DFD Structured Design using Structure Chart, Basic concepts of Object Oriented Analysis & Design. User interface design, Command language, menu and iconic interfaces.

Coding and Software Testing Techniques:

Coding, Code Review, documentation. Testing: - Unit testing, Black-box Testing, White-box testing, Cyclomatic complexity measure, coverage analysis, mutation testing, Debugging techniques, Integration testing, System testing, Regression testing.

Software Reliability and Software Maintenance:

Basic concepts in software reliability, reliability measures, reliability growth modeling, Quality SEI CMM, Characteristics of software maintenance, software reverse engineering, software reengineering, software reuse.

Emerging Topics:

Client-Server Software Engineering, Service-oriented Architecture (SOA), Software as a Service (SaaS)
Text Books:

1. Fundamentals of Software Engineering, Rajib Mall, PHI, 2014

Reference Books:


IT-3004 OBJECT-ORIENTED SYSTEM DESIGN Cr-4

Course Outcome: At the end of the course, the students will be able to:

CO1. Gather and specify requirements of the software projects and to analyze software requirements with existing UML tools
CO2. Design and test software using UML tools
CO3. Estimate the project with respect to effort and development time
CO4. Take up a software development project and to work in a team as well as independently on software projects.

Prerequisites: Object Oriented Programming (IT-1002), Software Engineering (IT-3003)

Introduction:

An overview of Object Oriented System Development, Object Basics, Object-Oriented systems, Development of Life Cycle.

Object-Oriented Methodologies:

Rumbaugh methodology, Booch methodology, Jackson methodology, Object Oriented Programming, Object Oriented Design, Object Oriented Analysis, Elements of Object Model.

UML:

Unified Modeling Language, Conceptual Model of the UML, Iterative development, Unified Approach, Unified modeling language, static and dynamic models, Use-case diagram, class diagram, UML dynamic models, package and model organization, UML meta-model.

Object-Oriented Analysis:

Understanding requirements, Identifying use cases, Use-case driven Object Oriented Analysis, Case studies, Classification, Identifying Object relationships, Attributes and Methods.

Object Oriented Design:


Object Oriented Data Model:

Quarry Languages, OODBMS, Object Rational Database system, designing access layer.
**View Layer:**

Designing interface objects, designing view layer classes, macro and micro level process, purpose of a view layer, case studies, Quality assurance test, Testing strategies, Test cases and test plan, continuous testing.

**Text Books:**


**Reference Books:**

1. Applying UML and Patterns, Craig Larman, Pearson Education

**Course Outcome:** At the end of the course, the students will be able to:

CO1. Understand the E-commerce strategies and value chains
CO2. Understand the E-commerce services
CO3. Understand E-commerce infrastructure, its applications and Supply Chain Management.
CO4. Know the availability of latest technology and applications of E-Payment Mechanism.
CO5. Apply E-Commerce in business-to-business application.

**Prerequisite:** NIL

**Electronic Commerce:**

**E-Strategy:**
Overview, Strategic Methods for developing E-Commerce. Four C's (Convergence, Collaborative, Computing, Content Management & Call Center). **Convergence:** Technological Advances in Convergence - Types, Convergence and its implications, Convergence & Electronic Commerce. **Collaborative Computing:** Collaborative Product Development, contract as per CAD, Simulations Collaboration, Security. **Content Management:** Definition of Content, Authoring Tools and Content Management, Content Management, Content - partnership, repositories, convergence, providers, Web Traffic. **Traffic Management:** Content Marketing **Call Center:** Definition, Need, Tasks Handled, Mode of Operation, Equipment, Strength & Weakness of Call Center, Customer Premises Equipment (CPE). [6L]

**Supply Chain Management:**
E-logistics, Supply Chain Portal, Supply Chain Planning Tools (SCP Tools), Supply Chain Execution(SCE), SCE- Framework, Internet's Effect on Supply Chain Power.
E-Payment Mechanism:
Payment through card system, E-Cheque, E-Cash, E-Payment, Threats & Protections.

E-Marketing:
Home - Shopping, E-Marketing, Tele-Marketing

Electronic Data Interchange (EDI):
Meaning, Benefits, Concepts, Application, EDI Model, Protocols (UN EDI, FACT/ GTDI), ANSI-X-12, Data Encryption (DES/RSA)

Risk of E-Commerce:

Text Book:
1. Electronic Commerce - Technologies & Applications, Bhaskar Bharat, TMH

Reference Books:
1. E-commerce, MM Oka, EPH
2. Frontiers of Electronics Commerce, Kalakotia, Whinston, Pearson Education

IT-3022 CLOUD COMPUTING Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Understanding the systems, protocols and mechanisms to support cloud computing.
CO2. Develop applications for cloud computing.
CO3. Understanding the hardware necessary for cloud computing.
CO4. Design and implement a novel cloud computing application.

Prerequisite: Computer Networks (IT-3001)

Introduction

Cloud Models:
Basics of Cloud Computing Concepts, Characteristics of Cloud Computing, Need for Cloud, Cloud Deployment models: private, public, hybrid and community cloud, Cloud Services: Resource-as-a-Service (RaaS), Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS) and Software-as-a-Service (PaaS), Examples of each services.

Cloud Services:
Cloud Application


Text Books:

Reference Books:
2. “New frontiers in information and software as a service”, Divyakant Agrawal, K. Selcuk Candan, Wen-Syan Li (Eds.), Springer Proceedings.

IT-3023 COMPUTER VISION Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Apply knowledge of mathematics, science, and engineering
CO2. Understand the time domain and frequency domain of digital signal
CO3. Understand the segmentation and feature extraction of the digital signals
CO4. Analyze the different Object Reorganization

Prerequisite: Data Structure and Algorithms (CS-2001)

Image formation

Introduction to Vision, Image Formation:
Geometric Primitivity, 2D and 3D transformation, Photometric image formation, Digitization, Sampling and Alising.

Low level processing:
Linear filtering, Smoothing, Sharpening, Shift invariant linear systems, Spatial Frequency and Fourier Transforms, Image Gaussian Pyramid.

Feature extraction:
Edges: Canny, Sobel, Line detectors (Hough Transform), Corners - Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, Feature analysis, feature vectors, distance/similarity measures.

Segmentation:
Clustering method, split and merge method, Graph based method, Applications: Shot Boundary Detection, Background Subtraction and Skin Finding.

Object recognition:
Object detection: Face detection, Pedestrian detection, Face recognition: Eigenfaces, Active appearance and 3D shape models.
Motion analysis:
Motion detection and tracking, Background Subtraction and Modeling, Optical Flow.

Text Books:


Reference Books:


IT-3025 ENTERPRISE RESOURCE PLANNING Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Comprehend the technical aspects of ERP systems;
CO2. Understand concepts of reengineering and how they relate to ERP system implementations;
CO3. Map business processes using process mapping techniques;
CO4. Understand the steps and activities in the ERP life cycle;
CO5. Identify and describe typical functionality in an ERP system;
CO6. Practical hands-on experience with one of the COTS ERP Software e.g. SAP, Oracle

Prerequisite: NIL

Introduction to ERP


ERP and Related Technologies

Business Processing Reengineering (BPR), Data Warehousing, Data Mining, On-line Analytical Processing (OLAP), Supply Chain Management (SCM), Customer Relationship Management (CRM), Management Information System (MIS), Decision Support System (DSS), Executive Information System (EIS).

ERP Implementation

Lifecycle, Implementation Methodology, Hidden Costs, Organizing the Implementation, Vendors, Consultants and Users, Contracts with Vendors, Consultants and Employees, Project Management and Monitoring

ERP Modules

Business modules in an ERP Package- Finance, Manufacturing, Human Resources, Plant Maintenance, Materials Management, Quality Management, Sales and Distribution

ERP Planning

ERP & E-Commerce, Future Directives in ERP, ERP and Internet, Critical success and failure factors, Integrating ERP into organizational culture, Performance measurement of ERP system, Maintenance of ERP system.
ERP Market

ERP Market Place, SAP AG, Peoplesoft, Baan, JD Edwards, Oracle, QAD, SSA

Text Books :

Reference Books :

IT-3026 BIO-INFORMATICS Cr-3

Course Outcome: At the end of the course, the students will be able to :

CO1. Have a basic knowledge of modern molecular biology and genomics.
CO2. Understand the advantages and disadvantages of different machine learning techniques in bioinformatics and how the relative merits of different approaches can be evaluated by correct benchmarking techniques.
CO3. To understand how theoretical approaches can be used to model and analyse complex biological systems.

Prerequisite: Data Structures and Algorithm (CS-2001)

Molecular Biology Primer:
Genetic Material, Function of Genes, Structure of DNA, transcription and translation, Protein structure, DNA analysis, Gene variation, Need of Bioinformatics.

Exhaustive Search:

Greedy Algorithm:
A greedy approach to Motif Finding.

Dynamic Programming Algorithms:
The power of DNA sequence comparison, Edit distance and alignments, Longest common sub sequences, Global sequence alignment, Scoring alignments, Local sequence alignments, Alignment with gap penalties, Multiple alignment, Gene Prediction, Statistical approaches to gene prediction, Similarity based approaches to gene prediction, Spliced alignment.

Combinational Pattern Matching:
Repeat finding, Hash tables, Exact pattern matching, Keyword trees, Suffix trees, Heuristic similarity search algorithms, Approximate pattern matching, BLAST-Comparing a sequence against a database.

Graph Algorithms:
Graphs, Graphs and genetics, DNA sequencing, Shortest super string problem, DNA arrays as an Alternative sequencing technique, Sequencing by hybridization, SBH as an Hamiltonian path problem, SBH as an Eulerian path problem, Fragment assembly in DNA sequencing.
Clustering and Trees:
Gene expression analysis, Hierarchical clustering, k-means clustering, Clustering and corrupted cliques, Evolutionary trees, Distance based tree reconstruction, Reconstructing trees from additive matrices, Evolutionary trees and hierarchical clustering, Character based tree reconstruction, Small parsimony problem, Large parsimony problem.

Text Books:

Reference Books:
1. Introduction to Bioinformatics, A. M. Lesk, Oxford University Press.

IT-3027 MULTIMEDIA APPLICATIONS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Analyse the structure of the tools in the light of low-level constraints imposed by the adoption of various QoS schemes (ie bottom up approach)
CO2. Analyse the effects of scale and use on both presentation and lower level requirements (ie top down approach)
CO3. plan experiments to test user perception of multimedia tools
CO4. State the properties of different media streams; compare and contrast different multicast protocols
CO5. Describe mechanisms for providing QoS guarantees in the network and to propose experiments to analyse their performance.

Prerequisite: Computer Graphics (CS-3004)

Introduction:
Definition, Evolution, Multimedia presentation and production, Characteristics of a multimedia presentation, Components and Structure, Hardware and Software Specifications, Digitization concepts, Application domains.

Text, Image & Graphics:

Audio & Video:
Nature of sound waves, Musical sound and noise, Tone and note, Psycho-acoustics and decibels, Microphone, Amplifier, Speakers, Digital audio specifications, Synthesizers, Musical Instrument Digital Interface (MIDI), Sound card, Audio processing steps and software, Audio File formats, Video frames and frame rate, Analog video camera, Video signal formats, Television broadcasting standards, Digital video, Digital video standards, PC Video, Video processing steps and software, Video File formats.

Compression:
Multimedia Architecture & Transmission:


Multimedia Database:

Limitations of textual descriptions of media, Content based storage and retrieval (CBSR), Image color, Image texture, Image shape, Audio speech and music discrimination.

Text Books:


Reference Books:


IT-3028 INFORMATION AND CODING THEORY Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Know the basic notions of information and channel capacity.
CO2. Understand the convolutional and block codes, decoding techniques, and automatic repeat request (ARQ) schemes.
CO3. Understand how error control coding techniques are applied in communication systems.
CO4. Understand the basic concepts of cryptography.

Prerequisite: Principle of Digital Communication (EC-2004)

Information Theory:

Uncertainty and information, average mutual information and entropy, Perfect secrecy. Source Coding: Source coding theorem, Shannon-Fano coding, Huffman coding, arithmetic coding, Lempel Ziv algorithm, run length coding.

Channel capacity & coding:
Channel models, channel capacity, channel coding, information capacity theorem, random selection of codes.

Error control coding:
Block codes: single parity check codes, product codes, repetition codes, Hamming codes, minimum distance of codes

Linear codes:
Generator matrices, parity check matrices, error syndromes, error detection and correction, shortened and extended linear codes.

Cyclic codes:
Generator polynomials, encoding and decoding cyclic codes, parity check polynomials, dual cyclic codes, generator and parity check matrices of cyclic codes.
**BCH Codes:**
Galois fields, Definition & construction of BCH codes, error syndromes in finite fields, RS codes, The Berlekemp algorithm, Error evaluator polynomial.

**Convolution codes:**
Encoding convolution codes, generator matrices for convolution codes, generator polynomials for convolution codes, The viterbi decoder, Tree codes, Turbo codes, Trellis codes.

**Text Books:**
1. Ranjan Bose, “Information Theory, Coding and Cryptography”, TMH

**Reference Books:**
1. Salvatore Gravano “Introduction to Error Control Codes”, Oxford

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**IT-3029 SOFTWARE DESIGN AND VALIDATION Cr-3**

**Course Outcome:** At the end of the course, the students will be able to:

 CO1. Know the software design phases.
 CO2. Understand the different modeling actions.
 CO3. Understand validation techniques for software.
 CO4. Understand the timing analysis and trace analysis.

**Prerequisites:** Programming in 'C' (CS-1001), Data Structures & Algorithms (CS-2001)

Introduction to Software Design:
Modeling notations:
Model Validation: Model simulation and model-based testing:
Performance validation - Timing analysis and prediction:
Performance validation - Scheduling methods:
Software validation - Trace analysis and Debugging methods:
Software validation - Static property checking of software:
Validation of communication behavior:

**Text Book:**


**Reference Book:**

Course Outcome: At the end of the course, the students will be able to:

CO1. Define Digital Design and verification.
CO2. Define and work with different simulators.
CO3. Generate Test Scenarios of different case studies.
CO4. Solve problems using state machine, equivalence checking, model checking.

Pre-requisite: Software Engineering (IT-3003)

Verification practices for hardware systems:
Introduction, Overview of Digital Design and Verification, Verilog HDL, Simulators, Test Scenarios and Coverage, Assertions, Binary Decision Diagrams (BDD), State Machines and Equivalence Checking, Model Checking, Bounded Model Checking, Counter Example Guided Abstraction Refinement

Software Analysis and Verification:
Type checking and type state verification, Dataflow analysis, Software model checking techniques

Text Books:

References Books:
1. E. M. Clarke, O. Grumberg and D. A. Peled, Model Checking, MIT Press, 2000
2. M. Huth and M. Ryan, Logic in Computer Science, Modelling and reasoning about systems, Cambridge University Press, 2004

Course Outcome: At the end of the course, the student should be able to:

CO1. Explain the basics of mobile telecommunication system
CO2. Choose the required functionality at each layer for given application
CO3. Identify solution for each functionality at each layer
CO4. Use simulator tools and design Ad hoc networks
CO5. Develop a mobile application.

Prerequisite: Computer Networks (IT-3001)

Introduction:
Mobile internet protocol and transport layer:

Mobile telecommunication system:
Global System for Mobile Communication (GSM) – General Packet Radio Service (GPRS) – Universal Mobile Telecommunication System (UMTS).

Mobile ad-hoc networks:

Mobile platforms and applications:

Text books:

References

IT-4021 INTERNET OF THINGS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Understand the application areas of IOT.
CO2. Realize the revolution of Internet in Mobile Devices, Cloud & Sensor Networks.
CO3. Understand building blocks of Internet of Things and characteristics.

Prerequisite: Computer Networks (IT-3001)

Introduction:
The Internet of Things: an Overview:
The flavour of the Internet of Things, The "Internet" of "Things", The Technology of the Internet of Things, Enchanted Objects, Who is Making the Internet of Things?

Design Principles for Connected Devices:
Calm and Ambient Technology, Magic as Metaphor, Privacy, Web Thinking for Connected Devices, Affordances.

Internet Principles:

Prototyping:
Thinking About Prototyping: Sketching, Familiarity, Costs versus Ease of Prototyping, Prototypes and Production, Open Source versus Closed Source, Tapping into the Community.
Prototyping Embedded Devices:

Prototyping the Physical Design:
Preparation, Sketch, Iterate, and Explore, Non-digital Methods, Laser Cutting, 3D Printing, CNC Milling, Repurposing/Recycling.

Prototyping Online Components:
Getting Started with an API, Writing a New API, Real-Time Reactions, Other Protocols.

Techniques for Writing Embedded Code:
Memory Management, Performance and Battery Life, Libraries, Debugging.

Prototype to Reality:


Moving to Manufacture:
What Are You Producing?, Designing Kits, Designing Printed Circuit Boards, Manufacturing Printed Circuit Boards, Mass-Producing the Case and Other Fixtures, Certification, Costs, Scaling Up Software.

Ethics:
Characterizing the Internet of Things, Privacy, Control, Environment, Solutions.

Text Books:

IT-4022 CYBER LAW AND INTELLECTUAL PROPERTY RIGHTS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Understand the role of intellectual property rights
CO2. Identify the main types of intellectual property rights
CO3. Understand the steps for successful registration and protection of intellectual property rights at national, regional and international levels
CO4. Search patent and trademark databases
CO5. Understand the legal aspects for intellectual property protection

Prerequisite: NIL

Cyber World:
An Overview, The internet and online resources, Security of information, Digital signature

An Overview Cyber Law:
Introduction about the cyber space, Regulation of cyber space – introducing cyber law Scope of Cyber laws – e-commerce; online contracts; IPRs (copyright, trademarks and software patenting); e-taxation; e-governance and cyber crimes, Cyber law in India with special reference to Information Technology (Amendment) Act, 2008

IPR:
Intellectual Property: Issues and Challenges:
Geographical Indications, Layout designs of Integrated Circuits and Protection of Plant Varieties and Farmers' Rights. Copyright protection with reference to performers rights and Artist rights, Global governance towards Patents, Trade Marks: Legal recognition, Comparative analysis in India, EU and USA, Trade secrets: Legal recognition, Comparative analysis in India, EU and USA

Intellectual Property: Contemporary Trends
Benefit sharing and contractual agreements – International Treaty on Plant Genetic Resources for Food and Agriculture – issues on patent policy and farmers’ rights- CBD, Nagoya Protocol and Indian law, UNESCO – protection of folklore/cultural expressions Developments in WIPO on traditional knowledge and traditional cultural expressions

Text Books:
1. Duggal Pavan, Cyber Law - An exhaustive section wise Commentary on The Information Technology Act along with Rules, Regulations, Policies, Notifications etc. UNIVERSAL LAW PUBLISHING CO. PVT. LTD. C-FF-1A, Dilkhush Industrial Estate, (Near Azad Pur Metro Station) G. T. Karnal Road, Delhi - 110033, INDIA2014

Reference Books:
1. Intellectual Property Rights in India : General Issues and Implications Prankrishna Pal

IT-4023    MOBILE COMPUTING    Cr- 3

Course Outcome: At the end of the course the student will be able to:

CO1. Understand the basic concepts of mobile computing and network protocol stack
CO2. Learn the basics of mobile telecommunication system
CO3. Explain the basics of mobile telecommunication system
CO4. Choose the required functionality at each layer for given application
CO5. Identify solution for each functionality at each layer
CO6. Develop a mobile application.
CO7. Gain knowledge on mobile platforms and application development

Pre-requisite: Computer Networks (IT-3001)

Introduction:

Mobile internet protocol and transport layer:
Mobile telecommunication system:
Global System for Mobile Communication (GSM) – General Packet Radio Service (GPRS) – Universal Mobile Telecommunication System (UMTS).

Mobile platforms and applications:

Text book:

References

IT- 4024                              COMPUTER SECURITY                              Cr-3

Course outcome: At the end of the course, the students will be able to:

CO1. Understand the basic concepts and goals of Information security such as Confidentiality, Integrity, Authentication, Non-Repudiation, Authorization, and Availability and their relevance in various Contexts.
CO2. Understand the mathematics related to Classical cryptosystems.
CO3. Understand the classical cryptosystems and techniques used to break them.
CO4. Understand the ideas of public key cryptosystems and digital signature schemes.
CO5. Understand different network issues and the solutions for them through firewall, intrusion detection system.
CO6. Understand and critically evaluate a range of access control and authentication mechanisms.

Pre-requisite: Computer Network(ITT-3001)

Introduction to Computer Security:
Security Goals and Principles, Cryptographic Attacks, Substitution Ciphers, Transpositions, Stream and Block Ciphers, Algorithm Modes.

Mathematics of Symmetric Key Cryptography:
Modular Arithmetic, Linear Congruence, GF(2^n) Fields.

Symmetric Key Cryptography:

Mathematics of Asymmetric Key Cryptography:
Primes, Primality Testing, Factorization, Chinese Remainder Theorem.

Asymmetric Key Cryptography:
Overview, RSA, Cryptographic Hash function: MD5, SHA, MAC, HMAC, Digital Envelope, Digital Signature.

Entity Authentication and Key Management:
Passwords, Challenge-Response, Zero-Knowledge, Kerberos, PKI.
Network Security:
Threats in Network, Network Security Controls, Firewalls, Intrusion Detection Systems, Secure E-mail, Malicious Programs.

Text Book:

Reference Books:
3. Applied Cryptography: Bruce Schneier, John Wiley & Sons

IT-4026 NETWORK SECURITY Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Understand the basic concepts of security such as Confidentiality, Integrity, Authentication, Key Management, and their relevance in various Contexts of Network Communication.
CO2. Understand the security mechanisms applied to the Application Layer along with their utility in Real time Communication.
CO3. Understand the various security aspects in Transport Layer along with their protocols and architecture.
CO4. Understand the security policies applied to Network Layer along with various protocols used for encryption and key management.

Prerequisite: Computer Network (IT-3001)

Introduction:

Symmetric Key Encryption:
Symmetric Encryption Principles, Symmetric Block Encryption Algorithms, Stream and Block Ciphers, Cipher Block Modes of Operations

Assymetric Key Encryption:

Key Management and Distribution:
Symmetric Key Distribution using Symmetric and Assymetric Encryption, Distribution of Public Keys, Kerberos, X.509 Certificates

Security at Network Layer:
IP Security Overview, IP Security Policy, Authentication Header (AH) and Encapsulating Security Payload (ESP), Internet Key Exchange (IKE)

Security at Transport Layer:
SSL Architecture, SSL Protocols, Transport Layer Security (TLS)
Security at Application Layer:
HTTPS, SSH, Email, PGP, S/MIME

Text Books:

Reference Books:

IT-4027 SOFTWARE PROJECT MANAGEMENT Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Differentiate between a common and software project. Need to know the business objectives, plans, method and methodology.
CO2. Give an idea about the project evaluation along with the financial layout.
CO3. Understand Step to step project planning and the execution.

Prerequisite: Software Engineering (IT-3003)

Introduction to Software Project Management:
Software Project Management, Software Project vs other types of Projects, Activities, Plan methods, Methodologies, Categorization, Management control.

Project evaluation and Programme Management:

An Overview of Project Planning:
Stepwise Project Planning

Selection of Project Approach:

Software Effort Estimation:
Estimates, Effort Estimation, top-down, Bottom up, Function Points, COCOMO.

Activity Planning and Resource Allocation:
Project Schedules, Network Planning Models, Sequencing and Scheduling, Resource Allocation, Scheduling Resources, Cost Schedules.
Risk Management, Monitoring and Control:

Managing Contracts & People and Team Working:

Software Quality:

Text Books:
1. Bob Hughes and Mike Cotterell, Rajib Mall, Software Project Management, TMH, 5e, 2011

Reference Books:

IT-4028 CYBER SECURITY Cr-3

Course Outcome : At the end of the course, the students will be able to :

CO1. Understand the concept of cyber security

Pre-requisite: NIL

Introduction:

Cyber security objectives and guidance
Cyber governance issues

Cyber infrastructure issues
Cyber Infrastructure Issue – economics ,finance and banking – Health care – Industrial Control systems. cyber insurance, cyber security in international relations.

Text Book:

References:

IT-4029 MANAGEMENT INFORMATION SYSTEM Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1 Evaluate the role of the major types of information systems in a business environment and their relationship to each other;

CO2 Assess the impact of the Internet and Internet technology on business electronic commerce and electronic business

CO3 Identify the major management challenges for building and using information systems and learn how to find appropriate solutions to those challenges;

CO4 Define an IT infrastructure and describe its components;

CO5 Learn the core activities in the systems development process;

CO6 Cultivate skills and experience in the development and implementation of information system projects.

Prerequisite: NIL

Information Systems in Business:

Fundamentals of Strategic Advantages:
Strategic IT, Competitive strategy concepts, The competitive advantage of IT, Strategic uses of IT, Building a customer-focused business, The value chain and strategic IS, Reengineering business processes, Becoming an agile company, Creating a virtual company, Building a knowledge-creating company.
Enterprise Business Systems:

Decision support in business:
Introduction, Decision support trends, Decision support systems (DSS), Management Information Systems, On-line analytical processing, Using DSS, Executive information systems, Enterprise portals and decision support, Knowledge management systems, Business and Artificial Intelligence (AI), An overview of AI, Expert systems.

Security, Ethical and societal challenges of IT:
Introduction, Ethical responsibility of business professionals, Computer crime, Privacy issues, other challenges, Health issues, Societal solutions.

Security management of IT:
Overview, Tools of security management, Internetworked security defenses, other security measures, System Controls and audits.

Managing IT:
Business and IT, Managing IT, Business / IT planning, Managing the IS function, Failures of IT management.

Managing global IT:
The International Dimension, Global IT Management, Cultural, Political and Geo - Economic challenges, Global Business/ IT strategies, Global Business / IT applications, Global IT Platforms, Global data access issues, Global Systems development.

Text Books:

Reference Books:
2. Information Systems -The Foundation of E-Business, Steven Alter, Pearson Education.

IT-4031 INFORMATION RETRIEVAL Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1 Use different information retrieval techniques in various application areas
CO2 Apply IR principles to locate relevant information large collections of data
CO3 Analyse performance of retrieval systems when dealing with unmanaged data sources
CO4 Implement retrieval systems for web search tasks.
Prerequisite: Data Structures and Algorithm (CS-2001)

Introduction:

Data Structures:
Introduction, Stemming Algorithms, Inverted file structures, N-gram data structure, PAT data structure, Signature file structure, Hypertext data structure.

Automatic Indexing:

User Search Techniques:
Search statements and binding, Similarity measures and ranking, Relevance feedback, Selective dissemination of information search, Weighted searches of Boolean systems, Searching the internet and hypertext, Information Visualization: Introduction, Cognition and perception, Information visualization technologies.

Text Search Algorithms:

Text Books:

Reference Books:
1. Modern Information Retrieval, Yates, Pearson Education.

IT-4033  NATURAL LANGUAGE PROCESSING  Cr-3

Course Outcome: At the end of the course, the students will be able to:
CO1. Introduce the problems and solutions of NLP, and their relation to linguistics and statistics.
CO2. Know how to program and use common data structures.

Prerequisite: Artificial Intelligence (CS-3028)

Introduction:
Linguistics:
Phonology and Morphology, Syntax (Phrase Structure vs. Dependency).

Words & Lexicon:

Hidden Markov Models & Tagging:

Grammars & Parsing Algorithms:

Statistical Parsing & Machine Translation:
Lexicalized PCFG, Statistical Machine Translation (MT), Alignment and Parameter Estimation for MT.

Text Books:

Reference Books:
1. Speech and Language Processing, Jurafsky, D. and J. H. Martin, Prentice-Hall.

IT-4035 OPERATIONS RESEARCH Cr-3

Course Outcome: At the end of the course the student will be able to:

CO1. Know different operation research techniques to solve Engineering problems.

Pre-requisite: NIL

Module – I
Formulation of optimization problems: Decision variables, objective function and constraints, Graphical solution and optimization outcomes, Linear and non-linear programs.
Linear Programming Problem: Formulation, Simplex method, Duality theory, Dual simplex method
Module – II
Sensitivity Analysis, Transportation Problem, Assignment Problem, Traveling Salesperson Problem
Network Models: Minimal Spanning Tree Problem, Maximal Flow Problem, Shortest Route Problem, Minimum Cost Flow Problem.

Module – III
Integer Linear Programming Problem, Branch and Bound and Cutting Plane Methods, Zero-one Programming Problem, Knapsack Problem, Set covering Problem, Set Partitioning Problem, Deterministic Dynamic Programming Problems

Module – IV
Game theory, Sequencing Problem, Unconstrained Non linear programming, constrained linear programming

Text Book:

References:

IT-4037 DATA MINING AND DATA WAREHOUSING Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Understand the basic principles, concepts and applications of data warehousing and data mining.
CO2. Introduce the task of data mining as an important phase of knowledge recovery process.
CO3. Do Conceptual, Logical, and Physical design of Data Warehouses OLAP applications and OLAP deployment.
CO4. Have a good knowledge of the fundamental concepts that provide the foundation of data mining.
CO5. Design a data warehouse or data mart to present information needed by management in a form that is usable for management client

Prerequisite: Data Base Management Systems (CS-2004)

Introduction:
Basic Data Mining Tasks, Data Mining Issues, Data Mining Metrics, Data Mining from a Database Perspective, A Statistical Perspective on Data Mining.

Data Warehousing and Preprocessing:
Data Warehousing, Data Warehousing Architecture, OLTP, OLAP, Preprocessing Techniques
A Statistical Perspective on Data Mining, Similarity Measures

Association Rules:
Classification:
Statistical-Based Algorithms, Distance-Based Algorithms, Decision Tree-Based Algorithms, Advanced Classification methods (Genetic, Rough Set, Fuzzy Set), Neural Network.

Clustering:
Data Types, Similarity Measure, Hierarchical Algorithms, Partitional Algorithms, Clustering Large Databases, Clustering with Categorical Attributes.

Advanced Techniques:
Web Mining, Spatial Mining, Temporal Mining, Text Mining, Multimedia Mining.

Text Books:

Reference Books:

IT-4039 INFORMATION SECURITY Cr-3

Course Outcome: At the end of the course, the students will be able to:
CO1. Understand what are the common threats faced today
CO2. What are the foundational theory behind information security, what are the basic principles and techniques when designing a secure system,
CO3. How to think adversarially, how today's attacks and defenses work in practice, how to assess threats for their significance, and how to gauge the protections and limitations provided by today's technology.

Prerequisite: Computer Networks (IT-3001)

Introduction:

Symmetric- and Asymmetric- Key Crypto:
Stream Cipher, Block Cipher, Fiestel Cipher, DES and Variations, AES, RSA, Diffie-Hellman Key Exchange, Uses of Public Key Crypto, Public Key Infrastructure.

Hash Functions & Cryptanalysis:
Birthday Problem, Non-Cryptographic Hashes, Tiger Hash, HMAC, Uses of Hash Functions, Linear and Differential Cryptanalysis.

Access Control & Authorization:
Authentication Methods, Passwords, Biometrics, Captcha, Firewall, Intrusion Detection.

Software Flaws & Malwares:
Network Security:

Text Books:

Reference Books:

IT-4041 NETWORK SECURITY AND CRYPTOGRAPHY Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Able to understand the basic concepts of security such as Confidentiality, Integrity, Authentication, Key Management, fundamental cryptosystems and their relevance in various contexts of Network Communication.

CO2. Able to understand the security mechanisms applied to the Application Layer along with their utility in Real time Communication.

CO3. Able to understand the various security aspects in Transport Layer along with their protocols and architecture.

CO4. Able to understand the security policies applied to Network Layer along with various protocols used for encryption and key management.

CO5. Able to understand the basic concepts of security such as Confidentiality, Integrity, Authentication, Key Management, fundamental cryptosystems and their relevance in various contexts of Network Communication.

Prerequisite: Computer Network (IT-3001)

Introduction:

Symmetric Key Encryption:
Symmetric Encryption Principles, Symmetric Block Encryption Algorithms, Stream and Block Ciphers, Cipher Block Modes of operations

Asymmetric Key Encryption:
Approaches to Message Authentication, Secure Hash Functions, Message Authentication Codes, Public Key Cryptography Principles, Public Key Cryptography Algorithms, Digital Signatures
Security at Network Layer:
IP Security Overview, IP Security Policy, Authentication Header (AH) and Encapsulating Security Payload (ESP), Internet Key Exchange (IKE)

Security at Transport Layer:
SSL Architecture, SSL Protocols, Transport Layer Security (TLS)

Security at Application Layer:
HTTPS, SSH, Email, PGP, S/MIME

Text Book:

Reference Books:
ELECTRICAL ENGINEERING
Program Educational Objectives (PEOs):

PEO-1. To lead a successful career in industry or pursue higher studies or entrepreneurial endeavours.

PEO-2. To offer techno-commercially feasible and socially acceptable solutions to real life engineering problems.

PEO-3. To demonstrate effective communication skill, professional attitude, desire to learn and adhere to ethical value.

Program Outcomes (POs):

a. Ability to apply knowledge of mathematics, science and engineering in domain of Electrical Engineering.

b. Ability to identify, formulate, and solve complex Electrical Engineering problems using first principle of mathematics, basic science & engineering.

c. Ability to design Electrical components or systems or processes to meet desired needs within realistic constraints of economics, safety and manufacturability.

d. Ability to design and conduct complex Electrical Engineering experiments as well as to analyze and interpret the experimental data.

e. Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

f. Ability to assess impact of contemporary social issues on professional practice.

 g. Ability to assess the feasibility of Engineering solutions in the context of environment and sustainability.

 h. Ability to select and adopt ethical Engineering practices.

i. Ability to function in multidisciplinary teams.

j. Ability to communicate effectively in oral and written forms.

k. Ability to engage in life-long learning.

l. Ability to identify factors influencing finance and management of a project.
Course Outcome: At the end of the course, the students will be able to:

CO1. Solve problems of DC and AC Circuits.
CO2. Realize Magnetic and electromagnetic circuits.
CO3. Know the operation and practical application of DC and AC machines
CO4. Get knowledge about the electrical measuring instruments, different lamps and safety in operation of different electrical appliances.

Pre-requisite: Nil

Introduction:
Essence of electricity, different electric wiring techniques, necessity of earthing and fuse, power system layout, electrical safety rules.

DC Circuits:
Active and passive elements, ohm’s law, Kirchhoff’s law, star-delta transformation, mesh analysis, nodal analysis, Superposition theorem, Thevenin’s Theorem, Norton’s Theorem (Elementary treatment only), DC transients (RL, RC series circuits).

AC circuits:

Magnetic circuits:
Basic definitions, magnetizing force, reluctance, permeance, magnetic field, magnetic permeability, self and mutual inductance, leakage flux, Faraday’s laws of electromagnetic induction, analogy between electric circuit and magnetic circuits, analysis of series magnetic circuit, B-H curve, hysteresis and eddy current loss.

DC Machines:
Principles of electrical machines, E.M.F equation in a dc generator, Torque production in a DC Motor, Operation of a dc machine as a generator, operation of a dc machine as a motor.

AC Machines and transformer:

Basic Instruments:
Classification of electrical instruments, essential features of analog measuring instruments, moving coil instruments (PMMC), moving iron instruments, extension of range , Dynamometer type Watt meter.

Illumination:
Luminous flux, luminous intensity, lumen, candela power, illumination, brightness.

Text Books:
**Reference Books:**

**Course Outcome:** At the end of the course, the students will be able to:

- **CO1.** Analyze DC and AC circuits by different network theorems, properties of coupled circuit and usage of network graph to solve electrical circuits.
- **CO2.** Realize transients in AC and DC circuits.
- **CO3.** Solve the two port networks, network functions and their response.
- **CO4.** Get knowledge about filter design and network synthesis.

**Pre-requisite:** Basic Electrical Engineering (EE-1003)

**Network Topology:**
Concepts of Network graph, Terminology, Element, Tree, Branch, Link, Twigs, formation of incidence matrix, loop matrix, cut-set matrix, Relation between branch voltage and current, loop current network topology analysis.

**Network Theorems:**
Maximum Power transfer theorem, Millman’s Theorem, Tellegen’s theorem, Reciprocity Theorem.

**Coupled Circuits:**
Self and mutual inductance, coefficient of coupling, Dot conventions for coupled circuits, tuned coupled circuits.

**Transients Response:**
Transient response of RL, RC and RLC circuits with constant and sinusoidal excitation in time domain by Introduction to different Signals, periodic and non-periodic function, Laplace transformation method, response to step, impulse and ramp inputs.

**Two Port Networks:**
Open circuit, Short Circuits, hybrid and transmission parameters, T and Π circuit representation, Interconnection of two port networks (Cascade, Series and Parallel).

**Network Function and Responses:**
Concept of complex frequency, driving point and transfer functions of one port and two-port network, Calculation of the network functions, Restrictions on poles and zero location of network function, impulse response, time domain behavior from pole zero plot using Laplace transformation.

**Synthesis of Passive Network:**
Causality and Stability, Hurwitz polynomial, Positive real Function. properties of Driving point function, synthesis of LC, RC and RL driving point function by Cauer-I and II, Foster-I and II forms.

**AC Circuits With Non-Sinusoidal Waveforms:**
Fourier series representation of complex waves, symmetry in Fourier series, Average and RMS values of periodic complex wave.

**Filter Design:**
Introduction, Active and passive filters, Design of low pass, high pass, band pass and band elimination filters, Circuit analysis using SPICE and PSPICE.
Text Books:

Reference Books:

EE 2005 DC MACHINES AND TRANSFORMERS Cr-4

Course Outcome: At the end of the course, the students will be able to:

CO1. Know the basic principle of operation, construction, performance characteristics, starting and testing of DC Machines.
CO2. Design and applications of DC Machines.
CO3. Realise the principle of operation, construction, performance characteristics and testing of transformers.

Pre-requisites: Basic Electrical Engineering (EE-1003) and Physics (PH 1003)

D.C. Machine:
Construction, Principle of operation, Armature winding, Simplex Lap and wave winding. Dummy coil, equalizer rings. EMF equation, Armature reaction, effect of armature reaction upon flux distribution curve, Effect of brush shifts, Demagnetizing and cross magnetizing ampere turns, commutation, Inter- poles and compensating winding.

D.C. Generator:

D.C. Motor:
Principle, Back emf, Torque and speed formula. Various types and their characteristics. 3-point and 4-point starters. Grading of starting resistance, speed control of D.C. motor, Losses and efficiency, Testing: Brake test, Swinburn’s test and Hopkinson’s test.

Single Phase Transformer:

Auto Transformer:
Construction, Principle of operation, Copper saving, equivalent circuit, phasor diagram and Applications.

Three-phase Transformer:
Construction, transformer connection and vector group, open delta connection. Phase transformation: 3- phase to 6-phase, 3-phase to 12-phase, 3-phase to 2-phase, phasor diagram and voltage ratio. Three winding transformers. Time harmonics in single phase and 3 phase transformer, Parallel operation. Magnetizing inrush current.
Text Books:
1. Electric Machinery, by E. Fitzagerald, C. M. Kingsley (Jr) and S. D. Umans, Tata McGraw Hill, 2003
2. Electrical Machines, by P. K. Mukharjee and S. Chakraborti, Danpat rai Publication, 18th reprint 2013

Reference Books:

EE 2007 NETWORK THEORY Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Analyze DC and AC circuit by different network theorems and properties of coupled circuit.
CO2. Realize transients in AC and DC circuits
CO3. Familiar with the operation of two port networks
CO4. Understand the usage of network graph to solve electrical circuits.

Pre-requisite: Basic Electrical Engineering (EE-1003)

Network Theorems:
Review of Kirchoff’s current law, Kirchoff’s voltage law and Superposition theorem. Thevenin’s Theorem Norton’s Theorem, source conversion, Maximum Power Transfer Theorem, Millman’s Theorem, Tellegen’s Theorem and Reciprocity Theorem. Mesh analysis and nodal analysis of DC circuits.

Analysis of AC circuits:

Coupled circuits:
Self and mutual inductance, coefficient of coupling, dot convention and analysis of coupled circuits.

Transient Response:

Two-port networks:
Open circuit, short circuit, hybrid and transmission parameters, T and π circuit representation, Interconnection of two port networks (Cascade, series and parallel configurations).

Network topology:
Concept of network graph and associated terminologies (node, element, branch, link, tree, twig and path). Representation of network graph using incidence matrix, loop matrix and cut-set matrix. Relation between branch voltage and current, loop current network topology analysis.

Text Books:
Reference Books:

EE 2008 ELECTRICAL MACHINES Cr-4

Course Outcome: At the end of the course, the students will be able to:

CO1 Know the basic principle of operation, construction, performance characteristics of DC Machines.
CO2 Understand the basic principle of operation, construction and testing of Transformer.
CO3 Know the details principle of operation, construction, types, use, starting, testing of three phase, single phase Induction motor and three phase synchronous motor.
CO4 Know the basic principle of operation and application of universal motors

Pre-requisites: Basic Electrical Engineering (EE-1003) and Physics (PH 1003)

DC Generator:
Construction, Principle of Operation, emf equation, Types of generators, No-load and load characteristics, Voltage build up of shunt generator, Voltage regulation, Applications.

DC Motor:
Construction, Principle of operation, Back emf, Speed and Ttorque formula, Motor characteristics and performance curve, Speed control of DC shunt and series motor, Necessity of starter, 3-point starter, Losses and efficiency, Industrial Applications.

Transformer:
Single phase transformer, Construction, Principle of operation, emf equation, equivalent circuit and phasor diagram, Open circuit and Short circuit test, Regulation, Losses and Efficiency.

Three-phase synchronous motor:
Construction, Principle of operation, V-curves, method of starting and applications.

Three-Phase induction motor:
Construction, Squirrel cage and Slip ring type, Principle of operation and equivalent circuit and phasor diagram, Torque-Slip characteristics, starting torque and maximum torque, starting and speed control and applications.

Single-phase Induction Motor
Construction, Staring method and applications.

Universal motor:
Construction and principle of operation, Applications.

Text Books:
2. Electrical Machines, by P. K. Mukharjee and S. Chakravorti, Danpat rai Publication, 18th reprint 2013
Reference Books:

EE 2009 ELECTRICAL MACHINES AND POWER ELECTRONICS Cr-3

Course Outcome : At the end of the course, the students will be able to:

CO1. Know the basic principle of operation, construction, performance characteristics of DC Machines and Alternator.
CO2. Understand the basic principle of operation, construction of Transformer.
CO3. Understand the details principle of operation, construction, types, use, starting, testing and to draw the performance curve of 3-Ø Induction motor..
CO4. Know the basic principle of operation, characteristics of power electronic components.

Pre-requisites: Basic Electrical Engineering (EE 1003) and Physics (PH 1003)

DC Generator:
Introduction, Construction of DC Machines, Types and uses, Principle of operation of DC generator, EMF Equation of DC Generator from 1\textsuperscript{st} principle, Different characteristics.

DC Motor:
Introduction, Principle of operation of DC Motors, Torque equation, Types and uses of DC Motors, Different characteristics, Speed control and Starting of D.C. shunt and series motors.

Induction Motors:
Construction, Types and uses of 3-phase induction motor, principle of operation, torque-slip characteristics, Speed control and Starting of 3-phase induction motor, Principle and Uses of single phase Induction motors, Stepper Motor.

Alternator:
Introduction, Construction, Types and uses, Principle of operation, EMF equation of Alternator, Voltage regulation by synchronous impedance method.

Transformer:
Definition, Types, Construction and uses of transformers, Voltage transformation ratio, Working principle, EMF Equation, No load phasor diagram, Losses and Efficiency, Voltage regulation, Principle and uses of 1-Phase Auto transformer, Connections of 3-phase transformer.

Power Electronics and Applications:
Power Semiconductor Devices: Thyristor, TRIAC, IGBT, Thyristor characteristics, Turn on methods, Turn off methods, Ratings, Simple Industrial Application.

Text Books:
2. Power Electronics By P S Bhimbra, Khanna Publishers
Reference Books:
1. Induction and synchronous machines, K. Murgesh Kumar Vikash Publishing House Pvt. Ltd, New Delhi

EE 2010 AC MACHINES Cr-4

Course Outcome : At the end of the course, the students will be able to:

CO1. Realise on principle of operation, construction, types, uses and voltage regulation of synchronous generator.
CO2. Analyse the principle of operation, construction, application and starting of synchronous motor.
CO3. Practical implementation of 3-Ø Induction motor and 1-Ø induction motors.
CO4. Realise on revolving field theory and construction of different types of 1-Ø induction motors.

Pre-requisite: DC Machines and Transformers (EE-2005)

Three-Phase Synchronous Generator:
Definition and Principle of operation of Alternator, Rotating Field, Synchronous Speed and frequency, Construction (stator and Rotor), Armature winding, pitch factor, distribution factor and winding factor, EMF equation from 1 st Principle, Armature reaction, Synchronous Impedance, Equivalent circuits, Phasor Diagram of a loaded alternator, Determination of voltage regulation - emf method, mmf method, zero power factor method, short circuit ratio, Parallel operation of Alternators and load sharing, Synchronizing Power, Blondel’s two reaction theory, phasor diagram, direct and quadrature axis reactance, power angle equation (for cylindrical and salient pole type), Slip test, Ratings and applications.

Three-Phase Synchronous Motor:
Definition and Principle of operation, Starting methods, Equivalent circuit and phasor diagram of cylindrical rotor, Power flow diagram, Torques equation, Power Developed Equation for both salient and cylindrical rotor machine, Effect of load changes on a Synchronous Motor, Construction of V curves and inverted V-curves, Synchronous condenser and power factor correction, Hunting, Ratings and applications.

Three-Phase Induction Machines:

Single-Phase Motors

Text Books:
2. Electrical Machines, P K Mukharjee and S Chakravorty, Danpatrai Publication, 18 th reprint 2013
Reference Books:

EE 2012 LINEAR CONTROL THEORY Cr-4

Course Outcome: At the end of the course, the students will be able to:

CO1. Design the different types of control systems, characteristics of control system components and the mathematical model of physical systems.
CO2. Analyze the time domain response of different systems.
CO3. Analyze the different techniques used to find the stability of a system by classical methods.
CO4. Understand the use of the classical compensation techniques

Pre-requisites: Network Analysis (EE 2003) and Mathematics-I (MA 1001)

Introduction:
Classification of systems, Causal and non-causal, Basic concept of Control System, Classifications, Differential Equation and Transfer Function, Order and Types of the system.

Feedback Theory:

Control System and Components:

Description of Physical System:
Mathematical Modeling of Electrical System and Mechanical System (Translational and Rotational Mechanical System), Analogous System, Block Diagram Algebra, Developing Block Diagram from a Mathematical Model, Signal Flow Graph (SFG), Mason’s Gain Formula, SFG from Block Diagram (SFG Terminology, Construction and Procedures, Problems.

Time Domain Analysis:

Concept of Stability:

Root Locus Technique:
Root Locus Concept, Construction of Root Locus, Rules for the Construction of the Root Locus, Effect of adding Poles and Zeros to G(s) H(s), Determination of Gain from Root Locus.

Frequency Domain Analysis:
Compensators:
Realization of basic compensators, Cascade Compensation and Feedback Compensation.

Text Books:

Reference Books:

EE 2014 ELECTROMAGNETICS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Solve the problems in different co-ordinate systems
CO2. Realize the Static Electric Field
CO3. Realize the steady-state and time-varying magnetic field and usage of Maxwell’s equation for both static and time varying fields.
CO4. Derive parameters of different shape of current carrying conductors and understanding transmission line equations.

Pre-requisites: Physics (PH 1003) and Mathematics (MA 1001)

Coordinate System and Vector Calculus:
Rectangular, Cylindrical and spherical, Transformation, Gradient, Divergence and curl operation and applications.

Static Electrical Field:
Coulomb’s Law, Electric field intensity due to continuous line charge, surface charge and volume charge. Gauss’s law Maxwell’s equation and its application, Application of Gauss’ law. Electric potential, equipotential surface, Boundary value problems, electric dipole.

Electric Field in Different Materials:
Electric properties of material, Convection current, Conduction current, Continuity equation, Poisson’s and Laplace’s equation

Steady Magnetic Field:
Magnetic forces, Biot-savart’s law and application. Ampere’s circuitual law, Magnetic scalar and vector potential, Energy stored in magnetic field, Boundary value problems.

Time Varying Field:
Charged particles moving in a static magnetic field. Moving conductor in a static magnetic field, Faraday’s law, General case of induction, Displacement current, Application of Maxwell’s equation.

Electromagnetic Waves and Transmission Line
Text Books:

Reference Books:
4. Electromagnetic Field Theory by Rohit Khurana Vikas Publisher 2015.

EE2016 ELECTRICAL MEASUREMENTS AND MEASURING INSTRUMENTS

Course Outcome: At the end of the course, the students will be able to:

CO1. Realize the principles, practical applications of different electrical instruments for measurement.
CO2. Measure the unknown electrical circuit elements by different AC/DC bridges.
CO3. Use instrument transformers in electrical system.
CO4. Operate different transducers and electronic instruments for measurement.

Pre-requisites: Basic Electrical Engineering (EE 1003), Basic Electronics (EC 1001), Physics (PH 1003)

Measuring Instruments:
Introduction, classification, absolute and secondary instruments, indicating instruments. Control, balancing and damping Torques Characteristics, Errors in measurements, Moving iron: Constructional details, extension ranges (both Moving Iron and Moving Coil).

Wattmeter:
Electrodynamometer type: Single and three phase wattmeter, calibration device, errors in wattmeter, compensation, Measurement of 3- Φ power. Induction type.

DC/AC Bridge:
General equation of bridge balance, Wheatstone bridge, Kelvin’s double bridge, measurement of self inductance: Maxwell’s inductance, Maxwell’s inductance-capacitance bridge, Hay’s Bridge, Anderson's bridge, Owne's bridges, Schering bridge, errors, Wagner’s earthing device, Megger and Insulation measurements.

Energy Meter:
Induction type single and three phase energy meter, compensation, errors, testing, creping.

Galvanometer:
General principle and performance equation of D’Arsonval Galvanometer, vibration galvanometer and ballistic galvanometer. Under damped, undamped, critically damped motion of galvanometer, measurement of charge and flux by ballistic galvanometer.

Frequency Meter:
Vibration reed type and Electrical resonance type.

Power factor Meter:
Single and three-phase electrodynamometer type power factor meter Advantages and Disadvantages.
**Instrument Transformers:**
Potential and current transformers: construction, ratio and phase angle errors, phasor diagrams, uses, testing.

**Potentiometer:**
DC potentiometer- Crompton meter, standardization, applications, AC potentiometer- Drysdale polar meter, Gall Tinsley coordinate type meter, standardization, measurement.

**Transducers:**
Stain gauge, Thermistors, Thermo couples, LVDT, Capacitance transducers, torque meter, inductive torque transducers, Tachometers.

**Electronic Instruments:**
Electronic voltmeter, block diagram, principle of operation, accuracy of multimeter, Digital Multi-meter, Digital Frequency meter, block diagram, principle of operation, accuracy of measurement. CRO: Block Diagram, Sweep Generator, Vertical amplifiers, Use of CRO for measurement of frequency, phase, amplitude, rise time.

**Text Books:**

**Reference Books:**
3) Electrical and Electronics Measurements and Instrumentation by R K Rajput, S Chand, 3rd edition -2013

EE 3002 POWER SYSTEM OPERATION AND CONTROL

**Course Outcome:** At the end of the course, the students will be able to:

CO1. Detect and analyse the type of fault
CO2. Solve load flow problems and economic operation of power system generation
CO3. Realize about generation control and voltage control
CO4. Implementation of different techniques for power system stability.

**Pre-requisite: Power Transmission and Distribution (EE 3007)**

**Symmetrical and Unsymmetrical Fault Analysis:**
Introduction, Transients in transmission line, Short circuit of synchronous machine, Symmetrical components, Sequence impedance and sequence network of power system, Symmetrical Fault analysis, Unsymmetrical Fault analysis: L-G, L-L, L-L-G.

**Load Flow Studies:**
Importance of load flow studies, Bus classification, Nodal Admittance matrix, Formulation of load flow problem, Approximate load flow solution by Gauss Siedel Method both PV and without PV (acceleration of convergence), Newton Raphson Method, Decoupled and Fast decoupled method.
Economic Operation of Power System:
Introduction, Optimal operation of generators, Distribution of load on various generating units, Penalty factor and Transmission loss as a function of plant generation, Automatic load dispatch.

Automatic Generation and Voltage Control:
Introduction, Load frequency control, Turbine speed governing system, Modelling of speed governing system, Turbine model, Generator load model, Integrated representation of various models, Steady state analysis, Dynamic response, Control area concept, Proportional plus integral control, Two area load frequency control, Automatic voltage regulator, Excitation system – DC Exciter, AC Exciter and Static Exciter.

Stability Analysis:
Introduction to stability, Dynamics of synchronous machines, Swing equation, Power angle curve and its equation, Steady state stability, Equal area criterion, Effect of clearing time on stability.

Text Books:

Reference Books:

EE 3005 POWER ELECTRONICS Cr-4

Course Outcome: At the end of the course, the students will be able to:

CO1. Design the AC to DC converter and use of power factor improvement techniques.
CO2. Realize the modes of operation of DC to DC converters.
CO3. Implement the control techniques for operation of DC to AC converters.
CO4. Use of resonant converters, soft switching converters and SMPS

Pre-requisites: Basic Electrical Engineering (EE 1003) and Basic Electronics (EC-1001)

Introduction to Power Electronics:
Elements of Power Electronics, Several Applications of Power Electronics.

Power Electronics Devices:
Thyristor characteristics Turn on methods, Dynamic characteristics of thyristors, Ratings, Protection, Two Transistor model of thyristor Characteristics and constructions of power MOSFETs, Comparison between power MOSFET and power BJT, Characteristics and constructions of IGBT forward and reverse blocking capability, Latch up, Switching characteristics, Safe operating area, Snubber protection, GTO - turn on and turn off methods, IGBT characteristics, TRAIC and DIAC characteristics and applications.

AC to DC Converters:
**Inverters:**
Single phase Half Bridge and Full bridge inverters, 3 phase inverters, $180^\circ$ and $120^\circ$ conduction, Voltage control of inverters: Single pulse and multiple pulse width modulation, Sinusoidal pulse width Modulation, Concept of current source inverters.

**DC to DC Converters:**
Step up and step down choppers, 2 and 4 quadrant choppers for control of DC motor.

**AC to AC Converters:**
Single phase AC to AC converter with R and RL load.

**SMPS:**
Advantages of switch mode power supply over conventional power supply, Fly back converters.

**Text Books:**

**Reference Books:**
2. Modern Power Electronics by P C Sen, S Chand Publisher- 2013

**EE 3006 ELECTRIC DRIVES AND CONTROL Cr-3**

**Course outcome:** At the end of the course, the students will be able to:

**CO1.** Select the motor for different type of industrial applications.
**CO2.** Start and control the speed of dc machine by different methods.
**CO3.** Control and to know the different types of braking of 3-phase induction motor.

**Pre-requisites:** DC Machine and Transformer (EE 2005), AC Machine (EE 2010), Power Electronics (EE 3005) and Linear Control Theory (EE 2012).

**Introduction:**
Basic elements of an electric drive, Four quadrant operation of an electric drive, Dynamics of motor load combination, Types of loads, Stable operating condition of various motor load combinations.

**DC motor:**

**Closed loop control of DC motor drives:**
Closed loop Speed control, Closed loop Torque control, Hysteresis control, PI control, PLL control.

**Induction Motors:**
Review of characteristics of three phase Induction motors. Modification of speed torque characteristics due to variation of: stator voltage, Stator frequency and rotor resistance. Methods of starting, Squirrel Cage and slip ring

**Solid State Control of DC drive:**
Phase controlled and Chopper controlled DC Separately excited motor and series motor drives. Four quadrants drive using dual converter. Closed loop control scheme for DC motor.

**Solid State Control of Induction Motors:**

**Text Books:**

**Reference Books:**

**EE 3007 POWER TRANSMISSION AND DISTRIBUTION**  
**Cr-3**

**Course Outcome:** At the end of the course, the students will be able to:

CO1. Use of the different power system components.
CO2. Realize the effects of corona and different factors effecting corona in transmission line.
CO3. Solve the problem in mechanical design of overhead transmission lines under different loading condition.
CO4. Application of underground cables.
CO5. Solve the different configuration of distribution system.

**Pre-requisites:** Basic Electrical Engineering (EE 1003) and Network Analysis (EE 2003)/ Network Theory (EE-2007)

**Introduction:**
Single and 3-phase transmission, Concept of complex power, Per Unit system, Power System layout.

**Supply System:**
Comparison of AC and DC transmission, Advantage of high voltage transmission, Advantages and Disadvantage of EHV (AC) and HVDC Transmission.

**Line constants:**
Resistance, Inductance of Single phase and three phase line with symmetrical and unsymmetrical spacing, GMD and GMR calculation, Transposition of power line, Capacitance of Single phase line, Effect of earth on line capacitance, Charging current due to capacitance effect, Bundle conductors, Skin and Proximity effect.

**Performance of Transmission line:**

**Corona:**
Critical disruptive voltage, Visual critical voltage, Corona Power losses, Factors affecting corona, Advantages and Disadvantages of Corona, Problem Discussion, Radio Interference between power and communication line.
Mechanical Design of over head transmission lines:
Types of conductor and insulator, Insulating materials, Potential distribution over a string of suspension Insulators, String Efficiency, Methods of equalization of the potentials, Sag and Stress calculation, Effect of ice and wind loading, Vibration dampers.

Underground Cable:
Overhead line verses underground cables, Type and construction, Grading of cables, Insulation resistance of cable, Capacitance of three core cable, dielectric losses.

Distribution Systems:
Classification of distribution system, Types of AC and DC distributors, Feeder, Voltage drop and load calculation for concentrated and distributed loads, Radial and ring main system, Economic choice of conductor, Kelvin’s law.

Text Books:

Reference Books:
5. Overhead Power lines planning, design and construction, by F Kiessling, P Nefzger, J F Nolasco and U Kaintzyk, Springer- Verlag

EE 3021 PRINCIPLES OF INDUSTRIAL INSTRUMENTATION Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Application of different measurement systems in Industry
CO2. Analysis of different quantities and different telemetry techniques.
CO3. Explore the different instrumentation usage and analysis in power plant.
CO4. Operate data logging systems.

Pre-requisite: Basic Electrical Engineering (EE 1003)

Characteristics of Measurement System:

Pressure, Temperature and Flow Measurement:

Instruments for Analysis:
Introduction, Gas Analyzers, Liquid Analyzers, X-ray Methods, Chromatography, Mass spectrograph.

Telemetry:
Introduction, Pneumatic Means, Electrical Means, Frequency Telemetering, Multiplexing, Modulation, Modulation
of Digital Data, Transmission Channels, Briefing of a Telemetry System in Operation.

**Power Plant Instruments:**

**Display, Recording, Alarm:**
Introduction, Display methods, Recorders, Alarm annunciation, Data logging system.

**Text Book:**

**Reference Books:**

**EE 3023 HIGH VOLTAGE ENGINEERING Cr-3**

**Course Outcome:** At the end of the course, the students will be able to:

CO1. Generate high Voltage and high current.
CO2. Measure and test of high voltage electrical equipments.
CO3. Perform the Breakdown characteristics of different dielectrics.
CO4. Implementation of HVDC Transmission system.

**Pre-requisites:** Basic Electrical Engineering (EE 1003) and Mathematics-I (MA 1001)

**Generation of High Voltage and Currents:**

**Measurement of High Voltage and Currents:**

**High Voltage Testing of Electrical Apparatus:**

**Conduction and Breakdown in Gases:**
**Conduction and Breakdown in Liquid Dielectrics:**
Pure and Commercial Liquids, conduction and Breakdown in Commercial liquids, Electronic, Cavitations and suspended particle theory.

**Breakdown in Solid Dielectrics:**
Intrinsic, Electromechanical, Thermal, Treeing and Tracking, Breakdown in composite dielectrics.

**Design of High Voltage Laboratories:**
Test facilities provided in High Voltage laboratories, Classification of High Voltage laboratories, selection and rating of HV test equipment, layout and clearance, Shielding and grounding of high voltage Laboratories, Introduction to the problem of Electromagnetic interference.

**Introduction to D.C. Power Transmission Technology:**

**Text Books:**

**Reference Books:**

**EE 3025 POWER STATION ENGINEERING Cr-3**

**Course Outcome:** At the end of the course, the students will be able to:

CO1. Realization of different Power Plants
CO2. Operate various electrical equipments connected with Power Plant and system parameters.
CO3. Realize the economic aspects of the power plants.

**Pre-requisite: Basic Electrical Engineering (EE 1003)**

**Introduction:**
Introduction to different sources of Energy. Discussion on application of energy sources to power station.

**Thermal Power:**
Layout of thermal power plant, Main Equipment, Coal Handling plant, Boiler, Super heater, Reheater, Economizer, Air Preheater steam turbine, Ash handling plant, condenser, Cooling tower and ponds, Feed water heater, E.S.P, Power supply to auxiliaries.

**Hydro Power Plant:**
Classification according to (i) Water Flow (ii) Load (iii) Head surge tank, Penstock, spillway, Tail Race, Types of turbine (i) Pelton turbine, (ii) Francis turbine, (iii) Kaplan turbine, Governor, specific speed, Plant auxiliaries.

**Nuclear Power Plant:**
Location, Layout of nuclear power plant, Fission, Fusion, controlled chain reaction, Classification of Nuclear reactors –Advanced Gas cooled Reactor, Pressurized Water Reactor, Boiling Water Reactor, Fast Breeder Reactor, and Reactor Control and Cooling.
Diesel Electric Power plant:
Introduction, Selection of site, Layout and Main components, Applications.

Gas Turbine:
Principle of operation.

Electrical System:
Testing and commissioning of generators and power transformers. HT, EHT and LV Substation arrangements. Station batteries and battery chargers.

Economic Aspects:
Load curve, Load duration curve, Connected load, Maximum demand, Demand factor, Average demand, Load factor, Diversity factor, Plant capacity Factor, Plant Use Factor, Tariffs-Types, power factor improvement.

Text Book:
1. M.V. Despande, Elements of electrical power system design, PHI, 2010

Reference Books:

EE 3027 ELECTRICAL ENGINEERING MATERIALS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Know the use of different of dielectrics, insulators and conductors.
CO2. Understand the usage of materials for each electric machine.
CO3. Realize various crystal structures.

Pre-requisites: Basic Electrical Engineering (EE 1003)& Physics (PH 1003)

Atoms and Aggregate of Atoms:
Structure of atom, electronic configuration, Bonds and bonding, crystallization of materials. Crystal symmetry and structure. Lattice arrangement of atom in materials, molecules and its structures, metallic and amorphous structures. Insulating materials: Dielectric properties of insulators in static fields. The static dielectric constant, Polarization and dielectric constant. The atomic interpretation of the dielectric constant of monatomic gases. Qualitative remarks on the dielectric constants on polyatomic molecules, Quantitative discussion of the dielectric constant of polyatomic gases, the internal field in solid and liquids, the static dielectric constant of solids, Spontaneous polarization, Piezoelectricity.

Behaviour of Dielectrics in Alternating Fields:
Frequency dependence of the electric polarization, Ionic polarization as function of frequency, the complex dielectric constant of non-polar solids. Dipolar relaxation, Dielectric losses. Magnetic properties of Materials: Summary of concepts pertaining to magnetic fields; The magnetic dipole moment of a current loop, The magnetization from a microscopic view point, Orbital magnetic dipole moment and angular momentum of two simple atomic models, Lenz’s Law and induced dipole moments.

Classification of Magnetic Materials:
Diamagnetism, The origin of permanent magnetic dipoles in matter, Paramagnetic spin system, Some properties of ferromagnetic materials, Spontaneous magnetization and the Curieweiss Law, Ferromagnetic domains and coercive force, Anti-ferromagnetic materials, Ferromagnetic materials, Mechanism of Conduction in Semiconductors:
Classifying materials as semiconductors, The chemical bond in Si and Ge and its consequences. The density of carriers, intrinsic semiconductors, the energy gap, the conductivity of intrinsic semiconductors, Carrier densities in n-type semiconductors, P-type semiconductors, Hall effect and carrier density.

**Conducting Materials:**
General properties and specifications of pure copper and aluminium, factors affecting resistivity, wiedemann Franz law, Materials and alloys for high conductivity, Characteristics of brass and different types of bronzes, Different types of solders, Metals and alloys for different types of fuses, fusing current and fuse ratings. Materials used for highly loaded metal contacts, electrical carbon material, characteristics of different carbon and graphite brushes. Materials of high resistivity, alloys for use in electrical resistance, arc-lamps and electric furnaces, introduction to superconductivity. Nano materials: Introduction, synthesis, and characterization; Description of basic energy carriers and nanostructures.

**Text Book:**

**Reference Books:**

**EE 3028 POWER ELECTRONIC CIRCUITS Cr-3**

**Course outcome:** At the end of the course, the students will be able to:

- CO1. Design the AC to DC converter and to analyse power factor improvement techniques.
- CO2. Realize the modes of operation of DC to DC converters.
- CO3. Realize the control techniques for operation of DC to AC converters.
- CO4. Know the use of resonant converters and soft switching converters, SMPS.

**Pre-requisites:** Basic Electrical Engineering (EE 1003) & Basic Electronics (EC-1001)

**Introduction to Power Electronics:**
Advantage of power devices operating in the switch mode to those operating in the active region.

**Power Electronic Devices:**
Thyristor characteristics, Turn ON methods, Dynamic Characteristics of thyristors, Ratings, Protection, Two Transistor Model of Thyristor, Characteristics and construction of Power MOSFETS, Comparison between Power MOSFET and Power BJT, Characteristics and construction of IGBT, Switching characteristics. GTO – turn on and turn off methods, SiC based power devices, TRIAC and DIAC Characteristics and applications.

**AC to DC Converters:**

**DC to DC Converters:**
Step up and Step Down choppers, 2 and 4 quadrant choppers for control of DC motor. Buck- Boost converter
Inverters:
Single Phase Half Bridge and Full Bridge Inverters, 3 Phase Inverters, 180° and 120° conduction, Voltage Control Of inverters;, Sinusoidal Pulse Width Modulation, Concept of multi level inverters.

AC to AC Converters:
Single phase AC to AC Controllers with R and RL load, Single Phase cycloconverters with R and RL load.

Switch Mode Power Supply (SMPS):
Advantage of Switch Mode Power Supply over Conventional Power Supply, Fly back converters.

Text Books:

Reference Books:
3. Modern Power Electronics by P C Sen, S Chand Publication 2013

EE 3030 OVERHEAD POWER TRANSMISSION LINE CONSTRUCTION AND MANAGEMENT

Course outcome: At the end of the course, the students will be able to:

CO1. Design different components of transmission and distribution lines.
CO2. Perform different testing of transformer and DC Machines.
CO3. Maintain different Electrical Machines.

Pre-requisites: Basic Electrical Engineering (EE 1003), Power Transmission and Distribution (EE 3007), and DC Machine and Transformer (EE 2005).

Installation, Commissioning and Testing of Transmission and Distribution Lines:
Planning the route of H.T. Lines, Planning the route of distribution lines, planning of construction work, erection and setting poles guys, cross arms, insulator and jumpers etc, fixing of guarding, anti-climbing devices and danger plates, concept of right of way, service connection, installation of energy meter.

Installation, Commissioning and Testing of Cables:
Inspection on arrival of cables, transportation, handling and storage of cables, consideration for selection of cables, current rating of cables, various causes of faults and testing of cables, joints in cable and various method of joining.

Installation, Commissioning and Testing of Transformers and DC Machines:
Inspection of arrival of machine, location for foundation of machine and its switch gear, foundation preparation-levelling, alignment, fittings and IER related to installation. Dispatch, inspection, storage and handling of transformer, civil construction feature regarding connection like ventilation, noise level, space for free movement, foundation, drainage of oil, cabling, cable box, fire protection, provision for bushing supports, location of switch gear, various steps for commissioning fitting of all accessories, filling of oil, drying out, charging the breather with
fresh silica gel, cleaning of bushing, fixing conductor and cables, earthing tank and cover, neutral earthing, fixing of protection circuit, setting of relays.

**Installation, Commissioning and Testing of Sub-station:**
Design and planning of indoor substation, layout with key diagram, consideration for safe operation of substation, installation of outdoor substation, testing and commissioning of substation, installation of control and relays panel, installation of outdoor circuit breaker, civil works, various step for installation, pre-commissioning checks/test.

**Maintenance:**
Fundamental of maintenance, preventive maintenance, maintenance planning, advantage of preventive maintenance-daily, weekly, monthly, half yearly, yearly maintenance. Break down maintenance, list of tools/instruments and material used for maintenance, making of maintenance schedule of DC machines, induction machines, synchronous machine, transformer, transmission lines, distribution lines, underground cables, circuit breaker, switch gear protective relays and substation, batteries in substation.

**Text Books:**

**Course Outcome:** At the end of the course, the students will be able to:

CO1. Learn about the trends in EHV AC Transmission and Calculate Line inductance and capacitance of bundled conductors
CO2. Realize the effects of corona like audible noise and Radio Interference
CO3. Calculate electrostatic field of EHV AC lines.
CO4. Understand the Lightning, Lightning Protection and over voltage in EHV Systems

**Pre-requisite: Power Transmission and Distribution (EE 3007)**

**Introduction to EHV AC Transmission:**

**Corona Effects: Power Loss and Audible Noise:**
PK Loss and Corona Loss, Corona-Loss Formula, Charge-Voltage (q-V) Diagram and Corona Loss, Attenuation of Travelling Waves due to Corona Loss, Audible Noise: Generation and Characteristics, Limits for Audible Noise, AN Measurement and Meters, Formulae for Audible Noise and Use in Design, Relation between Single-Phase and 3-Phase AN Levels, Day-Night Equivalent Noise Level, Some Examples of AN Levels from EHV Lines.

**Corona Effects-II: Radio Interference:**
Lightning and Lightning Protection:

Over voltage in EHV Systems Caused by Switching Operations:

Text Book:

Reference Books:

EE 3034 NEURAL NETWORK, FUZZY LOGIC AND EVOLUTIONARY ALGORITHM Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Know the Learning Paradigms and ANN Paradigms
CO2. Solve nonlinear problems by Neural Network and Fuzzy Controllers
CO3. Understand the convergence characteristics of Genetic Algorithms, ANN

Pre-requisites: Basic Electrical Engineering (EE 1003) and Mathematics-I (MA 1001)

Learning Paradigms:
Introduction models of neural Network, architectures, knowledge representation, Artificial Intelligence and Neural Networks, learning process, error correction learning, Hebbian learning, competitive learning, Boltzmann learning, supervised learning, unsupervised learning, reinforcement learning, learning tasks.

ANN Paradigms:
Multi-layer perceptron using back propagation algorithm (BPA), self organizing map (SOM), radial basis function network, Functional Link Network (FLN), Hopfield Network.

Fuzzy Logic:
Introduction, fuzzy versus crisp, fuzzy sets, membership function, basic fuzzy set operations, properties of fuzzy sets, fuzzy Cartesian product, operations on fuzzy relations, fuzzy-logic, fuzzy quantifiers, fuzzy inference, fuzzy rule based system, defuzzification methods.
**Genetic Algorithms:**
Introduction, encoding, fitness function, reproduction operators, genetic modelling, genetic operators, crossover, single site crossover, two point crossover, multi point crossover, uniform crossover, matrix crossover, crossover rate, inversion and deletion, mutation operator, mutation, mutation rate, bit–wise operators, generational cycle, convergence of genetic algorithm.

**Text Books:**
2. Computational Intelligence: Synergies of Fuzzy Logic, Neural Network and Evolutionary Computing by Nazmul Siddique, Hojjat Adeli, John Wiley and Sons, 2013

**Reference Books:**

**EE 3036 DISCRETE AND NON LINEAR CONTROL THEORY Cr-3**

**Course Outcome:** At the end of the course, the students will be able to:

CO1. Model the non-linear physical systems by state space techniques.
CO2. Formulate, design of digital control systems and represent digital control systems using state space models.
CO3. Design the compensator and understand the concepts of discrete Time Control Systems

**Pre-requisites:** Basic Electrical Engineering (EE 1003), Mathematics-I (MA 1001) and Linear Control Theory (EE-2012)

**State Space and State Solution:**
Concept of State, State Space, Concept of Physical variables and phase variables, Modelling of Mechanical, Electrical, Electro-Mechanical Systems in State Space; Transfer Function Decomposition Controllable Canonical Form, Observable Canonical Form, Cascade Form, Parallel Form, Non Uniqueness of State Model, Diagonalization: Similarity Transformation, State Transition Matrix: Concept, Resolvant Matrix Method, Infinite Series (Sylvester) Method, Clayey Hamilton Theorem; State Solution.

**State Feedback Design:**
Compensator Design:
Design of lag, lead, lag-lead compensator in Frequency Domain.

Discrete Time Control Systems:

Text Book:

Reference Books:

EE 3038 UTILIZATION OF ELECTRIC POWER Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Interpret Electric Tariff and its applications.
CO2. Study the process of Electrical heating and Electrical welding.
CO3. Analyze electrolytic process, Electric Drives, Electric Traction and Illumination techniques.

Pre-requisites: Basic Electrical Engineering (EE 1003) and Mathematics-I (MA 1001)

Electric Tariff:
Classification of costs, Formulation of Electric Tariff, Various kinds of Tariff, Economics of generation. Effect of load factor, Diversity factor and power factor on tariff, power factor improvement.

Electric Heating:

Electrical Welding:
Electric welding- Arc welding, Resistance welding circuit used in electric welding, Electric welding equipments and arc welding, Welding accessories.

Illumination:

Electrolytic Process:
Faradays law of electrolysis, Extraction of metals, Electroplating.
**Electric Drive:**
Types of Drive, Types of load, Selection of Electric Drive.

**Electric Traction:**
System of Track electrification, typical speed-time curve, Tractive effort calculation, Specific energy consumption calculation, Electric Traction motors, Electric braking, Power Supply for Electric Traction.

**Text Book:**

**Reference Books:**

EE 3040 ELECTRIC POWER GENERATION TECHNOLOGIES Cr-3

**Course Outcome:** Analyse at the end of the course, the students will be able to:

- **CO1.** The layout of different Power Plants (detailed operation and electrical power generation of the each Power Plant)
- **CO2.** Analyze various electrical components connected with Power Plant and system parameters.
- **CO3.** Understand the different renewable energy generation systems.

**Pre-requisite:** Basic Electrical Engineering (EE 1003)

**Thermal Power :**
Layout of thermal power plant, Main Equipment, Coal Handling plant, Boiler, Super heater, Reheater, Economizer, Air Preheated steam turbine, Ash handling plant, condenser, Cooling tower and ponds, Feed water heater, E.S.P, Power supply to auxiliaries.

**Hydro Power Plant:**
Classification according to (i) Water Flow (ii) Load (iii) Head surge tank, Penstock, spillway, Tail Race, Types of turbine (i) Pelton turbine, (ii) Francis turbine, (iii) Kaplan turbine, Governor, specific speed, Plant auxiliaries.

**Nuclear Power Plant:**
Location, Layout of nuclear power plant, Fission, Fusion, controlled chain reaction, Classification of Nuclear reactors – Advanced Gas cooled Reactor, Pressurized Water Reactor, Boiling Water Reactor, Fast Breeder Reactor, and Reactor Control and Cooling.

**Diesel Electric Power plant:**
Introduction, Selection of site, Layout and Main components, Application.

**Gas Turbine:**
Principle of operation.

**Solar Energy:**
Wind Energy:

Biomass Energy:

Geothermal Energy:

Text Books:
1. M.V. Despande, Elements of electrical power system design, PHI,2010

Reference Books:

EE 3042 PRINCIPLES OF ENERGY CONVERSION Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Principle of operation, construction, performance characteristics, starting and testing of DC machines.

CO2. Know the design and applications of transformers.

CO3. Understand the details about different parameters, principle of operation, and construction, types, usage and voltage regulation and starting of synchronous machines.

CO4. Understand the principle of operation, construction, types, use, starting, testing and to draw the performance curve of 3-Ø Induction motor.

Pre-requisite: Basic Electrical Engineering (EE 1003)

Electromechanical Energy Conversion:
Principle, Singly Excited Magnetic System and Doubly Excited Magnetic system, Physical concept of torque production, Electromagnetic torque and Reluctance torque.

DC Machines:
DC Generator:Construction features, emf equation of dc generator, methods of excitation, losses, condition for maximum efficiency, armature reaction, interpoles and compensating winding, commutation, characteristics of separately excited and self excited dc generator. DC Motor: Working principle, voltage equation, condition for maximum power, characteristics, operating characteristics of dc motor, torque developed, starting, 3 point and 4 point starter, speed control methods.

Transformers:
3 Phase induction motor:
Construction, types, rotating magnetic field, principle of operation, slip, frequency of rotor current, rotor emf, rotor current, expression for torque, conditions for maximum torque, torque slip characteristics, starting torque in squirrel cage and slip ring motors, effect of change in supply voltage on torque, slip and speed, relation between full load torque and maximum torque, Power stages in induction motor, vector diagram and equivalent circuit, speed control of 3 phase motor, starting methods for 3 phase induction motor.

Synchronous Machine:

Text Books:
1. Electrical Machines by Ashfaq Hussain; Dhanpatrai and Co.
2. Text of Electrical Technology; Vol -II; B. L. Theraja, and A. K. Theraja; S. Chand Publication

Reference Books:
1. Principles of Electrical power systems by J. B. Gupta
2. Generalised theory of rotating machines By P S Bhimra

EE 3044 CIRCUIT THEORY Cr-3

Course Outcome: At the end of the course, the students will be able to:
CO1. Analyze DC and AC circuit by different network theorems, properties of coupled circuit and usage of network graph to solve electrical circuits.
CO2. Realize transients in AC/DC circuits
CO3. Acquire knowledge of operation of two port networks, network functions and their response.
CO4. Learn the concepts of filter design

Pre-requisite: Basic Electrical Engineering (EE 1003)

Network Topology:
Concepts of Network graph, Tree, Co-Tree, Links and Twigs. Formation of incidence matrix [A] and loop matrix [B], Formation of Fundamental Cut-Set Matrix [QF], Tie-Set Matrix, Relation between branch voltage and current, loop current network topology analysis.

Network Theorems:
Maximum Power Transfer theorem (Both AC and DC Network), Reciprocity Theorem and Millman’s Theorem, Tellegen’s theorem.

Couple Circuit:
Self and Mutual Inductance. Dot conventions for couple circuits and coefficient of coupling, Tuned coupled circuits (Double Tune and Single Tune).

Transient Response:
Transient response of RL, RC and RLC circuits with a constant and sinusoidal excitation in time domain by Laplace transformation method, Introduction to different Signals, Periodic and non-periodic function, Response to step, impulse and ramp inputs, S-domain circuits.
Two-Port Networks:
Open Circuit, Short circuit, hybrid and transmission parameters, T and π-Circuit representation, Interconnection of two port networks (Series, Parallel and Cascade).

Network Functions and Responses:
Concept of complex frequency, driving point and transfer functions of one and two-port networks, Calculation of the network functions, Restrictions on poles and zero location of network function and impulse responses, Time domain behavior from pole-zero plot using Laplace transform.

Synthesis of Passive Network:
Hurwitz polynomial, Positive real Function and properties of Driving point function, Synthesis of LC, RC and RL driving point function by Cauer-I and Cauer-II, Foster-I and II forms.

AC circuits with non-sinusoidal wave forms:
Fourier series representation of complex waves and Symmetry in Fourier Series, Average and RMS values of periodic complex wave.

Filter Design:
Introduction, Active and Passive filters, Design of low pass and high pass filter, Design of Band-pass and band elimination filters.

Text Books:

Reference Books:

EE 3046 SOLAR POWER TECHNOLOGIES Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Implement various approaches of utilizing solar energy.
CO2. Realize power conditioning and MPPT operation.
CO3. Design grid connected PV system.

Pre-requisites: Basic Electrical Engineering (EE 1003) and Physics (PH 1003)

Introduction:
Basics of solar energy, Brief History of solar energy utilization, various approaches of utilizing solar. energy, Blackbody radiation, Relation between radiation field energy density and radiation spectrum, Planck’s formula in energy unit, Maximum spectral density, Planck’s formula in wavelength unit, Wien displacement law, Stefan Boltzmann law, Photoelectric effect, Einstein’s theory of photons, Einstein’s derivation of the black-body formula.

Solar Cells:
Formation of a p-n junction, Space charge and internal field, Quasi - Fermi levels, The Shockley diode equation - Structure of a solar cell, The solar cell equation, Fill factor and maximum power, Various electron, hole-pair recombination mechanisms, Crystalline silicon solar cells, Thin film solar cells.
Solar Photovoltaic Technology:
Solar PV modules from solar cells, Balance of solar PV system, Inverters (DC/DC, DC/AC), Power conditioning, Maximum power point operation, and Standalone PV system design, Grid-connected PV system, Balance of System (BOS) for PV module installation, Concentrated solar power (CSP) systems.

Energy Storage:
Necessity of storage for solar energy- Chemical energy storage - Thermal energy storage – Thermal Flywheels - Compressed air- Rechargeable batteries.

Text Books:

Reference Books:

EE 4003 SWITCH GEAR AND PROTECTION Cr-3

Course outcome : At the end of the course, the students will be able to:
CO1. Know the basics of the switchgears and current chopping phenomenon.
CO2. Understand the working principles of different types of Circuit Breakers.
CO3. Understand the requirements of substations and earthing mechanism.
CO4. Know the philosophy of protection, construction and operation of protective devices in power system.

Pre-requisites: Power Transmission and Distribution (EE 3007), Electrical Measurement and Measuring Instrumentation (EE 2016) and Microprocessor and Microcontrollers (EC 3003)

Introduction:
Requirement of circuit breakers, characteristics of an electric arc, principle of AC and DC arc interruption, Recovery voltage, re-striking voltage and effect of current asymmetry upon them, current chopping, resistance switching.

Circuit Breakers:
Types of AC and DC circuit breakers in general, oil circuit breaker, plain break and controlled break, minimum oil circuit breaker, air blast circuit breaker, vacuum and SF₆ circuit breaker, introduction to miniature case circuit breaker and moulded case circuit breaker, Calculation of fault MVA for symmetrical short circuits and determination of circuit breaker capacity, circuit breaker ratings.

Substation and Earthing:
Types of substations, arrangement of circuit breakers, isolators and bus bars, limiting reactors in power system, Methods of neutral grounding (solid earthing, resistance earthing and Peterson coil earthing and its effects on fault conditions). H.R.C, Fuse, its construction, capacity and characteristics.
Protective Devices:
Philosophy of protection, requirement of ideal protective scheme, definition of different terms in protective systems, Basic elements in protective scheme, Construction and Principle of operations of Electromagnetic type, induction type: over current, directional, distance relays.

Alternator Protection:
Different types of faults, differential protection with biasing, restricted earth fault protection, negative sequence protection, automatic field suppression and neutral circuit breakers.

Transformer Protection:
Buchholz relay, Biased differential protection, restricted earth fault protection, harmonic restraint, protection of combined alternator and transformer.

Bus Bar Protection: Differential scheme for both phase and line faults, frame leakage scheme, introduction to digital protective relay and microprocessor based relays.

Feeder Protection:
Time graded protection: radial, parallel and ring feeders; over current and earth fault protection, calculation of graded time setting, split core protection of feeders, carrier current protection and introduction to microwave pilot system, arrangement of relay contacts.

Pilot Wire Protection:
Circulating current differential protection (Merz-Price protection), Biased or percentage differential protection scheme, opposed (balanced) voltage differential protection system, Translay scheme; static relays.

Protection Against Surges: Ground wire, Surge diverters: rod gap, horn gap lighting arresters; surge absorbers.

Text Books:
2. Power System Protection and Switchgear by B Rabindranath and M Chander, Wiley Eastern (1977)

Reference Books:
**EE 4022**  
**BIO POWER**  
**Cr-3**

**Course Outcome**: At the end of the course, the students will be able to:

CO1. Study Composition and Conversion of biomass.
CO2. Know various gasification processes of Biomass.
CO3. Analyze and understand the various aspects of Bio Fuel.

**Pre-requisites**: Chemistry (CH 1003) and Environmental Science (CH 1005)

**Introduction**: 
Biomass and solid wastes, Broad classification, Production of biomass, photosynthesis, Separation of components of solid wastes and processing techniques, Agro and forestry residues utilization through conversion routes: biological, chemical and thermo chemical, Bioconversion into biogas mechanism.

**Composition and Conversion**: 
Composting technique, Bioconversion of substrates into alcohols, Bioconversion into hydrogen, Thermo chemical conversion of biomass, conversion to solid, liquid and gaseous fuels, pyrolysis, gasification, combustion, Chemical conversion processes, hydrolysis and hydrogenation, Solvent extraction of hydrocarbons, Fuel combustion into electricity, case studies.

**Biomass Gasification**: 

**Bio Fuel**: 
Solid, liquid and gaseous fuels, Coal as a source of energy and chemicals in India, Coal preparation, Carbonization, Gasification and liquefaction of coal and lignite, Principle of combustion, Petroleum and its derived products, Testing of liquid fuels, Petroleum refining processes, Inter-conversion of fuels, Natural gases and its derivatives, sources, potential, Gas hydrates, Combustion appliances for solid, liquid and gaseous fuels, Introduction to nuclear fuel, RDF, Bio-fuels, etc.

**Text Books**: 
2. Understanding Clean Energy And Fuels From Biomass, by H.S. Mukunda, Wiley India Pvt Ltd, 2011

**Reference Books**: 
2. Energy Technology by S. Rao. and B. B Parulekar, Khanna Publisher Delhi, 1999.
3. Non conventional Energy Sources, by G D Rai, Khanna Publisher, 200

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**EE 4024**  
**WIND POWER**  
**Cr-3**

**Course Outcome**: At the end of the course, the students will be able to:

CO1. Know the potential of wind energy worldwide and in India, and to study the aerodynamics of wind turbines.
CO2. Understand the classification of wind power plants and to study the different components of wind power plants. To study the power control strategy of wind power plants.
CO3. Study the details of the wind energy conversion systems.
Pre-requisites: Basic Electrical Engineering (EE 1003), Basic Electronics (EC 1001), DC Machine and Transformer (EE 2005) and AC Machine (EE 2010)

Wind Power:

Wind Power Plant:

Major Power Electronics Components in Wind Power Plants:
Power Electronics in Wind Power Plants, Type-A WPP with Squirrel cage Induction generator, Type-B WPP with Wound Rotor Induction generator, Type-C WPP with Doubly-fed Induction generator: Type-D WPP with Wound Rotor Synchronous generator, Type-D WPP with Permanent Magnet Synchronous generator.

Economics of Wind Power Plants:
Wind Power Quality and Electrical Generators, Grid Integration of Wind Power Plants, Wind resource Assessment, setting of Wind Power Plants, Economics of Wind Power Plants, Choice of Wind Turbines, Wind Power Project development.

Maintenance of Wind Power Plant components:

Text Books:

Reference Books:

EE 4025 ELECTRIC TRACTION AND DRIVE Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Understand the general features of Electric traction and the traction drives.
CO2. Familiarization with Prevailing Indian standard and vector control techniques of Induction Motor Drives.
CO3. Understand the parameter sensitivity compensation and vector controllers.

Pre-requisites: DC Machine and Transformer (EE 2005) and Power Electronics (EE 3005)

Introduction to Traction
General features of Electric traction, Measurement of train movement.

Tractive Effort:
Calculation of tractive effort, Electrical Motors for traction, Modern Power Electric converters in modern traction.

AC Drives in Electric Traction
Diesel electric traction, reference of Indian Standards, AC drives in Electric Traction.
Vector Controller Induction Motor Drive:
Dynamic d-q model of 3 phase induction motor d-q equivalent circuit(stator, rotor, synchronously rotating reference frames model), equation of flux linkage, small signal equations of induction motor, dynamic model state space equations, Principles of vector control, direct vector control, implementation with voltage source, Derivation of indirect vector control scheme.

Parameter Compensation :
Parameter sensitivity of the indirect vector controlled induction motor drive, Parameter Sensitivity compensation, Speed- Controller design for an indirect vector controller induction motor drive, Sensorless vector control.

Text Books:

Reference Books:

EE 4026 SOLAR POWER Cr-3

Course Outcome : At the end of the course, the students will be able to:
CO1. Understand the design and analysis of Solar Cells and sizing of Solar power plant.
CO2. Various aspects of solar PV applications.

Pre-requisites: Basic Electrical Engineering ( EE 1003), Basic Electronics (EC 1001) Electrical Engineering Material ( EE 3027) and Physics (PH 1003)

Design of Solar Cells:
Limits of cell parameter, losses in solar cell, solar cell design, Analytical techniques.

Solar Cell Technologies:
Production of Si, Growth of solar PV industry and Si requirements, Production of MGS and EGS, Si wafer based solar cell technology, thin film solar cell technologies, Concentrator PV cells and Systems, Emerging solar cell technologies and concepts.

Solar PV Application:

Balance of Solar PV Systems:
Basic of electrochemical cell, Factors affecting the battery performance, Batteries for PV systems, Algorithm of MPPT, Charge controllers.

Photovoltaic System Design:
Introduction to Solar PV systems, Stand alone PV system configurations, Design methodology PV systems, Wire sizing in PV system, Precise sizing of PV systems , Hybrid PV systems, Grid connected PV systems, Simple payback period, Life cycle costing(LCC).
Text Books:
2. Wind and solar systems by Mukund Patel, CRC Press, 2006

Reference Books:

EE 4028 SURGE AND LIGHTNING PROTECTION AND SAFETY DEVICES

Course Outcome: At the end of the course, the students will be able to:

CO1. Understand the protection of the system by use of safety devices.
CO2. Know the idea of surge and to recover from its impact, how to keep healthy the system from lighting by diversion of the extra energy.
CO3. Understand the different Lightning protection and their applications.

Pre-requisites: Power Transmission and Distribution (EE 3007), Switchgear and Protection (EE 4003)

Introduction:
Basics of Lightning - Formation, Types, Magnitudes, Waveshape. World Lightning Map

Damage due to Lightning:
Direct & Indirect damages due to Lightning - Ground Potential rise and induced emf, overview of latest Indian/International Standard for Lightning protection IS/IEC 62305

Equipment:
Lightning protection for equipments inside building, Lightning protection design criteria for Infrastructure / Building, Earthing requirements for lightning protection, Step and Touch Potential.

Lightning/Surge Protection Device - Type 1 (Multiple MOV / Spark Gap), Type 2 (MOV)

Lightning protection Application: for 415V AC 3 Phase /230Vac 1 Phase Power supply, for low voltage (24V DC) instrumentation & industrial automation, for Solar Power Plants - Rooftop KW capacity, for Solar Power Plants - Land based MW capacity, for explosive industrial environment (e.g. Chemicals, Petrochemicals), for Signal & Telecommunication system, CCTV Surveillance system.

Text Books:
1. Power System Protection and Switchgear by B Rabindranath and M Chander, Wiley Eastern (1977)

Reference Books:
EE 4029                HVDC TRANSMISSION                Cr-3

**Course Outcome**: At the end of the course, the students will be able to:

- CO1. Know the applications of HVDC transmission system.
- CO2. Understand the role of HVDC converters and controls.
- CO4. Understand the converter fault and its protection.

**Pre-requisites**: Power Transmission and Distribution (EE 3007) and Power Electronics (EE 3005)

**HVDC Transmission**:
Introduction - comparison of AC and HVDC, HVDC transmission analysis of HVDC converters - pulse number - analysis with and without overlap - converter bridge characteristics - converter.

**HVDC System Control**:
Principles of dc link control - starting and stopping of dc link, power control - harmonics and filters – introduction- generation of harmonics - types of ac filters. power flow analysis in ac/dc systems - general modeling of dc links, solutions of ac - dc power flow.

**REACTIVE POWER CONTROL IN HVDC**:
Reactive Power Requirements in steady state-Conventional control strategies-Alternate control strategies-sources of reactive power-AC Filters – shunt capacitors-synchronous condensers.

**CONVERTER FAULT & PROTECTION**:
Converter faults – protection against over current and over voltage in converter station – surge arresters – smoothing reactors – DC breakers –Audible noise-space charge field-corona effects on DC lines-Radio interference.

**Text Books**:

EE 4030                ECONOMIC OPERATION OF POWER SYSTEMS                Cr-3

**Course Outcome**: At the end of the course, the students will be able to:

- CO1. Implement mathematical optimization techniques to the economic operation of power systems with different constraints.
- CO2. Understand the concept of Unit Commitment and its Solutions Methods.
- CO3. Analyse the Hydro Thermal coordination concepts.
- CO4. Understand the optimal power flow, power system security and control problems.

**Pre-requisites**: Power Transmission and Distribution (EE 3007), Power System Operation and Control (EE 3002)

**Economics Operation**:
Economic dispatch problem of thermal units without and with losses –Gradient Method –Newton’s Method –Base point and participation factor method.

**Unit Commitment Solutions Methods**:
Hydro-Thermal Co-Ordination:

Optimal Power Flow:
Solution of OPF, gradient method, Newton’s method, linear programming method with only real power variables, linear programming with AC power flow variables, security constrained optimal power flow.

Power System Security:

The Control Problem:
The two-area system, Tie-line Bias control; steady state instabilities: Torsional Oscillatory Model-Damper windings and negative damping, effect of AVR loop: AGC Design using Kalman method-state variable form of the dynamic model, optimum control index.

Text Books:

References Books:
1. Kirchmayer L. K. Economic Control of Interconnected systems”, John Willey and Sons, 1959.

EE 4031 NUMERICAL RELAYS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Know the digital system for relaying and signal processing
CO2. Understand the principle and communication protocol of numerical relay
CO3. Know different monitoring protocols and architecture of relay
CO4. Understand different techniques of numerical relay testing

Pre-requisites: Switchgear and Protection (EE 4003), Microprocessor and Microcontroller (EC 3003) and Digital Electronics (EC 2011)

General Introduction to Numerical Relays
Digital / Numerical Relay, Number Systems, Digital Systems, Denary to Binary Equivalents, Microprocessors, Microprocessor Principles, Microprocessor Architecture, Microprocessor Memories. Analog to Digital Converter (ADC), Multiplexers, Sample and Hold(S/H) Circuits, Operational Amplifiers.

Digital Signal Processing
Logic Devices and Systems Signal Processing Filters, Conversion from Time Domain to Frequency Domain Analysis.

Principles of Numerical Relays:

Protection and Coordinated Control
Protection and Coordinated Control, Place of Personal Computer, Self-Monitoring and Post Fault Analysis, Workstations and Remote Communication, Alstom EPA Computer (Publication N.1.6918 B), PSCN 3020 Bay Module: Integrated

Reliability, Testing, and Maintenance for Numerical Relays
Reliability, Software Considerations, Scheduling Problems, Redundancy, Relay Testing, Privatization and Deregulation of Electrical Industry, Protective Relaying Capabilities, Maintenance, Opto-electronic Sensors

Text Book:

EE 4037 ADVANCED POWER ELECTRONICS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Design the AC to DC and DC to DC power electronics converters
CO2. Understand the working and application of PWM inverters.
CO3. Usage of resonant converter and SMPS
CO4. Understand the FACTS devices and the gate drive circuits.

Pre-requisites: Power Electronics (EE 3005)

AC – DC Converters:

DC to DC Converters:

PWM Inverters:

Resonant Converters:

SMPS:
Flyback Converters, Forward Converter, Current Mode Control. Magnetic Materials suitable for high frequency transformers, Design of High Frequency transformers and Inductors.

FACTS:

Gate drive Circuits:
Gate drive circuits for Thyristor, MOSFET, IGBT, BJT, GTO

Static Switches:
AC switches and DC switches

250
Text Books:

Reference Books:

EE 4039 POWER QUALITY Cr-3

Course Outcome : At the end of the course, the students will be able to:

CO1. Know power quality problems and their Constraints for mitigation.
CO2. Analyze the transients generated and the sources and effects of harmonics in power quality problems.
CO3. Understand the different power quality compensation techniques.

Pre-requisites: Power System Operation and Control (EE 3002) and Power Electronics (EE 3005)

Introduction:
Importance of power quality, terms and definitions of power quality as per IEEE std. 1159. such as transients, short and long duration voltage variations, interruptions, short and long voltage fluctuations, imbalance, flickers and transients. Symptoms of poor power quality. Definitions and terminology of grounding. Purpose of groundings.

Flickers & Transient Voltages:
RMS voltage variations in power system and voltage regulation per unit system, complex power. Principles of voltage regulation. Basic power flow and voltage drop. Various devices used for voltage regulation and impact of reactive power management. Various causes of voltage flicker and their effects. Short term and long term flickers.

Voltage Sag, Swells and Interruptions:

Waveform Distortion:

Power Quality Monitoring

Text Books:
Reference Books:

EE 4041 ALTERNATE ENERGY SOURCES Cr-3

Course Outcome : At the end of the course, the students will be able to:

CO1. Recognize the need of renewable energy technologies and Global and National scenarios of energy.
CO2. Understand the principles of renewable energy production from various renewable sources.

Pre-requisite: Physics (PH 1003)

Introduction:
Renewable and non-renewable energy sources, energy consumption as a measure of Nation's development; strategy for meeting the future energy requirements Global and National scenarios, Prospects of alternate energy sources.

Hydrogen Energy:

Fuel Cells:
Introduction, Design principle and operation of fuel cell, Types of fuel cells, conversion efficiency of fuel cell, Applications for power generations.

Ocean Energy:
Ocean Thermal Electric Conversion (OTEC) systems like open cycle, closed cycle, Hybrid cycle. Energy from tides, basic principle of tidal power, single basin and double basin tidal power plants, advantages, limitation and scope of tidal energy. Wave energy and power from wave, wave energy conversion devices, advantages and disadvantages of wave energy.

Geothermal Energy:
Estimation and nature of geothermal energy, geothermal sources and resources like hydrothermal, geo-pressured hot dry rock, magma, advantages, disadvantages and application of geothermal energy, prospects of geothermal energy in India.

Magneto Hydro Dynamic (MHD) Power Generation:
Principle of MHD power generation, MHD system, design problems and developments, gas conductivity, materials for MHD generators and future prospects.

Energy Storage System:
Batteries, types, working principles, role of carbon nano tubes in electrode, super conducting magnetic energy storage (SMES) systems, Capacitor and super capacitor.

Text Books:
Course Outcome: At the end of the course, the students will be able to:

CO1. Understand various transducers and sensors
CO2. Analyze various logic gates
CO3. Analyze various Adaptive control mechanisms
CO4. Understand the signal conditioning and Data Acquisition system.

Pre-requisite: Electrical Instrumentation (EE 4047)

Introduction to Sensors and Transducers:

Rotational Motion Transducers:


Automation: PLCs:
Introduction, Logic Gates, PLC System, PLC Programming, Case Studies

Adaptive Control:
Introduction, Feedback Linearization, Model Reference Adaptive Control, System Identification and Generalized Predictive Control in Self-Tuning Mode, Sliding mode Control, Overview of Intelligent Control in a generalized manner.

Signal Conditioning & Data Acquisition System:
Introduction, Functions of Signal Conditioning Equipment, Amplification, Type of Amplifiers, Mechanical Amplifiers, Fluid Amplifiers, Optical Amplifiers, Electrical and Electronic Amplifiers, Attenuators, Filters. Objectives and Configuration of Data Acquisition System, Different types of Data Acquisition Systems and their applications, Data Conversion.

Text Books:

Reference Books:
EE 4043  ELEMENTS OF POWER ELECTRONICS  Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Understand the power electronics devices
CO2. Realize the modes of operation of DC to DC and AC to DC converters.
CO3. Know the control techniques and operation of AC to AC converters.
CO4. Understand the concepts of Inverters and SMPS.

Pre-requisite: Basic Electronics (EC 1001) and Basic Electrical Engineering (EE-1003)

Introduction to Power Electronics:
Advantage of power devices operating in the switch mode to those operating in the active region.

Power Electronic Devices:
Thyristor characteristics, Turn ON methods, Dynamic Characteristics of thyristors, Ratings, Protection, Characteristics and construction of Power MOSFETS, Comparison between Power MOSFET and Power BJT, Characteristics and construction of IGBT, Switching characteristics. GTO – turn on and turn off methods, SiC based power devices, TRIAC and DIAC Characteristics and applications.

AC to DC Converters:

DC to DC Converters:
Step up and Step Down choppers, 2 and 4 quadrant choppers for control of DC motor. Buck- Boost converter

Inverters:
1 Phase Half Bridge and Full Bridge Inverters, 3 Phase Inverters, 180° and 120 ° conduction, Sinusoidal Pulse Width Modulation.

AC to AC Converters:
Single phase AC to AC Controllers with R and RL load, Single Phase Cycloconverters with R and RL load.

Switch Mode Power Supply SMPS:
Advantage of Switch Mode Power Supply over Conventional Power Supply, Flyback converters.

Text Books:

Reference Books:
**EE 4044  ENERGY AUDIT AND MANAGEMENT**  

**Course Outcome**: At the end of the course, the students will be able to:

CO1. Understand the concept of energy conservation, management and audit
CO2. Analyze combined power and heating systems
CO3. Analyze various applications and types of energy audit

**Pre-requisites**: Basic Electrical Engineering (EE 1003) and Physics (PH 1003)

**General Aspects**:
Definition of energy efficiencies, estimation of energy efficiencies in supply side and demand side, definition of energy conservation, management and audit, similarities and dissimilarities in financial audit and energy audit, approach, data collection and data analysis methodologies, demand and supply matching methodologies, energy sources, energy management system, types of energy policy, energy conservation, energy efficiencies.

**Energy Utilization and Conversion Systems**:
Furnaces: classification of furnaces; controlled atmospheres in furnaces; furnace fuels; efficient of energy in furnaces; thermal efficiency; heat losses; reducing heat losses hydraulic power systems compressed air; heat recovery; drying and leaks; operating conditions, steam turbines as alternatives to electric motors combined power and heating systems; characteristics of prime movers; heat and power requirements; economics of a c.h.p. system; energy conversion; distinct heating; factors affecting the choice of heating; distinct generation.

**Application of Energy Audit**
Definition of energy audit, need for energy audit, types of energy audit, energy audit reporting format, financial audit, energy audit: peak load, average load, firm power, dump power, secondary power, load curve, energy load curve, load distribution curve, plant capacity factor, energy index, cost index, budgeting and standard costing, representation of energy consumption, energy economics, financial appraisal and profitability with problems.

**Text Books**:

**Reference Books**:
2. Energy audit: Thermal power, combined cycle and co-generation plants by Y.P. Abbi, TERI, 2012

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**EE 4045  NON-CONVENTIONAL ENERGY SYSTEMS**  

**Course Outcome**: At the end of the course, the students will be able to:

CO1. Understand the various non-conventional sources of energy like wind, biomass etc and its applications.
CO2. Describe the various renewable energy sources and the possible conversion paths to a useful form of energy.
CO3. Explain the physical principles of wave energy, the generation of tides and how to harness their power; describe the physics of geothermal resources and energy from biomass.
CO4. Understand other direct energy conversion systems and fuel cells.
Pre-requisites: Basic Electrical Engineering (EE-1003), Physics (PH-1003) and Chemistry (CH 1003)

Introduction

Solar Energy

Wind Energy:
Principle of wind energy conversion; Basic components of wind energy conversion systems; wind mill components, various types and their constructional features; design considerations of horizontal and vertical axis wind turbines: analysis of aerodynamic forces acting on wind mill blades and estimation of power output.

Geothermal Energy:
Estimation and nature of geothermal energy, geothermal sources and resources like hydrothermal, geo-pressured hot dry rock, magma, advantages, disadvantages and application of geothermal energy, prospects of geothermal energy in India.

Ocean Energy:
Ocean Thermal Electric Conversion (OTEC) systems like open cycle, closed cycle, Hybrid cycle. Energy from tides, basic principle of tidal power, single basin and double basin tidal power plants, advantages, limitation and scope of tidal energy. Wave energy and power from wave, wave energy conversion devices, advantages and disadvantages of wave energy.

Bio-mass Energy:
Availability of bio-mass and its conversion theory.

Fuel Cells:
Principle of working of various types of fuel cells and their working, performance and limitations.

Text Books:

References Books:

EE 4046         FUNDAMENTALS OF ELECTRICAL DRIVES      Cr-3

Course Outcome : At the end of the course, the students will be able to:

CO1. Select the motor for different types of industrial applications.
CO2. Start and control the speed of dc machine by different methods.
CO3. Control and to know the different types of braking of 3-phase induction motor.
Pre-requisites:  Electrical Machines and Power Electronics (EE 2009) or Principles of Energy Conversion (EE 3042) and Elements of Power Electronics (EE 4043)

Introduction: Basic elements of an electric drive, four quadrant operation of an electric drive, dynamics of motor load combination, types of loads, stable operating condition of various motor load combinations.


Solid State Control of DC drive: Phase controlled and Chopper controlled DC separately excited motor and series motor drives. Four quadrants drive using dual converter. Closed loop control scheme for DC motor.


Text Books:

Reference Books:

EE 4047 ELECTRICAL INSTRUMENTATION Cr-3

Course Outcome : At the end of the course, the students will be able to:

CO1. Know the classification of measuring instruments, their applications and minimize the error sources in measuring instruments.
CO2. Understand the operation and measure the resistance, inductance and capacitance by AC/DC bridges.
CO3. Understand the different measuring techniques and operation of the different meters.
CO4. Know the operation of different transducers and electronic instruments for measurement.

Pre-requisite: Basic Electrical Engineering (EE 1003)

Measuring Instruments
Introduction, classification, absolute and secondary instruments, indicating instruments, Control, balancing and damping, characteristics, Errors in measurements, MI: Constructional details, extension range (both MI and MC).

DC/AC bridge
General equation of bridge balance, Wheatstone bridge, Kelvin’s double bridge, Maxwell’s inductance - capacitance bridges, Hay’s Bridge, Anderson’s bridge, Owen’s bridge, Schering bridge, errors.
**Wattmeter**
EDM type, Induction type, single and three phase wattmeter, calibration device, error's in wattmeter, compensation, Measurement of 3-phase power.

**Energy Meter**
Induction type single and three phase energy meter, compensation, creep errors, testing.

**Galvanometer**
General principle and performance equation of D’Arsonval Galvanometer, vibration galvanometer and ballistic galvanometer, measurement of charge and flux by ballistic galvanometer.

**Frequency meter**
Vibration reed type and Electrical resonance type.

**Power factor meter**
Single phase electrodynamometer type power factor meter, advantages and disadvantages.

**Instrument Transformers:**
Potential and current transformers, construction, ratio and phase angle errors, phasor diagrams, uses, testing.

**Potentiometer**
Dc potentiometer- Crompton meter, standardization, Ac potentiometer- Drysdale polar meter, Gall Tinsley coordinate type meter.

**Transducer**
Stain gauge, Thermistors, Thermocouples, LVDT, Capacitance transducers, torque meter, inductive torque transducers, Tachometers.

**Electronic instruments**
Electronic voltmeter, block diagram, principle of operation, accuracy of measurement, Digital Multi-meter, Digital Frequency meter, block diagram, principle of operation, accuracy of measurement.

**CRO**
Block Diagram, Sweep Generator, Vertical amplifiers, Use of CRO for measurement of frequency, phase, amplitude, rise time.

**Text Books:**

**Reference Books:**

**EE 4049 CONTROL SYSTEMS Cr-3**

**Course Outcome**: At the end of the course, the students will be able to:

CO1. Know the different types of control systems, characteristics of control system components and the mathematical model of physical systems.
CO2. Analyze the time domain response of different systems.
CO3. Analyze the different techniques used to find the stability of a system by classical methods.
CO4. Understand the concept of frequency domain analysis and usage of control system components.
Pre-requisites: Circuit Theory (EE 3044) and Mathematics-I (MA 1001)

Introduction:

Description of Physical System:
Mathematical Modelling of Electrical System and Mechanical System (Translational and Rotational Mechanical System), Analogous System, Block Diagram Algebra, Developing Block Diagram from a Mathematical Model, SFG, Mason’s Gain Formula, Signal Flow Graph from Block Diagram (SFG Terminology, Construction and Procedure), Problem Practice based on application of SFG to Control System.


The Root Locus Technique: Root Locus Concept, Construction of Root Locus, Rules for the Construction of the Root Locus, Effect of adding Poles and Zeros to G(s) H(s), Determination of Gain from Root Locus.


Control System and Components:

Text Books:

Reference Books:
1. Modern Control Engg., by D Roy Choudhury, PHI Publication
3. Control System by Anand Kumar, PHI Publication

EE 4051 ACTIVE AND PASSIVE FILTERS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Learn the concept and characteristics of Filters.
CO2. Design of Passive Networks.
CO3. Synthesize the Active filter.

Pre-requisites: Circuit Theory (EE 3044) and Basic Electronics (EC 1001)

Filter Preliminaries:
Terminology; Magnitude and Phase responses; Classification (LPF, HPF, BPF, APF etc.)
Approximation Theory:
Low pass approximations methods, Butterworth response, Butterworth pole locations, Butterworth filter design from specifications, Chebyshev and inverse Chebyshev characteristics, Network functions and pole zero locations, Characteristics of Cauer (elliptic) response, Bessel-Thomson approximation of constant delay, Delay Equalization.

Frequency Transformation:
Frequency transformation and its importance in filter design, Low pass to high pass transformation, Low pass to band pass transformation and Low pass to band stop transformation

Properties and Synthesis of Passive Networks:

Sensitivity:
Basic concepts; Application to filters- Q sensitivity, WP sensitivity, Elements of passive network synthesis, Properties and synthesis of LC, RC driving point and transfer functions, Singly- and Doubly-terminated ladder networks.

Active Filter Synthesis:
Active filter and passive filter, Ideal and real operational amplifiers, Gain-bandwidth product, Active building blocks: Amplifiers, Summers, Integrators, First order active sections using inverting and non-inverting Op-amp configuration, Second order active sections (biquads), Tow-Thomas biquad circuit, Design of active filter using Tow-Thomas space biquad, Sallen-Key biquad circuit and Multiple-feedback biquad (MFB) circuit, Gain reduction and gain enhancement, RC-CR transformation

Text Books:

Reference Books:

EE 6121 UNIVERSITY OF STUDENTS 2019

Course Outcome:
At the end of the course, the students will be able to:

CO1. Design mathematical models for power system components using graph theory
CO2. Understand the 3-phase network and the formulation of Z bus.
CO4. Understand Transient stability Analysis with Modified Euler’s and RK 4th order method.

Pre-requisites: Power Transmission and Distribution (EE 3007), Power System Operation and Control (EE 3002)

Introduction to Computer Method:
**Three Phase Network:**

**Representation of Three Phase Elements in Short Circuit Study:**
Short circuit study of balanced network by Z bus, LG fault, L-L fault, 3-ph fault with and without fault impedance, Problems.

**Transient stability Analysis:**
Load representation, Network performance equation, Swing equation, Machine equation, Solution techniques in transient stability study, Modified Euler’s method, RK 4\textsuperscript{th} order method, Problems.

**Text Books:**

**Reference Books:**

**EE 6123  POWER MARKET REFORMS  Cr-3**

**Course Outcome:** At the end of the course, the students will be able to:

CO1. Gain information about Indian power sector, utilities and their roles.
CO2. Realise the power sector restructuring and market reform, their benefits and challenges in Genco, Transco, and Disco.
CO3. Design the electricity market pricing.
CO4. Realize the different methods of transmission planning, congescion and pricing in electricity market.

**Pre-requisite: Power System Operation and Control (EE 3002)**

**Power Sector in India:**
Introduction to various institutions in Indian Power sector such as CEA, Planning Commissions, PGCIL, PFC, Ministry of Power, State and central governments, REC, Utilities and their roles. Critical issues / challenges before the Indian power sector, Salient features of Electricity act 2003, Various national policies and guidelines under this act.

**Power Sector Restructuring and Market Reform:**
Different industry structures and ownership and management models for generation, transmission and distribution. Competition in the electricity sector- conditions, barriers, different types, benefits and challenges, Latest reforms and amendments. Different market and trading models / arrangements, Open access, Key market entities- ISO, Genco, Transco, Disco, Retailco, Power market types, Energy market, Ancillary service market, Transmission market, Forward and real time markets, Market power.

**Electricity Markets Pricing and Non-Price Issues:**
Electricity price basics, Market Clearing price (MCP), Zonal and locational MCPs, Dynamic, spot pricing and
real time pricing, Dispatch based pricing, Power flows and prices. Optimal power flow, Spot prices for real and reactive power, Unconstrained real spot prices, Constrains and real spot prices. Non price issues in electricity restructuring (quality of supply and service, standards of performance by utility, environmental and social considerations) Global experience with electricity reforms in different countries.

**Transmission Planning and Pricing:**
Transmission planning, Different methods of transmission pricing, Different transmission services, Congestion issues and management, Transmission cost allocation methods, Locational marginal price, Firm transmission right. Transmission ownership and control, Transco and ISO, Transmission pricing model in India, Availability based tariff, Role of load dispatch centers (LDCs), Salient features of Electricity act 2003, Price based Unit commitment, Concept of arbitrage in Electricity markets, Game theory methods in Power System, Security constrained unit commitment, Ancillary services for restructuring, Forward ancillary service auction, Power purchase agreements.

**Text Books:**

**Reference Books:**

**EE 6139 ILLUMINATION ENGINEERING Cr-3**

**Course Outcome:** At the end of the course, the students will be able to:

- CO1. Analyze different radiation techniques and the laws of thermal radiation.
- CO2. Study and realize the colorimetric and photometry techniques.
- CO3. Study the characteristics and application different types of lamps.
- CO4. Acquire knowledge of the basic concepts of lighting design and maintenance of lighting system

**Pre-requisites:** Basic Electrical Engineering (EE 1003) and Physics (PH 1003)

**Introduction:**
Light and electromagnetic radiation, Sources of light, Thermal radiator, Blackbody radiator, Laws of thermal radiation, Daylight and artificial light, Spectral power distribution (SPD) of light sources.

**Visual system:**
Structure, External factors of vision, Continuous adjustment- photopic, scotopic and mesopic capabilities, Perception, CIE standard observer, Glare- discomfort and disability glare.

**Colorimetric:**
Dichromatic vision, RGB colour specification system, CIE 1931 XYZ colour specification system, Source colour and object colour specification, CIE standard illuminant, Radiometric and photometric quantities, Relation between Lumen and Watt, Photometric standards.
Photometry:
Measurement of luminous flux, Illuminance, Luminance, Luminous intensity distribution, Computation of lumen output from luminous intensity distribution of a source, Computation of CCT and CRI from CIE 1931 chromaticity diagram.

Different Types of Lamps:
Its characteristics and Applications, Luminaire- its function and classification, Lamp and luminaire specifications.

Basic Concepts of Lighting Design:
Design objectives, Design parameters, Qualitative and quantitative evaluation of lighting systems, Energy management in illumination, Energy efficient illuminating system components, Energy oriented new and retrofit installations, Power Quality, Demand side management (DSM).

Maintenance of Lighting System:
Indoor and outdoor, Maintenance schedule, scheme, Relamping-spot and group, Equipment and materials used for maintenance job, General guidelines on disposal of burnt out lamps

Text Books:

Reference Books:

EE 6336 SMART GRID Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Understand Smart Grid Architecture
CO2. Analyze different optimization techniques
CO3. Control smart grid system

Pre-requisite: Power System Operation and Control (EE 3002)

Introduction to Smart Grid:
Definition of smart grid.

Smart Grid Architecture:
Components and architecture of smart grid design, Review of the proposed architectures for smart grid. The fundamental components of smart grid designs, Transmission automation, Distribution automation, Renewable integration.
**Tools and Techniques for Smart Grid:**
Computational techniques, Static and dynamic optimization techniques, Computational intelligence techniques, Evolutionary algorithms, Artificial intelligence techniques.

**Distribution Generation Technologies:**

**Communication Technologies and Smart Grid:**
Introduction to communication technology, Synchro Phasor Measurement Units (PMUs)

**Control of Smart Power Grid System:**
Load Frequency Control (LFC) in micro grid system, Voltage control in micro grid system, Reactive power control in smart grid, Case studies and test beds for the smart grids.

**Text Books:**

**Reference Books:**
ELECTRONICS & TELECOMMUNICATION ENGINEERING
**Program Educational Objectives (PEOs)**

The Program Educational Objectives (PEOs) of the B.Tech Program in Electronics & Telecommunication Engineering are as follows:

PEO-I. To lead a successful career in industry or pursue higher studies or entrepreneurial endeavours.

PEO-II. To offer techno-commercially feasible and socially acceptable solutions to real life engineering problems.

PEO-III. To demonstrate effective communication skill, professional attitude and a desire to learn.

**Program Outcomes (POs)**

The Program Outcomes of the B.Tech Program in Electronics & Telecommunication Engineering are:

a) Ability to apply knowledge of mathematics, science and engineering to solve complex problems.

b) Ability to identify, formulate and solve electronics and communication engineering related problems using first principles.

c) Ability to design, implement and evaluate electronics and communications systems to meet the societal and environmental needs.

d) Ability to design and conduct complex experiments and interpret data.

e) Ability to use techniques, skills and modern engineering necessary for engineering practices.

f) Ability to assess the impact of contemporary social issues on professional practice.

g) Ability to recognize the sustainability and environmental impact of the engineering solutions.

h) Ability to follow prescribed norms, responsibilities and ethics in engineering practices.

i) Ability to work effectively as an individual and in a team.

j) Ability to communicate effectively through oral, written and pictorial means with engineering community and the society at large.

k) Ability to recognize the need for and to engage in life-long learning.

l) Ability to understand and apply engineering and management principles in executing projects.
Course Outcome: At the end of the course, the students will be able to:

- **CO1.** Differentiate between conductors, insulators and different types of semiconductor materials.
- **CO2.** Identify different types of diodes, transistor configurations, FETs and power amplifiers; analyze simple electronic circuits using diodes and BJTs.
- **CO3.** Identify different types of feedback and condition for oscillation.
- **CO4.** Analyze simple electronic circuits with op-amp using either inverting or non-inverting configurations.
- **CO5.** Identify different types of digital gates, flip-flops and analyze and build registers and asynchronous counters using gates and flip-flops.
- **CO6.** Identify different components of a CRO and Signal Generator.

Prerequisite: NIL

**Semiconductors:** Energy band concept of materials, difference between metal, insulator and semiconductor, Intrinsic and extrinsic semiconductors (n-type & p-type), current conduction in semiconductor, Photodiode, phototransistor, LED and seven-segment display.

**Junction Diodes:** Operation of p-n junction diode, diode characteristics, half-wave, full-wave and bridge rectifiers, rectifiers with C, LC and LC π filter, clipper and clamper circuits, breakdown mechanisms, Zener diode and voltage regulator.

**Bipolar Junction Transistor (BJT):** Transistor operation and current components in p-n-p and n-p-n transistors, CE, CB, CC configurations and characteristics, biasing, load line analysis.

**Field Effect Transistors (FET):** Operations of p-channel and n-channel JFETs, characteristics of JFET, operation of MOSFET and its characteristics.

**Power Amplifiers:** Class A, B, C and push-pull amplifiers.

**Feedback Concept:** General feedback structure, properties and advantages of negative feedback, Barkhausen criteria for oscillation.

**Operational Amplifiers (OPAMP):** Ideal OPAMP, CMRR, virtual ground, Inverting and non-inverting OPAMPs, summing amplifiers, Differential amplifier, integrator & differentiator.

**Digital Electronics:** Number systems, conversions and codes, Logic gates & Truth tables (OR, AND, NAND, EX-OR), flip-flops (RS flip-flop, D flip-flop, JK flip-flop and MS flip-flop). Shift register, Asynchronous (ripple) counter.

**Electronic Instruments:** Operation of CRO and its applications, Signal Generator.

**Text Books**


**Reference Books**

Course Outcome: At the end of the course, the students will be able to:

- CO1. Design biasing circuits using BJTs and FETs and analyze their stability.
- CO2. Analyze amplifier circuits using BJTs and FETs with help of their small signal model.
- CO3. Analyze and determine the bandwidth of different video amplifiers using frequency response method and step response method.
- CO4. Design and analyze compound circuit configurations used in operational amplifiers with BJTs and FETs.
- CO5. Differentiate between different negative feedback and sinusoidal oscillators.
- CO6. Analyze different types of power amplifier circuits using BJTs.

Prerequisite: Basic Electronics (EC1001)

Transistor Biasing Circuits: Different types of biasing circuits for BJT & FET, Stability factors & Bias compensation.

Small Signal Analysis of BJT: The transistor model-hybrid model, Graphical determination of h-parameters. Low frequency small signal analysis of CE, CC and CB configurations without feedback, Simplified CE & CC hybrid model, CE amplifier with an emitter Resistance.

Small Signal Modeling and Analysis of FETs: Signal Model of JFET, Analysis of JFET CS & CD configuration, Analysis of Enhancement and Depletion MOSFET amplifiers, small signal low frequency model of MOSFET, mid-frequency and low frequency analysis of CS, CG and CD amplifiers.

BJT and JFET Frequency Response: Classification of Amplifiers, Distortion in amplifiers, Frequency response of an amplifier, Lower Cut Off frequency and higher Cut Off frequency of an amplifier, Step response of an amplifier, Band pass of cascade stages, Low frequency response of RC coupled BJT and FET amplifier, High frequency modeling and analysis of BJT and FET amplifiers, Miller effect capacitance.

Compound Configurations: Differential amplifier, Differential amplifier circuit configurations, DC Analysis, AC Analysis, Constant current bias, current mirror, level translator, Cascade, Cascode and Darlington connections.

Feedback and Oscillator Circuits: Feedback concept, Feedback amplifier topologies, General characteristics of negative feedback amplifier, input and output resistance with negative feedback, Method of analysis of feedback amplifiers with practical examples, Positive feedback, Barkhausen Criterion of Oscillation, Sinusoidal Oscillator, LC Oscillators, RC phase shift oscillator, Crystal Oscillator.

Power Amplifiers: Definition of class A, B and C power amplifiers, Distortion analysis, Series fed and transformer coupled power amplifier, Push-pull amplifiers, Conversion efficiency

Text Book:

Reference Book:
Course Outcome: At the end of the course, the students will be able to:

CO1. Analyze the response of different linear wave shaping circuits and attenuators.
CO2. Determine the different DC and AC parameters of op amp; identify type of feedback and analyze its stability.
CO3. Analyze different circuits using op-amps. (closed loop: negative and positive feedback or open loop)
CO4. Design and analyze multi vibrator with its different applications using IC 555 timer.
CO5. Analyze the performance of negative resistance devices.

Prerequisite: Analog Electronic Circuits-I (EC2001)


Frequency Response of an Op-amp: Frequency response, Compensating Networks, Frequency response of compensated and non-compensated Op-amp, high frequency Op-amp equivalent circuit, open loop voltage gain as a function of frequency, Closed loop frequency response, Circuit stability, high frequency effects of op-amp gain and phase.

Op-amp Applications: Linear and non-linear circuit operations of op-amps like adder, substractor, multiplier circuits, SPICE analysis of op-amp circuits, instrumentation amplifiers, Voltage to current converter and vice versa, Integrator, Differentiator, first and second order active filter, triggerable and non-trigerrable multivibrator, triangular and sinusoidal wave generator, Precision rectifier, Peak detector, Phase shift oscillator, Wien bridge oscillator, voltage to frequency converter, comparator: Zero crossing detector & Schmitt Trigger, Sample and Hold circuit, the 555 timer as Monostable and Astable mode, PLL and its applications, IC voltage regulators.

Linear Wave Shaping Circuits: High pass and low pass circuit, Response of RC circuit to various inputs such as sinusoidal, step, pulse, square wave, exponential and ramp. High pass RC circuit as a differentiator. Low pass RC circuit as an integrator, Attenuator and its application.


Text Books:

Reference Books:
Course Outcome: At the end of the course, the students will be able to:

CO1. Differentiate between various types of signals and operate on signals.
CO2. Classify various types of systems and differentiate between convolution, de-convolution and correlation of arbitrary signals.
CO3. Analyze LTI systems and signals using Laplace transforms and Fourier transforms.
CO4. Differentiate between Laplace transforms and Fourier transforms.
CO5. Define and classify analog filters and find the frequency plots of various filters.

Prerequisite: Mathematics-II (MA1002)

Signals: Introduction, Classification, Signals and vectors analogy, Concept of Vector space and Orthogonality, Sampling and reconstruction of band limited signals, Representation of analog and discrete time signals in terms of impulses, Representation of discrete time signals and Basic operation on signals.

Sequences: Classification based on length, symmetric, periodicity, energy power, special sequences, arithmetic operations on sequences.

Systems: Introduction, Classification, LTI systems, Linear Convolution, Causality and stability of LTI systems, Representation of causal LTI systems, Order of systems, IIR and FIR systems, Correlation.

Fourier Analysis: Significance of Fourier series in LTI systems, Continuous time Fourier series formula and derivation, Dirichlet conditions & properties, Approximation of Fourier series to Fourier transform for aperiodic signals, Properties, examples, amplitude and power spectra, Analysis of LTI systems using Fourier Transform.


Text Books:

Reference Books:

Course Outcome: At the end of the course, the students will be able to:

CO1. Characterize signals in time and apply Fourier Transform for signals.
CO2. Differentiate between different Analog Modulation Schemes analytically as well as graphically.
CO3. Analyze different Analog to Digital Conversation techniques and multiplexing techniques like TDM and FDM.
CO4. Analyze the working principles of Digital Modulation Techniques & Data Transmission.
CO5. Differentiate between different channel coding techniques.
Prerequisite: Mathematics-II (MA1002)

Signal:
Signals in time domain, Fourier transform, Periodic and non periodic signal Analysis, spectral density.

Analog Modulation:
Types of analog modulation, Need for modulation, principles of AM, Types of AM (DSB, SSB, VSB), power relationship, principle of FM & PM, Types of FM, spectrum of FM, Bandwidth of FM (Carson’s rule).

Pulse Modulation:
Sampling Theorem, PAM, PWM, PPM, TDM, FDM.

PCM & Delta Modulation:
Quantization process, PCM, Noise consideration in PCM system, Delta and Adaptive Delta modulation.

Digital Modulation Techniques & Data Transmission:
ASK, FSK, PSK, DPSK, QPSK, probability of error, BER calculation, matched filter, relationship between Bit error rate and symbol error rate, comparison of modulation system, Data Communication systems, parity, Asynchronous and Synchronous transmission, low speed, medium speed and high speed modems.

Basic Information theory:
Information and Entropy, Binary symmetric channel and Binary error channel, Shannon’s channel capacity theorem, capacity of Gaussian channel, Basics of source and channel coding (Huffman, Cyclic codes).

Text Book:

Reference Books:

EC2005 SEMICONDUCTOR DEVICES Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Differentiate the conduction techniques in semi-conductor materials.
CO2. Analyze characteristics of Semi-conductor diodes and solve problems.
CO3. Analyze characteristics of Bi-polar Transistors and solve problems.
CO4. Analyze characteristics of MOS Transistors and solve problems.
CO5. Differentiate between different Opto-electronic devices.

Prerequisite: Basic Electronics (EC1001)

Energy bands & Current Carriers in Semiconductors: Bonding Forces in Solids, Energy Bands theory in crystals (Qualitative Analysis), Metals, Semiconductors, & Insulators, Fermi-Level, Intrinsic and Extrinsic Semiconductors, Concept of Holes, Carrier Concentration and Mobility, diffusion and drift of carriers, continuity equation, Injected minority carrier charge, Recombination and generation of charge carriers.

P- N Junction: Physical Description of p-n junction, Basic device technologies for fabrication of a p-n junction current flow at a junction, homojunction and heterojunctions, equilibrium band diagram, charge, field and potential profiles in p-n junctions, depletion region, biased P-N junctions, diode equation and diode characteristics, equivalent circuit, temperature dependence, Capacitance of p-n junction diode (transition & storage), junction
Breakdown (Avalanche & Zener), Step and linearly graded junction, diode switching characteristics, Metal – Semiconductor junction (Schottky barrier, Ohio contact and rectifying contact).

**BJT:** Junction transistors, Charge transport in BJT, base narrowing (Early effect), Avalanche breakdown & Punch Through, transistor switching, Coupled-Diode model, Ebers-Moll equations.

**MOSFET:** MOS structure, Basic operation of Enhancement & Depletion mode MOSFET, MOS capacitance (Operation with band diagram, threshold voltage & Characteristics), CCD and applications.

**Opto-Electronics:** Optical absorption in semiconductors, photovoltaic effects, solar cells (p-n junction), Photoconductors, Photodiode, PIN photodiode, Avalanche photodiode, Phototransistor, LED, Semiconductor Laser (p-n junction)

**Text Books:**

**Reference Books:**

**EC2008**

**MEASUREMENTS & INSTRUMENTATION**

**Cr–4**

**Course Outcome:** At the end of the course, the students will be able to:

- CO1. Estimate the error and interpret the instrument datasheet.
- CO2. Derive the balance equations to analyze the unknown electrical quantities.
- CO3. Select the appropriate instrument for measuring A.C & D.C currents and voltages.
- CO4. Select the appropriate sensor to measure physical parameters.
- CO5. Differentiate between digital measuring instruments, function generators, spectrum analyzers and analytical instruments.

**Prerequisite: Basic Electrical Engineering (EE1003), Network Theory (EE2007)**

**Measurement & Error:** Calibration of Instruments, Accuracy, Precision & Resolution, Types of Errors, Statistical analysis, Probability of error, Limiting error.

**A.C. & D.C. bridges:** General equation for bridge balance, DC bridges: Wheatstone bridge, Kelvin’s double bridge; General form of AC bridge; Maxwell’s inductance-capacitance bridge, Anderson’s bridge, Schering bridge, Wien’s bridge; Sources of error in bridge measurement, Wagner’s earthing device.

**Electrical measuring instruments:** Classification of instruments, Overview of PMMC, Moving iron, Dynamometer type instruments, Overview of Ammeter, Voltmeter, Multimeter, True RMS voltmeter, Potentiometer, Current transformer, Potential transformer, Strip chart recorders.

**Transducers:** Strain Gauges, LVDT, Thermistor & Thermocouples, Piezo – electric transducer and Bourdon tube.

**Electronic measuring instruments & CRO:** Q-meter, Digital Voltmeter, Digital frequency meter, CRO: construction, Time base circuit, measurements with CRO, CRO probes.
Signal generator & waveform analyzing instruments: Function generator: Square, triangular & sinusoidal waveform generator & Spectrum analyzer.

Analysis instruments: Principle of operation of pH meter, Liquid chromatograph, Spectrophotometer

Text Books:

Reference Book:

EC2011 DIGITAL ELECTRONICS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Simplify and realize Boolean expression.
CO2. Design combinational circuits and various asynchronous & synchronous sequential circuits using FLIP-FLOPs.
CO3. Design & implement Mealy and Moore model FSM for different synchronous sequential circuits.
CO4. Differentiate between different logic families and analyze TTL & CMOS chips.
CO5. Differentiate between different types of D/A and A/D converters.

Prerequisite: Basic Electronics (EC1001)


Combinational Circuits: Adders (Half and Full adders, parallel binary adders, look ahead carry adder generator), Subtractors (Half and Full Subtractors, 4-bit Adder/Subtractor), Magnitude comparator, decoders (3 to 8, BCD to Decimal decoder, BCD to SSD) and Encoders, Priority Encoder, Multiplexer and Multiplexer-tree, De-multiplexer.

Sequential Logic: Shift Register (SISO, SIPO, PIPO, PISO, Bidirectional), Counter (Ripple and Synchronous), Ring and Johnson Counters.


Logic Families: Transistor as a switch, Characteristics (Propagation delay, Speed-power product, Noise margin, Fan-in, Fan-out), Standard logic families (TTL, ECL, CMOS), Digital ICs TTL (74 Series) and CMOS (4000 Series).

D/A and A/D: Digital to Analog converter (Binary weighted resistor network & R-2R ladder network), Analog to Digital converter (Flash type, Counter type & Successive approximation type).

Text Books:
Reference Books:

EC2012 ANALOG COMMUNICATION TECHNIQUES Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Analyze amplitude modulation and demodulation techniques with applications.
CO2. Differentiate between FM and PM techniques with methods of generation and detection.
CO3. Analyze super heterodyning, AM Receiver and FM receiver.
CO4. Analyze sampling theory and pulse modulation techniques.
CO5. Differentiate between types of noise in communication systems.
CO6. Analyze the noise performance of different types of AM and FM systems.

Prerequisite: Signals and Systems (EC2003)

Introduction: Introduction to communication system, dB, dBm, Concept of bandwidth, spectral efficiency, Hilbert Transform, Pre-envelope, base-band and band-pass signals

Amplitude Modulation and Demodulation: AM DSB , DSB-SC, SSB,Modified SSB,Calculation of transmitted power, Efficiency, SSB-SC, VSB, method of recovery of the base signal, Square law demodulator, Envelop detector,Superheterodyne AM receiver, FDM

Angle Modulation and Demodulation: Phase and frequency modulation, Relationship between PM & FM, Threshold in FM, Phase and frequency deviation, Spectrum of an FM signal, Some features of Bessel’s coefficient, Effect of modulation index on Bandwidth, Phasor diagram for FM signals, FM generation, parameter variation method, Armstrong system for NBFM, Frequency multiplier. An example of an Armstrong FM system, FM Demodulators, FM detection using PLL, Pre-emphasis and De-emphasis ,FM Radio receiver.

Pulse Modulation and Demodulation : Sampling theorem (low pass and Band pass signals), Natural sampling, Flat – top sampling, signal recovery through holding, Pulse Amplitude modulation, Channel bandwidth for PAM signal, TDM, PWM, PPM.

Noise in Communication Systems: Sources of noise, Types of Noise, Frequency domain representation of noise, Effect of filters on the PSD of noise, SNR of DSB/FC, DSB/SC, SSB/SC system, Comparison of AM, SSB, DSB, VSB modulation schemes. Calculation of output SNR of FM system, Comparison between FM and PM,

Text Books:

Reference Books:
Course Outcome: At the end of the course, the students will be able to:

CO1. Differentiate between different biasing for BJT and FETs and analyze their stability.
CO2. Analyze amplifier circuits using BJT and FETs with the help of their small signal model.
CO3. Analyze compound circuit configurations with BJT and FETs.
CO4. Design electronic circuits using BJT or FETs for different negative feedback topologies depending on applications.
CO5. Analyze different types of Power amplifier, Differential amplifier and Current mirror circuits.
CO6. Analyze Operational amplifiers and its applications including 555 timer.

Prerequisite: Basic Electronics (EC1001)

Bipolar junction transistor and its circuits: Review of transistor, Biasing of BJT, Concept of stability and compensation of biasing circuits, Simplified small signal hybrid modeling of BJT, Analysis of transistor amplifiers (CB, CE and CC) using BJT simplified small signal model, Applications of Miller’s theorem.

Field effect transistor and its circuits: Review of FET (JFET & MOSFET), Biasing of FET (JFET & MOSFET), Small signal modeling of FET, Analysis of CS and CD amplifiers using FET small signal model, MOS as switch and CMOS as inverter.

Feedback Amplifier and Oscillator Circuits: Types of amplifiers and their equivalent circuits, Feedback concept, Feedback amplifier topologies, General characteristics of negative feedback amplifier, input and output resistance with negative feedback, Method of analysis of feedback amplifiers with practical examples, Frequency response of amplifiers with and without feedback, Positive feedback, Barkhausen criterion, RC and LC phase shift oscillators, Crystal Oscillator.

Power amplifiers: Definition of class A, B and C power amplifiers, Distortion analysis, Series fed and transformer coupled power amplifier, Push-pull amplifiers, Conversion efficiency.

Differential amplifier and current mirror circuits: Differential amplifiers under balanced and unbalanced conditions, differential and common mode gain, Constant current bias, Current mirror, Level Translator.


Text Books:

Reference Books:
EC2014 ELECTROMAGNETIC THEORY Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Identify the appropriate coordinate system for a particular vector based problem, and the laws of vector calculus.
CO2. Solve numerical problems involving static charges and constant currents.
CO3. Analyze and differentiate between Maxwell’s equations for electromagnetism.
CO4. Analyze wave behavior during its propagation through multiple media in presence of different boundary conditions.
CO5. Differentiate between transmission lines and waveguides
CO6. Design transmission line sections or waveguides (length and other dimensions) along with feeding mechanism for realizing impedance matched conditions.

Prerequisite: Mathematics-II (MA1002)

Static Electric and Static Magnetic Fields: Orthogonal Co-ordinate systems, statements of Coulomb’s and Gauss’s laws, boundary conditions for electrostatic fields, electrostatic energy density, Poisson’s and Laplace’s equations, Statement of Ampere’s circuital law, Lorentz’s force equation, vector magnetic potential, Biot-Savart law and applications, Boundary conditions for magentostatic fields.

Time Varying Fields and Maxwell’s Equations: Faraday’s law, Maxwell’s Equations in point form and integral form, displacement current, electromagnetic boundary conditions, interface between a dielectric and a perfect conductor, wave equations and their solutions, source-free wave equations, Helmholtz’s wave equation in free space, principle of duality.

Plane Electromagnetic Waves: Plane waves in lossless media, polarization of plane waves, plane waves in lossy media, low-loss dielectrics, skin depth, group and phase velocities, flow of electromagnetic power and Poynting vector, normal and oblique incidences of electromagnetic waves (parallel & perpendicular polarized) at plane perfect conducting and dielectric boundaries, Brewster’s angle.

Theory and Applications of Transmission Lines: General transmission-line equations, wave characteristics on an infinite transmission line, transmission line parameters, attenuation constant from power relations, wave characteristics of finite transmission lines, transmission lines as circuit elements, transmission lines with resistive termination and arbitrary termination, transmission line circuits, transients on transmission lines, voltage reflection and current reflection diagrams, Smith chart, quarter wave transformer, single stub and double stub matching.

Text Books:

Reference Books:
Course Outcome: At the end of the course, the students will be able to:

CO1. Design biasing circuits using BJTs and analyze their stability.
CO2. Analyze amplifier circuits using BJTs with help of their small signal model.
CO3. Design and analyze compound circuit configurations with BJTs used in operational amplifiers.
CO4. Design electronic circuits for different negative feedback and sinusoidal oscillators depending on applications using BJTs or MOSFETs.
CO5. Design and analyze different types of power amplifier circuits using BJTs.

Prerequisite: Basic Electronics (EC1001)

Bipolar junction transistor and its circuits: Review of transistor theory, transistor characteristics, early effect and punch through, biasing of BJT (Fixed, collector to base, emitter biasing), stability & compensation of biasing circuit (Qualitative only), Analysis of transistor amplifier (CB, CC, CE) using BJT small signal model.

MOS Device & Circuit: MOS structure & characteristics, MOS as switch CMOS as inverter, MOSFET biasing circuit (CS & CD), Analysis of MOSFET amplifier using small signal model.

Amplifier & feedback circuit: types of amplifier & their equivalent circuit (VA, CA, Transconductance & Transresistance amplifier), Concept & types of feedback topology, Analysis of practical feedback amplifiers, frequency response of amplifier with & without feedback, Barkhausen criterion, RC & LC phase shift oscillator (qualitative description), output frequency of the oscillator.

Power amplifier: Class A, B, AB, C amplifier & their distortion.


Text Books:

Reference Books:
Course Outcome: At the end of the course, the students will be able to:

CO1. Acquire in-depth knowledge of the 8 bit and 16 bit Microprocessors (like 8085 and 8086) and 8 bit Microcontrollers (such as MCS – 8051) including the peripheral chips.

CO2. Design a Microprocessor / Microcontroller based system for industrial or any other control applications.

Prerequisite: Digital Electronics (EC2011)

8085 Microprocessor Architecture: Introduction, 8085 Architecture, Pins & signals.

Instruction Set Of 805 And Software Development: Addressing Modes, Timing Diagrams, 8085 Instructions, Assembler Directives, Sample programs, Software development tools.

8085 Interrupts: Hardware Interrupts, Selective masking, Interrupt structure.

Memory Interfacing: Memory chips (27 series EPROM and RAM chips), Memory interfacing.

Interfacing Chips: Programmable peripheral Interface (8255), Priority Interrupt Controller (8259), Concepts of serial communication and USART (8251).


8051 Family Of Microcontrollers: Introduction, Overview of 8051 family, Architecture & Memory organization, Pins & signals, Addressing Modes, 8051 Instructions & sample programs, Timers, Counters and serial communication.

Text Books:
1. Microprocessor architecture, Programming and Applications with the 8085 – Ramesh S. Goankar – Penram International Publishing (India) 6th edition,

Reference Books:
Course Outcome: At the end of the course, the students will be able to:

CO1. Analyze random processes and probability distribution functions.
CO2. Differentiate between PCM and DM technique.
CO3. Analyze the noise performance of different waveform coding techniques.
CO4. Analyze and differentiate between different digital modulation techniques.
CO5. Analyze performance analysis of different modulation techniques.

Prerequisite: Analog Communication Techniques (EC2012)


Noise in PCM and Delta – Modulation: Quantization noise, output signal power, output SNR in PCM, quantization noise in DM, output SNR in DM and DPCM.

Multiplexing: Introduction, frequency division multiplexing (FDM), time division multiplexing (TDM), Introduction to Code division multiplexing.

Digital Modulation and Demodulation Techniques: Band-pass transmission system, Gram-Schmidt orthogonalization, BPSK, DPSK (Differential Encoded PSK), QPSK, π/4 QPSK, OQPSK, M-ary PSK, BFSK, M-ary FSK, Minimum shift keying (MSK), GMSK, Comparison of BPSK, QPSK, π/4 QPSK, OQPSK, BFSK, GMSK, QAM. Comparison of modulation schemes in terms of probability of error and spectral efficiency.


Text Books:

Reference Books:
Course Outcome: At the end of the course, the students will be able to:

CO1. Select appropriate transformation technique for signal analysis.
CO2. Apply the knowledge of analog filters to digital filters, design a digital filter and physically realize any digital filter.
CO3. Analyze multi-rate systems and filter banks.
CO4. Apply the adaptive filters for system identification, channel equalization and noise cancellation.

Prerequisite: Signals and Systems (EC2003)


Multi-rate DSP: Introduction to multi-rate DSP, Decimation and interpolation, Polyphase decomposition, Uniform DFT filter banks, Quadrature mirror filters and perfect reconstruction, Introduction to finite register length effects on digital filter performance, Introduction to spectral density and spectral estimation.


Text Books:

Reference Books:

Course Outcome: At the end of the course, the students will be able to:

CO1. Determine the statistical behavior of signals and noise, and their modeling.
CO2. Differentiate different analog modulation and digital modulation techniques.
CO3. Analyze different AM and FM radio receivers.
CO4. Analyze different Digital modulation techniques.
Prerequisite: Signals and Systems (EC-2003)/ Principle of Digital Signal Processing (EC-3013)


Signals: Signals in time domain, Fourier transform and Series, properties of FT and FS, Unit impulse and unit step function


Digital Modulation: Data Form, Principles involved in ASK, PSK (BPSK, QPSK, π/4 QPSK), FSK.

Modern Communication Systems: Introduction to Modems, Block diagram Description of satellite communication, Fiber optic communication and Mobile communication.

Text Books:

Reference Books:

EC3011 VLSI DESIGN Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Select appropriate method to design using VLSI design flow and implementation using FPGA.
CO2. Analyze basic working principle and process of manufacturing of a MOSFET.
CO3. Depict the stick diagram of any circuit and produce its corresponding layout by using layout rules.
CO4. Analyze the working of any analog and digital circuit using MOS.
CO5. Apply circuit partitioning methods on given circuit.
CO6. Design circuits using low power methods.
Prerequisite:  Analog Electronics Circuit-I (EC2001) / Analog Electronics (EC2013) / Analog Circuits (EC2015), Digital Electronics (EC2011)

VLSI Methodologies: Introduction to VLSI design, Moore’s Law, VLSI Design flow, Design hierarchy, VLSI Design style: Full custom, Gate array, standard-cell, Macro cell based design, Field programmable devices, design quality.

MOSFET: Electrical characteristics of MOSFET, Threshold voltage, Body effect, current expression (gradual channel approximation method), Channel length modulation, MOSFET scaling: constant field and constant voltage scaling, Short-channel effects.

Unit process in VLSI and IC fabrication: Unit process in VLSI: Wafer preparation, Oxidation, Diffusion, Ion implantation, Deposition, Metallization, Etching and Lithography. nMOS fabrication, n-well and p-well process.

CMOS Logic Circuits: General CMOS logic structure, VTC of inverter, noise margin, Different types of inverter (resistive load, enhancement and depletion nMOS load and CMOS), Switching characteristic (propagation delay and parasitic capacitance estimation), NAND, NOR and other complex CMOS logic circuits, Sizing of CMOS logic circuits, CMOS Power: static and dynamic power dissipation, latch-up, sizing for large capacitive load., Dynamic CMOS logic circuits, charge leakage and charge sharing problem, dynamic gate cascading problem, Domino and NORA logic, Introduction of sequential CMOS logic circuits, Stick diagram. Layout and Layout design rules.

Physical Design Automation: Objectives and goals of partitioning, floor planning and placement, Global routing.

Text Books:

Reference Books:

EC3012 ANTENNA AND RADIO WAVE PROPAGATION Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Differentiate between various parameters of antenna and will be able to evaluate the radiation pattern of metallic and aperture type antenna.
CO2. Analyze the radiation pattern of a uniform linear array and synthesize a linear array from given radiation pattern.
CO3. Evaluate the radiation pattern and input impedance of biconical, helical, loop, V, rhombic, parabolic, offset parabolic, cassegrain, slot, horn, planar log-spiral, log periodic, Yagi-Uda, Microstrip antenna having 4 different feeding structure.
CO4. Analyze the propagation mechanism of signal in earth’s atmosphere.

Prerequisite: Electromagnetic Theory (EC2014)

Radiation and Thin Linear Antennas: Vector magnetic potential, retarded potential, radiation from an oscillating electric dipole, radiation resistance of quarter-wave monopole and half-wave dipole.
Basic Antenna Parameters and Theorems: Radiation patterns, E-plane & H-plane, directivity, gain, efficiency, effective length, effective aperture, wave polarization & cross-polarization, LHCP & RHCP, FRISS transmission formula, antenna noise temperature, applications of reciprocity theorem and other theorems in antennas.

Antenna Arrays: Uniform n-element linear array, broadside & end-fire arrays, grating lobes, principle of pattern multiplication, design of linear array using Tchebyscheff distribution, phased array, adaptive array, basic concept of smart antennas.

Wire Antennas: V-antenna, Rhombic antenna, Loop antenna, Helical antenna

Reflector Antennas: Parabolic disc antenna, losses in disc antenna, tilted & off-set fed discs, Cassegrain reflector antenna.

Slot, Horn and Complementary Antennas: Slot antenna feedings and radiation pattern of slot antennas, Babinet’s principle and complementary antennas, impedance of complementary screens & slot antennas, Horn antennas, radiation from horn antenna.


Microstrip Antennas: Radiation mechanism of microstrip antenna, advantages & disadvantages, bandwidth enhancement of microstrip antennas using stacked, proximity-coupled and aperture-coupled microstrip antennas.

Radio Wave Propagation: Surface wave, space wave, tropospheric wave propagation, tropospheric scatterer, ducting, ionospheric layers, ionospheric wave propagation, critical frequency, MUF, skip distance, millimeter wave propagation, absorption of millimeter wave by rain and atmospheric gasses.

Text Books:

Reference Books:

EC3013 PRINCIPLE OF DIGITAL SIGNAL PROCESSING Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Select appropriate transformation for signal analysis.
CO2. Analyze importance and utility of DFT filter banks.
CO4. Apply the knowledge of analog filters to digital filters, design a digital filter and physically realize any digital filter.

Prerequisite: Mathematics-II (MA1002)

Introduction

Brief idea about analog and digital signals, Definition of signal and systems, Signal Processing (ASP and DSP), Advantages and Disadvantages of DSP, Application of DSP.
Discrete time Signals & Systems


Fourier Transform, DTFT, DFT, IDFT and FFT


Z-Transform


Digital filters (IIR & FIR FILTERS)


Text Books :

Reference Books :

EC3022 ADVANCED MICROPROCESSORS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Analyze the operation of 8086 Processor in minimum and maximum mode configurations.
CO2. Analyze advanced concepts of different higher level processors (from 80286 to Pentium) such as virtual memory, memory management, multi-tasking, protection capabilities, paging, cache concepts in 486 and Pentium.
CO3. Analyze RISC features and parallel processing of instructions through U and V pipelines, incorporated in the design of Pentium processors

Prerequisite: Microprocessors and Microcontrollers (EC3003)

8086 Microprocessor: Review of 8086 Architecture, Pins and Signals, Minimum and maximum mode configurations, Interrupts and Memory Interfacing.

8086 Addressing modes and Instructions, Multiprocessor configurations, 8086 Coprocessor.
Intel 80286: Introduction, Multiuser and Multitasking concepts, Virtual memory, Memory management, Architecture, Pins and signals, Real and protected modes of operation, Limitation of 80286.

Intel 80386: Introduction, Register organization, Pins & signals, Real and protected modes, Virtual – 86 mode, 80386 privilege levels and protection, Call gates, Task switching, Memory management, Segmentation, Paging, TLB.

Intel 80486: Introduction, Enhanced features.

Pentium Processor: RISC features, Architecture, Pipelining, Superscalar execution, Branch prediction & handling.

Text Books:

Reference Books:

EC3024 EMBEDDED SYSTEMS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Differentiate the design constraints of embedded systems.
CO2. Design the algorithm for various models of embedded system.
CO3. Design the algorithm based on differentiating the hardware requirements.
CO4. Analyze the design constraints of System on chip using different IP Cores and Protocols.
CO5. Write code for embedded system.

Prerequisite: Microprocessors and Microcontrollers (EC3003)


Embedded Hardware:


Interrupt Service Mechanism: Concept of ISR, different interrupt sources, Interrupt handling Mechanism, Multiple Interrupts, Interrupt Latency and deadline.
Embedded Software Development-
Software Development: Programming concept in ALP (assembly language programming) and High level language-C, Processor directives, functions and macros and other programming elements, Embedded C++ concept only.

RTOS(Real time operating System)- OS overview, Process, Interrupt and memory management, RTOS overview, Basic Design rule using RTOS, Task scheduling using Priority based scheduling, cyclic scheduling and round robin scheduling.

Embedded system Design using PIC microcontroller: Introduction to Microchip PIC16 family, PIC16F873 processor architecture- features, memory organization, on chip peripherals, Watchdog timer, ADC, Data EEPROM, Asynchronous serial port, SPI mode, I2C mode, Interfacing with LCD, ADC, sensors, stepper motor, key board, DAC.

Case study of different types of Embedded System: Design of Automated Chocolate Vending Machine, Digital Camera.

Text Books:

Reference Books:

EC3025 COMPUTATIONAL INTELLIGENCE Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Apply the concepts of fuzzy set theory to model different inference schemes using fuzzy rules.
CO2. Implement different derivative free optimization techniques for solving engineering problems.
CO4. Utilize Neural Network Systems for different processes and perform optimization on these neural models for designing high performance systems.

Prerequisite: Mathematics-I (MA1001)

Introduction to Soft Computing:
Soft computing constituents and conventional Artificial Intelligence, Neuro-Fuzzy networks.

Fuzzy Sets Theory and applications:

Derivative-free optimization:
Genetic algorithm, simulated annealing, random search, Downhill simples search.
Adaptive Networks:
Architecture, Back propagation for feed forward networks, Extended back propagation for recurrent networks, Hybrid learning rule.

Neural Networks:

Adaptive Neuro-Fuzzy Inference Systems:
ANFIS architecture, Hybrid learning algorithms, Learning methods that cross-fertilize ANFIS and RBNF, Simulation examples.

Text Book:

Reference Book:

EC3027  OPTICAL & SATELLITE COMMUNICATION  Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Analyze the principle of light propagation through optical fiber, advantages and types of material used for fabrication of fiber.
CO2. Differentiate between different types of modes.
CO3. Analyze various types of losses, dispersion, bandwidth requirement and repeater spacing for optical communication system.
CO4. Analyze the structure, principle of operation and characteristic of optical sources and detectors.
CO5. Differentiate between different types of noises at the receivers and calculate SNR and NEP.
CO6. Prepare optical link budget and explain concept of WDM.
CO7. Analyze satellite orbits, calculate orbital parameters, launching of satellites and satellite subsystems.
CO8. Differentiate between various types of losses in satellite communication and make link budget design taking those into consideration.

Prerequisites: Physics (PH1003) & Analog Communication Techniques (EC2012) / Introduction to Communication Engineering (EC3044) / Communication Engineering (EC3009)

Introduction: Optical Frequencies, Principle of Light Propagation in a fiber, Advantages of optical fiber communication.

Wave Propagation in optical fiber: Relation between refractive index and velocity of light, basic structure and ray diagram of optical path in an optical fiber, Acceptance cone, Numerical aperture. Concept of modes, Different types of mode in optical fibers, Cut-off condition for guided modes, Boundary conditions, single mode / multi mode fiber, Concept of V number and its importance.
**Losses in fiber**: Material or impurity losses, Rayleigh scattering loss, Absorption loss, Bending loss, Concept of dispersion, Intermodal dispersion, Intramodal dispersion, Wave guide and material dispersion, Minimization of dispersion.

**Optical sources**: Characteristics of good optical source, Principle of operation of LED, Principle of operation of laser diode, Intensity modulation using both LED and Laser diode.

**Optical detectors**: Principle of operation of PIN diode, Principle of operation of APD, Comparison of PIN / APD, Noises at optical receiver, Thermal noise, Short noise, SNR and Noise equivalent power.

**Fiber link**: Optical link budget, Concept of WDM

**Satellite Communications Introduction**: Frequency spectrum for satellite communication, Types of orbits, Kepler’s Laws of planetary motion, Orbital perturbations, geostationary orbit, Satellite launching, General satellite communication, Block diagram uplink, Downlink frequencies, Types of modulation techniques used, Common Satellite applications.

**Losses / Attenuation**: Signal loss on transmission through earth’s atmosphere, Atmospheric losses, Ionospheric effects, Rain attenuation.

**Satellite link budget**: Transmission losses, Interference, System noise temperature, Link power budget.

**Satellite sub-systems**: Antenna sub-systems, Attitude and orbit control sub-system, Power sub-system, Communication sub-system, TTC&M sub-systems.

**Text Books**:  

**Reference Books**:  
1. Optical Fiber Communication – J. C. Palais – Pearson Education  

**Course Outcome**: At the end of the course, the students will be able to:

- CO1. Analyze the function of OSI model and Layered Architecture and Compare and contrast different analog and digital data transmission protocols in LAYER-I.
- CO2. Analyze algorithms and calculate parameters associated with Flow Control, Error control and Media Access Control (MAC) techniques used in LAYER-II.
- CO3. Analyze and calculate parameters related to Routing Algorithms and protocols and design network with different IPv4 addressing scheme used in LAYER-III.
- CO4. Compare different Transport layer protocols and calculate parameters used in LAYER-IV.
- CO5. Formulate different mathematical models based on queuing theory and traffic models.
- CO6. Differentiate between different QoS approach and calculate parameters associated with it.

**Prerequisites**: Analog Communication Techniques (EC2012), Digital Communication Techniques (EC3005) / Communication Engineering (EC3009)

**Introduction**: Overview of analog and digital data transmission, Historical background of data network, Protocol and their function, OSI model and layering.

**Link Layer Protocols:** Circuit switching and packet switching. Framing, Error detection and correction, Retransmission Mechanisms (ARQ), Go Back N, Selective Repeat, Sliding window Protocol.

**Multiple Access Protocols:** Aloha System, Carrier Sensing (CSMA, CSMA/CD, CSMA/CA), Examples of Local area networks: Ethernet (IEEE 802.3), Wi-Fi (IEEE 802.11), IEEE 802.11ac.

**Internetworking:** Bridging, Global Internet, IP protocol and addressing (IP V4), Subnetting and supernetting, Classless Inter-domain Routing (CIDR), IP address lookup, Domain Name Systems (DNS), Network Address Translator (NATs), Unicasting, broadcasting and multicasting, Routing in Internet: Link-state, RIP, OSPF, ICMP

**End-to-End Protocols:** TCP and UDP, Congestion Control, Additive Increase/Multiplicative Decrease, Slow Start, Fast Retransmit/Fast Recovery.

**Quality of Services (QoS):** Introduction to Quality of Services (QoS), Integrated and Differentiated Services.

**Text Books:**

**Reference Books:**

**EC3030  ADAPTIVE SYSTEMS & SIGNAL PROCESSING  Cr-3**

**Course Outcome:** At the end of the course, the students will be able to:

- CO1. Solve problems in various discrete random processes.
- CO2. Differentiate between different Linear predictive Filters.
- CO3. Design Wiener Filter and apply it for practical applications.
- CO4. Design Adaptive Filters.

**Prerequisite: Digital Signal Processing (EC3007)**

**Discrete random processes:** Random variables, random processes, filtered random processes. Ensemble averages, correlation, covariance, power spectrum, cross power spectrum. Ergodicity, time averages, biased & unbiased estimators, consistent estimators.

**Linear prediction:** Direct form linear prediction filtering, Normal equations for linear prediction filtering, Levinson algorithm, linear prediction lattice filtering.

**Digital Wiener filtering:** Wiener smoothing and prediction filters, Application of Wiener smoothing to noise cancelling, Application of Wiener prediction filters, Constrained, linear MMSE filtering, Minimum variance beam-forming.

Text Books:

Reference Books:

EC3032 TELEMETRY AND REMOTE CONTROL Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Analyze principles of Telemetry, functional blocks of telemetry systems and different types of telemetry.
CO2. Differentiate between different modulation and multiplexing techniques in telemetry.
CO3. Analyze the concepts and applications of remote sensing.
CO4. Analyze the fundamental operating blocks and applications of fiber optic telemetry systems.

Prerequisite: Communication Engineering (EC3009)


Modulation codes: PAM, PFM, PTM, PCM, Bit error rate, Inter symbol, noise, parity checking, Review of modulation and multiplexing: FM-AM, FM-FM, PAM-AM, PAM-FM, PCM-AM, etc, Quantization and conversion methods, error in quantization, bandwidth consideration.

FDM and TDM systems, IRIG standards in FDM systems in FDM telemetry, SCO’s, Mux and Demux circuits, Detectors and Demodulators, Pulse averaging, Quadrature FM and PLL, Mixers, TDM systems (architecture)-TDM- PAM, PAM- PM, TDM- PCM systems.

Overview of Digital modulation, Modem Protocols, Synchronous protocols, Satellite telemetry, TT and C services, Subsystems, Earth station, Global Positioning System, Overview of wave propagation, Basics of remote sensing, Concept of GIS.

Fiber optic Telemetry- The Fibre as transmission medium, Interconnections, Repeaters, Sources, Detectors, WDM, Remote control: concept and example from a typical industrial situation.

Text Books:

Reference Books:
4. Telecommunication and Switching systems and Networks, Viswanathan T, Prentice Hall, New Delhi, 1992
Course Outcome: At the end of the course, the students will be able to:

CO2. Apply MODBUS protocol structure, its function codes and troubleshooting. Further they will have insight to Data Highway (plus) protocols, HART Protocol.
CO3. Analyze Physical layer, Data Link Layer and Operating Characteristics of AS interfaces and Device net.
CO4. Identify different operational aspects of ProfiBus including the protocol stack, communication object and model.
CO5. Identify, compare and contrast different industrial Ethernet standards and Wireless communication, components of radio link, radio spectrum and frequency allocation aspects.

Prerequisites: Communication Engineering (EC3009), Data Communication and Networking (EC3028)

Rs – 232 and Rs – 485:

Modbus Data Highway (Plus) And Hart Protocols:

AS – Intreface And Devicenet:
AS interfaces:- Introduction, Physical layer, Data link layer and Operating characteristics.
Device net: - Introduction, Physical layer, Data link layer and Application layer.

ProfiBus PA/DP/FMS and FF:
ProfiBus:- Introduction, Profibus protocol stack, Profibus communication model, Communication objects, System operations and Troubleshooting – Foundation fieldbus versus Profibus.

Industrial Ethernet and Wireless Communication:
Industrial Ethernet:- Introduction, 10Mbps Ethernet and 100Mbps Ethernet – Radio and wireless communication:- Introduction, Components of radio link, radio spectrum and frequency allocation and radio modems – Comparison of various industrial networks.

Text books:

Reference books:

Course Outcome: At the end of the course, the students will be able to:

VAS, M2M (Machine to Machine) and TV & Media are Cutting Edge Domains and knowing these domains will keep the students market ready with respect to knowledge.
Prerequisite:

**Topic 1: General**
OOPS & Programming concepts, Operating System Concepts & basic knowledge of Linux, Scripting knowledge - Unix Shells Scripting, Java Scripting, Perl Scripting, Data structure /Algorithm, DBMS, Networking Concepts

**Topic 2: Technology Specific**
Basic knowledge of JAVA, Servlets, JSP and XML processing with JAVA, Spring /Hibernate, JBoss(App Server), Messaging (JMS), Restful web service, AV formats (HD ..), Video codecs (MPEG...), IP Multicast

**Topic 3: Domain Specific**
Telecommunication Overview, Telecom Ecosystem (North / South Bound, GSM Concepts), VAS and Media as a function overview (EGI team would support), Basic concepts of Protocols (HTTP, TCP, UDP, STPP, SMPP, RTSP, IGMP)

**MAIN SYLLABUS**

**MODULE - 1: TVM**

**Topic 1: TVM Overview**
Introduction to TV and Media & Industry overview, Cable, DTH, IP network, IPTV concepts, Video Standards, Video Codecs, OTT, Catch up TV

**Topic 2: Multiscreen TV, Middleware, DRM, VOD**
Multiscreen TV - Live TV, Multiscreen TV Platforms, Multiscreen converged TV services & Middleware platform Middleware - Multiscreen converged TV services & Middleware platform, DRM, Encryption, Access control and Authentication, DRM implementations and various players, Digital rights management and digital Copy Protection, VOD Video on Demand (VOD) Subscription VOD (SVOD)

**Topic 3: Content Delivery & Video optimization, CDNs**
Content delivery & Video optimization - Diagnostics and monitoring systems, User authentication systems, Content delivery & optimization CDN/ MDN Encoders, streamers, Receivers LTE Broadcast Overview

**Topic 4: End User devices & UI, Content management, DVR, Broadcast services**
End user devices & UI - Electronic Program Guide, Digital TV Consumption Devices, STB Architectures, Mobile clients, Tablets, Personal Computers, Digital home networking Content management - Video on Demand (VOD) asset preparation, Content management systems (CMS), Analytics and Reporting systems, Content lifecycle DVR - PVR/DVR, nPVR, Cloud Broadcast services

**MODULE - 2: VAS**

**Topic 1: VAS & M2M Overview**
Topic 2: Service Enablement
SDP Architecture Overview, Network Enablers Protocol (Native) SMPP, MM7 Architecture
Network Enablers Protocol (Web 2.0) Parlay X, Business Integration Protocol (Network Management) SNMP,
Content delivery concepts: OMA / Non OMA & HTTP - Premium messages, Infotainment Services, Caller/Hello
Tunes, Wallpaper, Ringtones, Polytones, Gifting services, Referrals services etc, Concept Handling using DRM,
Application to peer messaging(A2P) & Peer to Application messaging (P2A)
Role of Operators, Service Provider and Subscribers, Subscriber provisioning, enable and access services, Use case
Simulation, M2M Enablement Framework

Topic 3: Service Applications - (IP/Messaging)
SS7 and SIGTRAN: SS7 Overview, SIGTRAN Overview, MTP Links and Link-set, Low Speed and High Speed
Links, MTP Route and Route-Sets, MTP Routing, MTP Connectivity Setup, SCCP, SCCP Connection Less
Services, SCCP GT Translation, SCCP GT Based Routing, SIGTRAN SCTP and M3UA, SCTP Connectivity Setup,
M3UA Connectivity Setup, TCAP, TCAP Dialog and Component Primitives, TCAP Session Examples, Messaging
specific Protocols etc
Legacy Messaging – SMS, MMS, VMS: GSM overview, GSM Architecture Overview, GSM Nodes (Radio, MSC,
HLR, VLR), SMS Flow, MMS Flow, VMS Flow
IP Messaging - RCS, EM (Rich communication Suit & Enriched Messaging): IP Messaging overview (SIP
Messaging, RCS, etc), IP Messaging Gateway overview

Topic 4: Service Applications - (IN Applications)
IN and NGIN Architecture: Overview of Intelligent Networks (IN), IN and NGIN Architecture, IN BCSM, INAP
CAP Application Example
NGIN Applications: Basic Telephone Call, Basic GSM Call, NGIN Application Overview, Toll-free, Universal
Access Number, Premium Rate, Collect Call, VPN, Tele-Voting Services and Features. Custom NGIN Applications
NGIN Platforms: SS7 Cards, SS7 Hardware, SS7 FE and BE Architecture, NGIN Platform based on Java, Oracle
OCCAS, JAIN SLEE, Open Cloud Rhino, Other NGIN Service Development Platforms, Traditional IN App
Development, NGIN Application Development

EC4001 RF AND MICROWAVE ENGINEERING Cr-4

Course Outcome: At the end of the course, the students will be able to:

- Analyze microwave vacuum tube amplifier and signal source.
- Design semiconductor microwave source and amplifier.
- Design various microwave components using simulation software.
- Design & implement various transmission lines.
- Analyze microwave filter design and implement in simulation software.
- Measure characteristics of microwave component and devices.

Prerequisite: Electromagnetic Theory (EC2014)

Waveguide and Cavity Resonator: Transverse electric and transverse magnetic wave propagations in rectangular
and circular waveguides, wave impedances, rectangular cavity resonator, quality factor of the rectangular cavity
resonator.

Microwave Vacuum Type Amplifiers and Sources: Limitations of conventional vacuum tubes, Klystron
amplifier, Reflex Klystron oscillator, Travelling Wave Tube (qualitative), Backward Wave Oscillator (qualitative),
Magnetron Oscillator.

Microwave Solid State Devices & Sources: TED, RWH theory, Gunn Effect, two-valley model theory, modes of
operation of Gunn, READ diode, PIN diode, IMPATT diode, TRAPATT diode and BARITT diode.
**Microwave Components:** Scattering matrix representation, variable attenuators, linear and rotary phase shifters, E-plane, H-Plane and Magic Tees, rat race power divider, two-hole and Bethe hole directional couplers, slotted section, matched terminations, coupling probes, crystal detector, Faraday rotation in ferrites, Faraday rotation isolator, Faraday rotation 3-port and 4-port circulators.

**Microwave Integrated Circuits:** Introduction to microwave integrated circuits, strip line, microstrip line, slot line, CPW, coupled microstrip lines.

**Microwave Measurements:** Power, frequency and impedance measurements. Gain and radiation pattern measurement of antennas.

**Text Books:**

**References Books:**

**EC4003 WIRELESS & MOBILE COMMUNICATION ENGINEERING** Cr-4

**Course Outcome:** At the end of the course, the students will be able to:

- CO1. Analyze basic Cellular Architecture and practical mobile communication strategies.
- CO2. Solve basic propagation models and understand signal degradation in a wireless channels.
- CO3. Differentiate between various modulation schemes used in present day mobile communication.
- CO4. Apply channel equalization and diversity techniques in wireless systems.
- CO5. Distinguish between the different types of multiple access schemes and GSM technology.
- CO6. Differentiate between CDMA and OFDMA modulation.

**Prerequisites:** Analog Communication Techniques (EC2012) and Digital Communication Techniques (EC3005) / Communication Engineering (EC3009)


**RF Propagation & Multi-path Model:** Free space propagation model, propagation mechanism, Large Scale fading, Diffraction & Scattering by high – raise structures, shadowing and path loss, Small Scale Fading, Doppler and time-delay spread, coherence Bandwidth and coherence-Time, Types of Small – Scale Fading.

**Equalization and Diversity Techniques:** Fundamentals of Equalization, Adaptive equalizer, Concept of diversity, Types of diversity (space, time, frequency, polarization, Rake receiver).

**Spread Spectrum modulation:** Spread Spectrum Modulation and principle, PN sequence and its properties, Direct sequence SS and frequency – hopped SS (DS – SS and FH – SS), TH – SS.
Multiple Access Techniques: Multiplexing and multiple access, TDD and FDD techniques, Description of FDMA, TDMA, CDMA systems, Description and special features of GSM and IS – 95, WCDMA, Wireless data communication and services, Mobile communication standards, Transmitting and Receiving Antenna Systems.

Multicarrier Modulation: Data transmission using multiple carriers, OFDM, Multi carrier CDMA.

Multiple Antennas and space time communications: Concept of Multi Input Multi Output Antenna system, Narrow band MIMO model, MIMO channel capacity, MIMO Diversity gain, Space time Modulation.

Text Books:

Reference Books:

EC4021 RADAR & TELEVISION ENGINEERING Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Analyze video bandwidth of monochrome signal and the different sync pulse with the video signal to from composite video signal.
CO2. Analyze signal transmission, channel bandwidth and types of antenna used for reception of TV signal.
CO3. Differentiate between different constituents of TV Receiver.
CO4. Analyze the concepts related to color television.
CO5. Analyze the principle of radar operation and distinguish between pulse and CW radars.

Prerequisites: ACT (EC2012) and DCT (EC3005) / Communication Engineering (EC3009)

Basic Television System, Scanning Principle & Composite Video Signal: Principle of Television, Aspect ratio & flicker, Concept of scanning & No. of scanning lines, Interlaced scanning, Video Bandwidth, Video signal & DC component, Blanking pulse, Horizontal & Vertical sync/ pulse, Equalizing pulse

Signal Transmission, Channel Bandwidth & TV Transmitting & Receiving Antenna: Need of vestigial Transmission, Channel Bandwidth for monochrome, transmission, Transmitting (Turnstile) & receiving, Antenna (Yagi), Co-axial & twin wire cable &Balun transformer.

Monochrome Television Reciever: Monochrome TV receiver: Block diagram, RF tuner, Video amplifier, Video detector, inter carrier sound detection, Sync separator, AGC, SMPS Power Supply.

Colour Television Principle: Luminance & chrominance signals, Channel bandwidth & frequency interleaving, Color subcarrier and modulation of R-Y, B-Y and signals, color burst signal, Color TV receiver block diagram.

Principle of Radar System: Radar block diagram, its operation & radar range equation, Pulse repeating frequency and range ambiguities.

MTI & PULSE Doppler Radar: MTI radar block diagram & its operation, delay line canceller, blind speed & its minimization.

Tracking Radar: Principle of Tracking radar, sequential lobing, conical scanning & Monopulse tracking radar.

Text Books:

Reference Books:
1. Microwave & Radar Engineering by M. KULKARNI

EC4031 MOBILE COMMUNICATION ENGINEERING Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Analyze the concepts of Cellular System.
CO3. Differentiate between QPSK, Offset QPSK, π/4 QPSK, MSK, GMSK, and QAM.
CO4. Differentiate between various Equalization and Diversity Techniques.
CO5. Characterize various Spread Spectrum modulation.
CO6. Differentiate between various Multiple Access Techniques like TDMA, FDMA and CDMA.

Prerequisite: Communication Engineering (EC3009)/ Introduction to Communication Engineering (EC3044)


RF Propagation & Multi-path Model: Free space propagation model, propagation mechanism, Large Scale fading, Diffraction & Scattering by high – raise structures, shadowing and path loss, Small Scale Fading, Doppler and time-delay spread, coherence Bandwidth and coherence-Time, Types of Small – Scale Fading.

Modulation Techniques: Overview of QPSK, Offset QPSK, π/4 QPSK, MSK, GMSK, QAM.

Equalization and Diversity Techniques: Fundamentals of Equalization, Adaptive equalizer, Concept of diversity, Types of diversity (space, time, frequency, polarization, Rake receiver).


Multiple Access Techniques: Multiplexing and multiple access, TDD and FDD techniques, Description of FDMA, TDMA, CDMA systems, Description and special features of GSM and IS – 95, Wireless data communication and services, Mobile communication standards, Transmitting and Receiving Antenna Systems.
Text Books:

Reference Books:

EC4033 SMART ANTENNAS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Analyze the basic working of different array antennas and also adaptive and smart antennas.
CO2. Differentiate between different direct domain least square approaches to adaptive processing in adaptive array antennas.
CO3. Analyze the mutual coupling between different array elements and their compensation techniques.
CO4. Analyze the direction of arrival estimation techniques and adaptive signal processing techniques for smart antennas.

Prerequisite: Antenna and Radio wave propagation (EC3012)

Introduction: Basics of linear antenna arrays, circular antenna arrays and phased array antenna, concept of adaptive antennas and smart antennas, adaptive processing using minimum variance distortionless technique.

Direct Data Domain Least Square Approaches to Adaptive Processing: Direct data domain least square procedures, eigenvalue method, forward method, backward method, main beam construction for prevention of signal cancellation.

Mutual Coupling in Adaptive Smart Antennas: Mutual coupling among an array of dipoles (qualitative), compensation using open-circuit voltages and minimum norm formulation, effect of mutual coupling for constant jammers and constant signals, compensation for mutual coupling for constant jammers and constant signals.


Text Books:

Reference Books:
EC4041 MICROPROCESSOR, MICROCONTROLLER & APPLICATIONS Cr–3

Course Outcome: At the end of the course, the students will be able to:

CO1. Analyze Architecture and operation of 8 bit Microprocessor (like 8085) and 8 bit Microcontroller (such as 8051) including the peripheral chips.

CO2. Design applications using Microprocessors and Microcontrollers.

Prerequisite: Digital Electronics (EC2011)


8085 Interrupts & Memory Interfacing: 8085 Interrupts, Memory chips and Memory interfacing.

Interfacing Chips: Programmable Peripheral Interface (8255), Priority Interrupt Controller (8259) and USART (8251).

8051 Family Of Microcontrollers: Introduction, Overview of 8051 family, Architecture & Memory organization, Pins & signals, Addressing Modes, 8051 Instructions & sample programs, Timers, Counters and serial communication.

Text Books:
1. Microprocessor architecture, Programming and Applications with the 8085 – Ramesh S. Goankar – Penram International Publishing (India) 6th edition,

Reference Books:

EC4044 INFORMATION THEORY & CODING Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Differentiate between different forms source information and coding techniques.
CO2. Analyze channel coding schemes and shannon’s information theory.
CO3. Distinguish between various error decoding schemes.
CO4. Analyze and design cyclic codes, CRC codes and BCH codes
CO5. Analyze the recent coding schemes.

Prerequisite: Digital Communication Techniques (EC3005)

Source Coding: Introduction to information theory, definitions of self-information and mutual information, conditional self-information, average mutual information and entropy, binary entropy function, FLC & VLC, prefix code and Kraft inequality, source coding theorem, code efficiency, redundancy, Shannon-Fano algorithm, discrete memory less source and Markov source, Huffman coding.
Channel Capacity & Coding: DMC, BSC, BEC & other special channels, channel capacity, channel coding, code rate, channel coding theorem, Information capacity theorem, Shannon limit.

Speech Coding: Characteristics of speech signals, frequency domain speech coding, sub-band coding, adaptive transform coding, Vocoders (channels vocoders, formant vocoders, cepstrumvocoders).

Error Control Coding: Code, codeword, weight of a codeword, generator polynomial, vector, matrices, Galois field, liner code, linear block code, matrix description of linear block code, parity check matrix, systematic code, decoding of a linear block code, standard array, syndrome decoding, error probability after coding, Hadamard code & Hamming code, optimal linear code, maximum distance separable code.

Cyclic codes: Method for generating cyclic codes, burst error correction, Fire code, Golay code, CRC codes, circuit implementation of cyclic codes.

BCH Codes: Primitive element, minimal polynomial, method of generating BCH code, examples of BCH codes, decoding of BCH code, Reed-Solomon code.

Convolutional Codes: Tree & Trellis codes, Convolutional codes, Viterbi decoding,

Text Books:

Reference Books:

EC4046 MODERN DIGITAL COMMUNICATION TECHNIQUES Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Analyze random processes for the design of digital communication systems.
CO2. Differentiate between different digital modulation schemes.
CO3. Design an optimum receiver for AWGN channels.
CO4. Estimate the channel with distortion.
CO5. Analyze different types of adaptive equalization methods and related issues.

Prerequisite: Digital Communication Techniques (EC3005)


Digital Modulation Schemes: Memory-less modulation method, QAM signaling with memory, Continuous –Phase frequency Shift Keying (CPFSK), Continuous –Phase Modulation (CPM), Power Spectral Density (PSD): digital signal with memory, linearly modulated signal with finite mean, PSD of CPFSK and CPM signals.

Optimum Receiver for AWGN Channels: Correlation Receiver, Matched filter receiver, optimal detection, error probability for band limited signal, optimal detection, detection of signaling schemes with memory (maximum likelihood sequence detection, optimum receiver for PCM signals).
**Synchronization:** Carrier phase estimation (maximum likelihood, phase lock looped, decision-directed loop), symbol time estimation (maximum likelihood, non-decision-directed timing estimation).

**Digital Communication through Band-Limited Channels:** Band-limited channel: Characterization, optimal receiver for band-limited channels with ISI and AWGN, Linear equalization (peak distortion criterion, Mean Square Error (MSE) criterion), decision feedback equalizer.

**Text Books:**

**Reference Books:**

**EC6102 TELECOMMUNICATION SWITCHING NETWORKS & PROTOCOLS Cr-3**

**Course Outcome:** At the end of the course, the students will be able to:

- CO1. Analyze the switching technique in telecommunication system.
- CO2. Analyze the concept of telecommunication traffic management.
- CO3. Design and implement switching system.
- CO4. Differentiate between different telephone exchanges.
- CO5. Analyze various signaling systems and its architecture.

**Prerequisite:** Digital Communication Techniques (EC3005) / Communication Engineering (EC3009)

**Introduction:** Evolution of Telecommunication, Switching system, Classification of switching, Elements of Telecommunication, Telecommunication standard

**Telephone System:** PSTN, Modern Telecom System, Telephone Network, Telephone numbering plan, Central battery system, Transmission impairments, two/four wire transmission, subscriber loop design.

**Telecommunication Traffic:** Telecommunication traffic, Grade of service, Traffic measurement, Mathematical model for telecommunication traffic.

**Switching Systems:** Switching, Types of switching, Circuit switching, Message/Packet switching, Functions of switching system, Electronics switching system, Multiplexing, TDM (E1/E2, T1), FDM, Implementation of switching system, Blocking and Non-blocking Switches, Single stage and Multistage switches, Space switching, Time switching, Hybrid switching, Path finding, Complexity, Blocking probability of switch.

**Telephone exchange:** Stored program controlled exchange, Electronic exchange, Example of modern exchange (C-DOT exchange), availability of parallel exchange.

**Signaling systems:** Types of signaling information, forms of signaling, Channel Associated Signaling (CAS), Common Channel Signaling, CCITT No-7 system, SS 7 Signaling Architecture.
Text Books:

Reference Books:

EC6108 DIGITAL IMAGE PROCESSING Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Analyze different image processing technique to retrieve image information.
CO2. Differentiate between different image transformation techniques.
CO3. Analyze different image enhancement techniques.
CO4. Analyze the concept of color image processing.
CO5. Analyze the concept of image restoration.
CO6. Differentiate between different image compression and segmentation techniques.

Prerequisite: Digital Signal Processing (EC3007) / Principle of Digital Signal Processing (EC3013)

Introduction: Historical Background of image processing, fundamental steps in image processing elements of digital image processing systems. Digital image representation, Different image processing tasks: Image enhancement, Image restoration, Image compression and image analysis.


Color Image Processing: RGB, CMY and YIQ color models conversion from RGB to HIS and HIS to RGB.


Image Compression: Introduction and motivation, fundamental concepts: Data redundancy (coding redundancy, interpixel redundancy and psycho visual redundancy), fidelity criteria, image compression models, elements of
information theory, image compression techniques: pixel coding (PCM run-length – coding, bit-plane coding), Predictive coding, Delta modulation, DPCM etc., Transform coding (Zonal coding, Thresh holding, coding with different transforms), Other techniques such as vector quantization and hybrid coding, Image compression standards.

**Morphological Image Processing:** Dilatation and erosion, Opening and closing, some basic morphological algorithms.

**Image Segmentation:** Detection of discontinuities, Edge linking and boundary detection, Thresholding, Region based segmentation.

**Text Books:**

**Reference Books:**

**EC6112 COMMUNICATION & NETWORK SECURITY Cr-3**

**Course Outcome:** At the end of the course, the students will be able to:

- **CO1.** Analyze different security threats and attacks with reference to ISO/OSI model security.
- **CO2.** Differentiate between various cryptography, watermarking, steganography methods.
- **CO3.** Analyze different Symmetric and Asymmetric cryptographic algorithms.
- **CO4.** Differentiate various key distribution and Digital Signature.
- **CO5.** Analyze the working of various communication security protocols with respect to OSI layer.
- **CO6.** Analyze different network security systems implementation in Wireless systems.

**Prerequisite:** Data Communication and Networking (EC3028)


**Ciphers & Algorithm:** Symmetric Ciphers, Asymmetric Ciphers systems, Elliptic Curve Crypto systems, RSA Algorithm.

**Cryptographic Key distribution system:** Key Distribution, Merkle’s Puzzle Method, Shamir’s Key Distribution Method, Digital Signature.

**Communication Security layer classification:** A synergistic security frame work, Firewalls & Gateways, Security Cross- portfolios, attacks and security in the internet, TACACS.


**Text Books:**
Reference Books:

EC6114 SPREAD SPECTRUM TECHNIQUES AND MULTIPLE ACCESS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Analyze different Spread Spectrum Techniques such as DSSS and FHSS.
CO2. Analyze different Spreading Sequences: Correlation functions, Binary linear feedback Shift register sequence for spread spectrum.
CO3. Analyze the concept of jamming in Spread spectrum communication model.
CO4. Analyze the process of Code acquisition and Tracking Loops.
CO5. Differentiate between multiple access such TDMA, FDMA and CDMA.
CO6. Differentiate between various CDMA –SS application like of CDMA digital cellular systems.

Prerequisites: Digital Communication Techniques (EC3005) and Wireless and Mobile Communication Engineering (EC4003)

Spread Spectrum Techniques: Introduction, Basic communication problems, Pulse noise jamming, Low probability of detection, Signal structure secrecy, Direct sequence spread spectrum, Frequency hopping spread spectrum: Coherent slow frequency hopping spread spectrum, Non coherent slow frequency hopping spread spectrum, Non coherent fast frequency hopping spread spectrum, Hybrid direct sequence and frequency hopping spread spectrum, Time hopping and Multicarrier Systems.

Spreading Sequences: Correlation functions, Binary linear feedback Shift register sequence for spread spectrum, Definitions, mathematical background and sequence generator fundamentals, Maximal length sequences, Gold Sequences.


Code acquisition and Tracking Loops: Introduction, Optimum tracking of wideband signal, Baseband delay-lock tracking loop, Non coherent delay lock tracking loop, Code tracking loop for frequency hop system.


Text Books:
Reference Books:

EC6128 WIRELESS SENSOR NETWORK Cr-3

Course Outcome: At the end of the course, the students will be able to:

- CO1. Analyze the architecture of wireless sensor networks and the factors influencing WSN architecture design.
- CO2. Analyze the physical and MAC Layer issues in WSN.
- CO3. Analyze the basic principles of Routing Mechanisms in WSN.
- CO4. Analyze the localization and time synchronization problems with reference to WSN.

Prerequisite: Data Communication and Networking (EC3028)

Introduction: Basic Concepts, Platforms, Standardization, architecture and protocols, Applications in military, environment, healthcare, industry and energy, factors influencing WSN Design.

Physical & MAC Layer: PHY layer standard (IEEE 802.15.4), MAC challenges, MAC protocols for Sensor Network - Contention based (S-MAC, B-MAC, CC-MAC), reservation based-(TRAMA) & Hybrid MAC (Zebra MAC).

Network & Transport layer: Routing challenges, Data Centric and Flat-architecture protocol (SPIN), Hierarchical protocol (LEACH), Geographical routing protocol (MECN), QoS based Protocol (SAR), Challenges of Transport layer, Transport Layer protocols (PSFQ & CODA).


Time Synchronization: Challenges for Time synchronization, Timing Sync protocol for sensor network (TPSN), Time Diffusion Synchronization protocol (TDP), Rate based diffusion protocol (RDP).

Text Books:

Reference Books:

EC6224 LOW POWER VLSI DESIGN Cr-3

Course Outcome: At the end of the course, the students will be able to:

- CO1. Design different MOS Logic circuits
- CO2. Analyze different types of power dissipation in CMOS circuits
- CO3. Differentiate between different scaling techniques
- CO4. Optimize the power dissipation in CMOS circuits through switched capacitance minimization approach
- CO5. Optimize the power dissipation in CMOS circuits through different lower power minimization techniques.
Prerequisite: VLSI Design (EC3011)

Basics of MOS circuits: MOS transistor structure and device modeling, MOS inverters, MOS combinational circuits - different logic families.

Sources of power dissipation in CMOS circuits: static power dissipation - diode leakage power, subthreshold leakage power, gate and other tunnel currents; dynamic power dissipation - short circuit power, switching power, glich power; degrees of freedom, energy delay product, power delay product.

Supply voltage scaling approaches: technology Level - feature size scaling, threshold voltage scaling; logic level - gate sizing for voltage architecture level - parallelism and pipelining; algorithm level - transformations to exploit concurrency; dynamic voltage scaling. Switched capacitance minimization approaches: system level - power down, system partitioning; algorithm level - concurrency, locality, regularity, data representation; architecture level - concurrency, signal correlation; logic level - gate sizing, logic styles; layout level - layout optimization; technology level - advanced packaging, SOI.

Leakage power minimization techniques: threshold voltage scaling: MT-RAM, VTCMOS and Multiple-Vt CMOS circuits; gate sizing. Low power memory design: ROM, SRAM (4T, 6T), DRAM.

Text Books

Reference Book
1. CMOS VLSI Design: A circuits and Systems Perspective, West, Harris and Banerjee, 3rd edition, Pearson Education.

EC- 6313 OPTIMIZATION TECHNIQUES IN ENGINEERING Cr–3

Course Outcome: At the end of the course, the students will be able to:

CO1. Formulate fitness functions and cost functions for engineering optimization problems and specify the constraints as required.
CO2. Implement different single variable optimization algorithms including the gradient based methods.
CO3. Analyze and implement different multi variable optimization algorithms and a multi objective optimization techniques based on Parento-Fronts.

Prerequisites: Mathematics-I (MA1001) & Mathematics-II (MA1002)

Introduction: Optimal problem formulation, Design variables constraints, Objective function, Variable bounds, Engineering optimization problems, Optimization algorithms.
**Single-variable Optimization Algorithm:** Optimality Criteria, Bracketing methods: Exhaustive search methods, Region-Elimination methods; Interval halving method, Fibonacci search method, Point estimation method; Successive quadratic estimation method.

**Gradient-based Methods:** Newton-Raphson method, Bisection method, Secant method, Computer programmes.

**Multivariable Optimization Algorithm:** Optimality criteria, unidirectional search, Direct search methods: Evolutionary optimization method, Simplex search method, Hooke-Jeeves pattern search method, Cauchy’s (Steepest descent) method, Newton’s method, multi-objective optimization, Pareto optimization.


**Advanced Optimization Algorithms:** Genetic Algorithm (GA), working principles, GA operators, selection methods, advanced GAs, computer programmes, simulated annealing. Particle swarm optimization (PSO), differential evolution (DE) algorithm, bacterial foraging algorithm, ant colony optimization algorithm.

**Text Books:**

**Reference Book:**

**EC6316 MICROWAVE INTEGRATED CIRCUITS**

**Course Outcome:** At the end of the course, the students will be able to:

- **CO1.** Analyze the fabrication techniques of MIC and MMIC, use of active devices with MIC and MMIC, differentiate between MIC and MMIC.
- **CO2.** Analyze and design strip lines and microstrip lines, and model the discontinuities in those lines.
- **CO3.** Analyze and design slot lines, fin lines, coplanar lines and coplanar wave-guides.
- **CO4.** Design parallel coupled lines for couplers and power divider circuits.
- **CO5.** Differentiate between various measurement techniques associated with planar transmission lines.

**Prerequisites:** Analog Electronic Circuits-I (EC2001) & RF and Microwave Engineering (EC4001)

**Introduction:** Introduction to Microwave Integrated Circuits (MIC) and Monolithic Microwave Integrated Circuits (MMICs), their advantages over discrete circuits, MMIC fabrication techniques, Thick and Thin film technologies and materials, encapsulation and mounting of active devices in MIC and MMIC.

**Planar Transmission Lines-I:** Strip line & microstrip line, field configurations, quasi-TEM mode in microstrip line, analysis of microstrip transmission line, concept of effective dielectric constant, impedance of Strip line & microstrip line, dispersion and losses in microstrip line, discontinuities in microstrip.
Planar Transmission Lines-II: Slot Line, approximate analysis and field distribution of slot line, transverse resonance method and evaluation of slot line impedance, comparison with microstrip line. Fin lines & Coplanar Lines, analysis of Fin lines by transverse resonance method, conductor loss in Fin lines, coplanar wave guide (CPW).

Parallel-coupled Microstrip Lines and Power Dividers: Coupled microstrip lines, even mode and odd mode characteristic impedances, semi-empirical formulae for coupled line parameters, coupled-region length, coupler directivity, crosstalk between microstrip lines, design of microstrip branch-line power divider and rat-race ring power divider.

MIC Measurement, Testing and Applications: MIC measurement system, microwave test fixtures and probes, measurement techniques of S-parameters, noise measurement.

Text Books:

Reference Books:
ELECTRONICS & ELECTRICAL ENGINEERING
**Program Educational Objectives (PEOs)**

The Program Educational Objectives (PEOs) of the B.Tech Program in Electronics & Electrical Engineering are as follows:

PEO-I. To lead a successful career in industry or pursue higher studies or entrepreneurial endeavours.

PEO-II. To offer techno-commercially feasible and socially acceptable solutions to real life engineering problems.

PEO-III. To demonstrate effective communication skill, professional attitude and a desire to learn.

**Program Outcomes (POs)**

The Program Outcomes of the B.Tech Program in Electronics & Electrical Engineering are:

a) Ability to apply knowledge of mathematics, science and engineering to solve complex problems.

b) Ability to identify, formulate and solve electronics and electrical engineering related problems using first principles.

c) Ability to design, implement and evaluate electrical and electronics systems to meet the societal and environmental needs.

d) Ability to design and conduct complex experiments and interpret data.

e) Ability to use techniques, skills and modern engineering necessary for engineering practices.

f) Ability to assess the impact of contemporary social issues on professional practice.

g) Ability to recognize the sustainability and environmental impact of the engineering solutions.

h) Ability to follow prescribed norms, responsibilities and ethics in engineering practices.

i) Ability to work effectively as an individual and in a team.

j) Ability to communicate effectively through oral, written and pictorial means with engineering community and the society at large.

k) Ability to recognize the need for and to engage in life-long learning.

l) Ability to understand and apply engineering and management principles in executing projects.
Course Outcome: At the end of the course, the students will be able to:

CO1. Determine the transfer function.
CO2. Calculate the effect of feedback on gain, time constant, bandwidth, noise etc.
CO3. Analyze the working and importance of control components in a control loop.
CO4. Define performance characteristics.
CO5. Define type and order and then calculate rise time, peak time, steady state error for standard test inputs.
CO6. Determine the stability from characteristic equation using Routh stability criterion.
CO7. Draw the root locus to determine the system stability.
CO8. Draw the bode and nyquist plots and determine the system stability

Prerequisite: Signals and Systems (EC2003)

Introduction:
Basic concepts of Control Systems, Classifications, Servomechanism and Regulators.

Depreciation of Physical System:
Differential Equation of Physical System, Transfer function, Block Diagram Algebra, Signal flow graph, Mason’s gain formula, application of signal flow graph to control system.

Feedback Theory:
Feedback and non feedback systems, Reduction of parameter variation by use of feedback, Control of the Effects of Disturbance Signals by use of feedback, Regenerative Feedback.

Control Systems & Components:

Time domain Analysis, Design Specification & Performance Indices:
Standard Test Signal: Step, Ramp, Parabolic, Impulse.

Time Response of First-order System:
Response of the Unit step Input, Response to the Unit Ramp Input.

Time Response of second-order System:
Response to the Unit Step Input, Time Response specifications, Steady state Error and Design specification, Error constant of 2nd order system, Derivative and Integral control PID control, Design consideration for higher order systems, Performance indices, Optimization using ITAE.

Concept of Stability:

Root of Stability:
Root Locus Concept, Construction of Root Loci, Construction Rules, Determination of gain from Root Locus.

Frequency Domain Analysis:

Text Books:
Reference Books:
1. Modern Control Engg, K. Ogata, PHI, 3rd Edn, 1997
   Publishing Company

EL3022 ADVANCED CONTROL SYSTEMS Cr-3

Course Outcome: At the end of the course, the students will be able to:

- CO1. Design cascade and feedback compensation using Bodes Plot.
- CO2. Design PID Controllers.
- CO3. Analyze State-Space Analysis for Linear Continuous time.
- CO4. Solve of stage equations, State Transform matrix
- CO5. Test for Controllability & Observability.

Prerequisite: Control Systems (EL3001)

Introduction to Design:
Cascade and feedback compensation, Lead and Lag compensation design using Bodes plot.

Cascade Compensation in Frequency Domain:
Correlation of time and frequency domain specifications, Lead and Lag compensation design using Bode plot,
Comparison of Lead & Lag Compensation, Feedback compensation in Frequency domain.

PID and Robust Control System Design:
Zigler Nichols rules for Turning PID controllers, Modifications of PID control Scheme. Robust control System
Design Examples.

State-space Analysis:
(Linear Continuous time) Concept of state variables and state model State representation using physical variables
and using phase variables & canonical variable.

Solution of stage equations, State Transform matrix:
Properties, Computation by Laplace Transform and using Caley-Hamilton Theorem. Transfer function from state
equations. Characteristics equation eigen values & eign vectors. Digitalization using similarly Transform, Vander
monde Matrix and Modal matrix.

Controllability & Observbility Test:
Pole placement using stage feedback for Regulator Type Systems, Full order state observer design, Ackermann’s
formula, Effect of observer on classed loop system.

Nonlinear Systems:
Definitions, examples, Vander Pole’s equations
Linearization of nonlinear system, Around equilibrium points, Phase plane method, Singular points, Method of
Isoclines, Stability of nonlinear systems, Limit cycles, Phase plane trajectories of simple nonlinear control system.

Discrete-Time System:
Sampled data digital control system, Uniform periodic sampling, Mathematical description of sampling process,
Spectrum analysis, sampling theorem, aliasing, signal reconstruction, using zero order hold.
Z transform of signals and discrete sequences Z transform theorems Conversion of G (&) to G(Z), Difference
equation, Inverse Z-transform methods. The Z transfer function (pulse transfer function)
Difference equation Solution, Z & S domain relationship, Impulse response and step transient response, Error
constants, steady state error.
EL3024 INDUSTRIAL AUTOMATION AND CONTROL Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Select suitable sensor to measure industrial parameters and the different types of actuators and its working. They will be able to design proper signal conditioning circuit to the transducer.

CO2. Determine the effect of proportional gain, integral time, derivative gain constant on the system performance and will be able to tune the controller using tuning methods, implement PID using electronic, digital, pneumatic and hydraulic methods.

CO3. Design the ladder logic to implement any process with given problem statement.

CO4. Analyze DCS hardware and its merits/demerits in an industrial automation

CO5. Analyze SCADA hardware and software and its merits/demerits in industrial automation.

CO6. Design the complex control scheme to a particular process.

Prerequisite: Control Systems (EL3001) / Introduction to Control Systems (EC3045)

Sensors, Actuators and Signal conditioning:
Sensors: Displacement sensors, Force sensors, Ultrasonic sensors, Temperature sensors, Pressure sensors etc.
Actuators: DC motors, Servo motors, Step motors, Pneumatic actuators, Hydraulic actuators etc.

Controller tuning:

Automation:
PLC (Programmable logic controllers): Overview, operation and architecture, PLC programming, Application examples.
DCS (Distributed control systems): Overview, Advantages, Functional requirements of Distributed control systems, Communication for distributed control, Application examples.
SCADA (supervisory control and data acquisition): Introduction to SCADA, SCADA system components, architecture and communication, SCADA applications.
Advanced control techniques: Feed forward control, Ratio control, Cascade control, Adaptive control, Duplex or split range control, Override control, Internal mode control.

Text books:

Reference books:
2. Modern Control Engineering, 4th edition, Ogata, Prentice Hall of India
ELECTRONICS & INSTRUMENTATION ENGINEERING
Program Educational Objectives (PEOs)

The Program Educational Objectives (PEOs) of the B.Tech Program in Electronics & Instrumentation Engineering are as follows:

PEO-I. To lead a successful career in industry or pursue higher studies or entrepreneurial endeavours.
PEO-II. To offer techno-commercially feasible and socially acceptable solutions to real life engineering problems.
PEO-III. To demonstrate effective communication skill, professional attitude and a desire to learn.

Program Outcomes (POs)

The Program Outcomes of the B.Tech Program in Electronics & Instrumentation Engineering are:

a) Ability to apply knowledge of mathematics, science and engineering to solve complex problems.
b) Ability to identify, formulate and solve electronics and instrumentation engineering related problems using first principles.
c) Ability to design, implement and evaluate electronics and instrumentation systems to meet the societal and environmental needs.
d) Ability to design and conduct complex experiments and interpret data.
e) Ability to use techniques, skills and modern engineering necessary for engineering practices.
f) Ability to assess the impact of contemporary social issues on professional practice.
g) Ability to recognize the sustainability and environmental impact of the engineering solutions.
h) Ability to follow prescribed norms, responsibilities and ethics in engineering practices.
i) Ability to work effectively as an individual and in a team.
j) Ability to communicate effectively through oral, written and pictorial means with engineering community and the society at large.
k) Ability to recognize the need for and to engage in life-long learning.
l) Ability to understand and apply engineering and management principles in executing projects.
Course Outcome: At the end of the course, the students will be able to:

CO1. Differentiate between different measurement methods and universal instruments.
CO2. Differentiate between measurement techniques for measuring the value of different electrical and electronic components.
CO3. Analyze internal construction of instruments used for measuring current, voltage, power, energy, frequency and spectrum.

Prerequisites: Basic Electrical Engineering (EE1003), Basic Electronics (EC1001)

Introduction:
Measurement and its significance, Methods of measurement, Classification of instruments, Errors in measurement, Types, Accuracy and Precision, Significant figures, Units and standards of measurement, classification, Electrical standards, IEEE standards.

Measurement of Resistance, Inductance and Capacitance:
Resistance: Measurement of low and medium resistance, DC bridges - Wheatstone bridges, Limitations of Wheatstone bridge, Kelvin’s double bridge, Measurement of high resistance-Megohm bridge. Megger, Inductance: Maxwell’s, Hay’s, Anderson and Owen’s bridge.

Capacitance: Schering & Wein’s bridge. Errors in bridge measurement and Wagner’s earthing device.

Measurement of voltage and current:
Galvanometer: Construction, principle of operation of D’Arsonval and Ballistic, sensitivity and Galvanometer constants.

Ammeter and Voltmeter: Construction, theory and principle of operation of PMMC, MI, Electro dynamometer, Inductive, Electrostatic type.


Sensitivity, Loading effect on measurements, Range extension and calibration of Voltmeter and Ammeter.

Measurement of Power, Energy and Power factor:
Power: Construction, Theory and principle of operation of electro dynamometer, electrostatic Wattmeter, Measurement of 1Φ and 3 Φ power by Wattmeter.

Energy: Construction, Theory and principle of operation of 1 Φ and 3Φ Induction watt-hour meter, Errors and compensation.

Theory and operation of frequency, power-factor meters, calibration of Wattmeters and Energymeters.

Current Transformers and Potential Transformers:
Construction, Theory, characteristics and testing of CTs and PTs.

Electronic Instruments for measurement of basic parameters:
Introduction, Electronic DC & AC Voltmeters, Chopper amplifier type, True RMS Voltmeter, Peak response Voltmeter, Q-meter, Digital Voltmeters (Block diagram only).
**Oscilloscope:**
CRO, Block diagram, sweep circuits, Delay line, multiple trace, and oscilloscope probes. Introduction to analog and digital storage oscilloscope, Measurement of frequency, phase angle and time delay using oscilloscope.

**Frequency Counters, Function Generators and Spectrum analyzers:**
Frequency Counters, Function generators, spectrum analyzers: Block diagram, working, types.

**Text Books:**
2. Modern Electronic Instrumentation and Measurement Techniques, Helfrick & Cooper, 2nd Edition. PHI,

**Reference Books:**
1. Electrical Measurements and Measuring Instruments, Golding & Widdis, 5th edition, Reem Publication,
2. Electronic Instrumentation, H S Kalsi, 3rd Edition, TMH.

**EI2006 INSTRUMENTATION – I Cr-4**

**Course Outcome:** At the end of the course, the students will be able to:

CO1. Differentiate between various transducers, sensors and their brief performance specifications.
CO2. Analyze the principle of working of various transducers used to measure temperature, level and pressure.
CO3. Analyze various signal conditioning techniques.
CO4. Analyze applications of various transducers in industry.

**Prerequisites:** Basic Electrical Engineering (EE1003) and Analog Electronics (EC2013)

**Introduction:** Instrument and measurement system and its functional elements
Input – Output configuration, correction methods

**Performance characteristics of Instrumentation system:**
Static and dynamic characteristics, loading effect, Impedance concept.

**Statistical analysis:**
Statistical concepts, probability distribution function, chi-square test, curve fitting techniques, Reliability.

**Primary sensing elements and Transducers:**
Primary sensing elements: Mechanical, Pressure and flow sensing elements.
Transducers: Introduction, classification, characteristics and selection
Resistive transducers – Potentiometers, strain gauge, RTD, Thermistor, Photo Conductive cell, pirani gauge.
Inductive transducers: Variable inductance, LVDT, RVDT, Synchro, Resolver.
Magnetic type transducers – eddy current, magnetostrictive and magneto resistive types Digital transducers.

**Signal conditioning:**
Introduction, signal conditioning circuits using DC bridges (Wheatstone bridge), AC bridges with push-pull transducer - Blumlein bridge, Diode circuits, Op-Amps, Attenuators, Filtering, Modulation and Demodulation techniques, A/D and D/A conversion in measurement.
Measurement of non-electrical quantities:

Measurement of force, weight, stress and strain, velocity and acceleration and torque, Shock measurement, Introduction to vibration measurement and monitoring.

Text Books:

Reference Books:
2. Sensors & Transducers - D. Patranabis, 2nd edition, PHI

EI3004 PROCESS CONTROL-I Cr-4

Course Outcome: At the end of the course, the students will be able to:

CO1. Design active and passive compensators and also able to perform the state-space representation.
CO2. Analyze different physical controlling processes mathematically and compensator design for the same.
CO3. Differentiate between different controllers and control schemes.

Prerequisites: Instrumentation-I (EI2006) and Control Systems (EL3001)

Introduction to design:

State-space analysis:

Process dynamics and modeling:

Basic control schemes:

Controller tuning:
Performance criteria Tuning methods: Process Reaction Curve method, Continuous cycling method and Damped oscillation method, Zeigler-Nichols method, Cohen - Coon method.
Complex control schemes:
Ratio control, Split range control, Cascade control, Feed forward control, selector control, Inverse derivative control, Antireset control. Multivariable control systems Dead time compensation-Smith predictor, selective and Adaptive control systems.

Text Books

Reference Books

EI3005 INSTRUMENTATION – II Cr-4

Course Outcome: At the end of the course, the students will be able to:

CO1. Analyze the construction and working principle of Industrial Instruments for Temperature, Level, Pressure, Flow and Viscosity.
CO2. Identify sensor, transducer and their performance specifications for measurement of different process variables.
CO3. Apply specific instrument for the measurement of different process variable.
CO4. Analyze the industrial application and calibration of Industrial Instruments.
CO5. Analyze the use of Industrial Instruments in hazardous locations.

Prerequisite: Instrumentation-I (EI2006)

Temperature measurement:
Temperature scales, ITS90. Filled in systems, Bimetal elements, RTD, Thermocouple, Semiconductor temperature sensors, Radiation pyrometers.

Pressure & vacuum measurement:
Manometer types, Elastic type, D/P Transmitters. Electronic type: capacitive, piezoresistive and resonator type, Installation of pressure measuring devices, accessories.
Vacuum: McLeod gauge, thermal conductivity gauge, ionization gauge.

Level measurement:
Gauge glass, float, displacers and hydrostatic types, D/P type, capacitive type, conductive type, ultrasonic type, microwave type, radiation type, vibration type.

Flow measurement:
Basic principles of flow measurement, Differential pressure devices: orifice, venturi, flow nozzle, pitot tube, annubar, Area flow meter: Rotameter and piston type. Mass flow meter: Coriolis, thermal & impeller types. Electromagnetic type, ultrasonic type, vortex type, turbomagnetic type, target type, positive displacement type, open channel flow measurement, solid flow rate measurement.

Viscosity, density, conductivity and humidity measurements:
Capillary Viscometer, Saybolt viscometer, float viscometer, plastometer, vibrating type, oscillating type, ultrasonic type. Measurement of density: liquid density measurement, gas densitometers, Conductivity measurement, Humidity measurement.
**Instrumentation in hazardous locations:**
Area, material & temperature, classification, explosion proof enclosures, intrinsic safety, Pressurization, non incendive systems, Combustible gas detectors, Enclosure classification: IP & NEMA standards.

**Text books:**

**Reference books:**
1. Instrument engineers handbook, Vol-1, B.G Liptak, CRC press

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**EI3021 MATERIAL SCIENCE Cr-3**

**Course Outcome:** At the end of the course, the students will be able to:

- CO1. Apply knowledge of mathematics, science and engineering (to solve problems related to materials science and engineering)
- CO2. Design and conduct experiments, as well as to analyze and interpret data (using statistical, computational or mathematical methods)
- CO3. Differentiate between different materials for a wide range of applications in engineering.
- CO4. Realize the professional and ethical responsibilities of a materials scientist and engineer.
- CO5. Develop skills and techniques of modern materials engineering practice.

**Prerequisite: Physics (PH1003)**

Classification of engineering Materials:

**Crystal Structures:**
Types of crystal, Unit Cells and Basis Vectors, Miller Indices, Crystal Structure of materials (SCC, BCC, FCC, HCP), Classification of crystals – ionic, covalent and molecular crystals.

**Crystal Defects:** Point defects, Line Defects, Planar or Surface defects.

**Dielectric Materials and Insulators:**
Polarization, Dielectric constant of mono-atomic and polyatomic gases; Dielectric constant of solids, spontaneous polarization, ferroelectric materials, Curie-Weiss Law, Dielectrics in ac fields, complex polarizability and complex dielectric constant, Dielectric Losses.

**Magnetic Properties of materials:**
Dia, Para, ferro, anti-ferro and ferrimagnetism, Magnetic hysteresis, Ferrites and their applications, Hard and soft magnetic materials.

**Piezoelectric Materials:**
Electrostriction, Displacement strain and stress in solids, Quartz- Its piezoelectric properties, applications, Pyroelectric.

**Superconductivity:**
Review of superconductivity, Application of superconductivity- SQUID, Cryotron.

**Advance Materials:**
Brief description of other materials such as Corrosion Resistant materials, Nano-phase materials, Shape Memory Alloys, SMART materials, Biomaterials.
EI3022 BIOMEDICAL INSTRUMENTATION Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Identify various bio-medical signals and instruments, transducers, sensors and their brief performance specifications.
CO2. Analyze the principle of various bio-medical instruments, transducers used to measure temperature, level, pressure.
CO3. Differentiate between various bio-medical instruments.
CO4. Analyze applications of various bio-medical instruments in medical purposes.

Prerequisite: Chemistry (CH1003)

Fundamentals of Biomedical Instrumentation:
Sources of Biomedical Signals, Basic Medical Instrumentation System, Intelligent Medical Instrumentation Systems, PC Based Medical Instrumentation Systems, General Constraints & Regulations of Medical Devices.

Biomedical Signals & Electrodes:
Origin of Bioelectric Signals-Repolarization, Depolarization, Resting Potential Recording Electrodes – Ag-AgCl Electrodes, Electrodes for ECG, EEG, EMG, Microelectrodes, Skin Contact Impedance, Motion Artifacts, Transducers used in biomedical applications.

Blood pressure measurements:

Heart:
Engineering analog of heart, model of heart, electrocardiograph-principle of instrument, detail instrumentation, noises and interference in the measurement, its solutions, other systems of diagnosing the heart. Pacemaker – general description and instrumentation details, Defibrillator.

X-ray imaging:
Range for medical use, principle of X-ray generation, instrumentation of X-ray image.

Computer aided tomography (CAT):
Basic principle, image acquisition, mathematical modeling for reconstruction of image, block diagram representation of the instrument and detailing of some parts.

Biotelemetry:
Techniques and Applications.

Patient Safety:
Electric Shock Hazards, Leakage Currents, Safety Codes for Biomedical Equipment.
EI3023       NEURAL NETWORK AND FUZZY LOGIC CONTROL       Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO2. Apply suitable algorithms on different cases.
CO4. Analyze the applications of Neural Network and Fuzzy logic in image processing.

Prerequisites: Mathematics-I (MA1001), Mathematics-II (MA-1002) and Control Systems (EL3001)

Neural Networks and Pattern Association:

Neural Networks based on Competition:
Kohonen self organising maps – Learning vector quantization – Counter propagation – Architecture – Algorithm and applications

Adaptive Resonance and Backpropagation Neural Networks:
ART1 and ART2 – Basic operation and algorithm – Standard back propagation architecture – Derivation of learning rules – Boltzmann machine learning – Architecture – Algorithm and simple applications

Fuzzy sets and Membership Functions:
Properties and operations on classical and fuzzy sets – Crisp and fuzzy relations – Cardinality – properties and operations – Composition – Tolerance and equivalence relations – Simple problems – Features of membership function – Standard forms and boundaries – Fuzzification – Membership value assignments – Fuzzy to crisp conversions – Lambda cuts for fuzzy sets and relations – Defuzzification methods.

Applications of Neural networks and Fuzzy logic:

Text Books:

References:
1. Introduction to Neural Networks Using Matlab 6.0, Sivanandam, S.N., Sumathi, S. and Deepa, S.N, 2005, TMH.
3. Neural Networks and Fuzzy Systems, Bark Kosko, 1st edition, PHI
**Course Outcome**: At the end of the course, the students will be able to:

- CO1. Analyze the virtual instrumentation and programming techniques.
- CO2. Differentiate between different data acquisition techniques on virtual instrumentation.
- CO3. Implement different controllers and testing using industry standard software.
- CO4. Differentiate between various Industrial network components and protocols.

**Prerequisites**: Instrumentation-I (EI2006) and Digital Electronics (EC2011)

**Introduction:**

**VI Programming Techniques:**

**Data Acquisition in VI:**
Introduction to data acquisition-signal conditioning-classes of signal conditioning-field wiring and signal measurement-ground loops-A/D, D/A converters, plug-in DAQ boards- Analog input/output cards -Digital Input/Output cards-counter and timer I/O boards-Isolation-techniques- Opt isolation -Data acquisition modules with serial communication.

**Communication networked modules:**

**Real time control and Applications:**
Design of ON/OFF controller- PID controller –electronic prototyping and testing with ELVIS- real-time data acquisition-transducer analysis-signal processing with DSP module-real-time embedded control with CRIO.

**Text Books:**

**Reference Books:**
1. Practical Data Acquisition for Instrumentation and Control Systems, John Park and Steve Mackay, 2003, Newnes
2. Labview based advanced instrumentation system, psumathi, 1st edition,2007, springer science Elsevier
Course Outcome: At the end of the course, the students will be able to:

CO1. Differentiate between various techniques involved to determine the concentration of each component from a mixture.
CO2. Analyze different parameters of liquid used for industrial and biomedical application.
CO3. Analyze the operating principle of instruments used for radiation detection and pollution monitoring.

Prerequisite: Chemistry (CH1003)

Fundamentals of Analytical Instruments:
Introduction, Elements of an Analytical Instrument.

Spectrophotometry:

Chromatography:
Gas Chromatograph, Basic Parts of a Gas Chromatograph, Methods of Measurement of Peak Areas. Liquid Chromatography, principle, construction.

pH Meters And Ion Analyzers:

Analyzers:

Spectrometers:

Radiochemical Instruments:
Radiation Detectors, Liquid Scintillation Counters, Gamma Spectroscopy.

Pollution Monitoring Instruments:
Air pollution due to carbon monoxide, sulphur dioxide, Nitrogen oxides, Hydrocarbons, Ozone, Water pollution monitoring instruments.

Text books:

Reference books:
2. Principles of Industrial Instrumentation, D. Patranabis, 3rd edition, TMH.
Course Outcome: At the end of the course, the students will be able to:

CO1. Differentiate between various optical sources and detectors used for communication.
CO2. Analyze various phenomenons of transmission media and its performance calculation.
CO3. Differentiate between various sensors and amplifiers used in optical transmission for performance calculation.

Prerequisite: Physics (PH1003)

Optical Sources:
Light Emitting Diodes (LEDs), LED Structures, Light Source Materials, Quantum Efficiency and LED Power, Modulation of an LED.

LASER diodes:
Principle of Operation, Modes and Threshold Conditions, Optical output power and drive current, Quantum efficiency, Resonant frequencies, Radiation Pattern, Single Mode Lasers, Modulation of Laser diode.

Optical Detectors:
P-n junction Photo diodes, Power relationship, Responsivity Versus wavelength, Equivalent Circuit of a p-n Photo diode, Bandwidth, p-i-n photo diode and APD, Principle of operation, Sources of noise, Noise Equivalent Circuits, Signal to noise ratio for p-i-n and APD.

Optical Fiber:
Fiber Materials, Ray Propagation in Step-Index Fibers, Total internal reflection, Ray Propagation in Graded Index Fibers, Mode Theory, Monomode Fibers, Attenuation in Optical Fibers – absorption, scattering and bending losses

Power Launching and Coupling:

Fiber-Optic Sensors:

Optical Amplifiers:
Semiconductor Optical amplifiers (SOA), Erbium Doped Fiber amplifiers, Fiber Raman amplifier.

Text Books:

Reference Book:
1. Optical Fiber Communications Principles and Practice by John M. Senior, 3rd Edition Pearson Education
   New Age International
Course Outcome: At the end of the course, the students will be able to:

CO1. Analyze the construction and working principle of Industrial Instruments for measurement of different process variable like Temperature, Level and Pressure.
CO2. Identify sensor, transducer and their performance specifications for measurement of different process variable.
CO3. Analyze various Instrumentation and control used in power plant.
CO4. Analyze Spectrophotometry and chromatography techniques.

Prerequisite: Electrical & Electronic Measurements (EI2004)

Temperature measurement:
Bimetal elements. RTD, Thermocouple, Semiconductor temperature sensors, Radiation pyrometers, thermistor.

Pressure & vacuum measurement:
Manometer types, Elastic type, D/P Transmitters. Electronic type: capacitive
Vacuum: McLeod gauge, thermal conductivity gauge, ionization gauge, Bourdon tube.

Level measurement:
D/P type, capacitive type, ultrasonic type, microwave type, radiation type.

Analytical measurements:
Mass Spectrometer: Principle, Types, Components of a mass spectrometer.
Chromatography: Gas chromatograph, Basic parts of gas chromatograph, Methods of measurements of peak areas.
Pollution Monitoring Instruments: Air pollution due to carbon monoxide, sulphur dioxide, Nitrogen oxides, Hydrocarbons, Ozone, Water pollution monitoring Instruments.

Power Plant Instrumentation:
Over view Of Power Generation: Introduction, Basic overview of power generation in thermal power plants, P & I diagram, Cogeneration of Power, Importance of Instrumentation and control in power generation.
Instrumentation and Control In Water Circuit: Introduction, Measurements in Water Circuit Water flow, steam flow, water and steam pressure, water and steam temperature, boiler drum water level, Measurement of impurities in water and steam.
Controls in water circuit: Boiler, drum level, superheated steam temperature, steam pressure.

Text books:
2. Power plant Instrumentation-K. Krishnaswamy, M. Ponnibala, 2nd edition, PHI publication

Reference books:
1. Industrial instrumentation, K. Krishnaswamy, S. Vijayachitra, 2nd edition, New age international.
Course Outcome: At the end of the course, the students will be able to:

CO1. Analyze digitize the system output and apply controllers whenever needed.
CO2. Analyze various different hardware used in industry for programming and controlling purposes.
CO3. Differentiate between control elements and their application in industry.

Prerequisites: Control System (EL3001) and Process control-I (EI3004)

Computer Aided Process Control:
Introduction, Overview on computer control of process plants.

Digital control systems:

Programmable Logic Controller:
Introduction, Architecture, relay ladder logic, programming, software, configuration and applications.

Distributed control system and SCADA:
Introduction. DCS system architecture and elements, configuration and applications, The basic SCADA structure, hardware and software.

Final control elements:

Plant process control:
Boiler control- Control schemes, combustion control, optimizing air-flow, feed water control, furnace pressure control, and steam temperature control. Distillation column- Control schemes, Batch process control-Control schemes.

Industrial control applications:
Cement plant, Thermal power plant, and Steel plant- objectives, automation strategy, and their DCS structure.

Text Books:

Reference books:
EI4028 POWER PLANT INSTRUMENTATION  Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Differentiate between various components of thermal power plants in brief and their operations.
CO2. Differentiate between the sensors used in power plants for various applications.
CO3. Differentiate between controlling strategies used in power plant for error corrections and efficiency enhancing.

Prerequisite: Instrumentation-II (EI3005)

Overview of Power Generation:
Introduction, Basic overview of power generation in thermal power plants, P&I diagram, Cogeneration of power, Importance of instrumentation and control in power generation.

Instrumentation and Control in Water Circuit:
Introduction, Measurements in water circuit: water flow, steam flow, water and steam pressure, water and steam temperature, boiler drum water level, Measurement of impurities in water and steam, Controls in water circuit: boiler drum level, superheated steam temperature, steam pressure.

Instrumentation and Control in Air-Fuel Circuit:

Turbine-Monitoring and Control:

Text books:

References:

EI4029 INSTRUMENTATION FOR OIL & GAS INDUSTRIES  Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Differentiate between various processes involved in petrochemical industry.
CO2. Differentiate between various sensors used in petrochemical industry and their working mechanism, limitations, range of operation.
CO3. Differentiate between various controlling schemes involved in petrochemical industry.
Prerequisite: Instrumentation-II (EI3005)

Overview of petrochemical processes:
Introduction, Petroleum Feedstocks: exploration, recovery, composition, Oil and Gas separation, Refining of crude oil, Processes, Products from crude oil: Methane, Acetylene, Ethylene, Propylene – derivatives etc., Unit operations: Distillation etc.

Measurements:
Pressure, Temperature, Flow, Level sensors; Analytical Instruments: Chromatography, Gas analyzer etc.; Special types of sensors: Soft-sensors in distillation columns, magnetostrictive and magnetic float for level measurement etc.

Control of refinery processes:
Process control in refinery and petrochemical industry: Control of distillation column, Control of catalytic crackers and pyrolysis unit, Automatic control of polyethylene production, Control of vinyl chloride and PVC production; Controls for Safety.

Text books:

Reference books:

EI4033 NONLINEAR CONTROL THEORY Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Analyze various applications of nonlinear control in practical applications.
CO2. Analyze various types of phase plane and describing function analysis.
CO3. Analyze various types of stability on different types of system.

Prerequisite: Control Systems (EI3001)

Introduction to nonlinear phenomena:
Phase plane analysis:
The phase-plane method-basic concepts-singular points-nodal point-saddle point-focus point-vortex point, Construction of phase trajectories-analytical method-graphical methods-isocline method, delta method, Example problems.

Describing function analysis:

Lyapunov Stability Theory:

Text Books:

Reference Books:
**Program Educational Objectives (PEOs):**
The Program Educational Objectives (PEOs) of B.Tech Program in Mechanical Engineering are established and are listed as follows:

PEO-1. To lead a successful career in industry or pursue higher studies or entrepreneurial endeavors.

PEO-2. To offer techno-commercially feasible and socially acceptable solutions to real life engineering problems.

PEO-3. To demonstrate effective communication skill, professional attitude and a desire to learn.

**Program Outcomes (POs):**
The Program Outcomes of UG in Mechanical Engineering are:

a) Ability to apply knowledge of mathematics, science and engineering in domain of mechanical engineering

b) Ability to identify, formulate, and solve complex mechanical engineering problems using first principle of mathematics, basic science & engineering

c) Ability to design a mechanical component or system or process to meet desired needs within constraining realistic factors including economy, safety and manufacturability.

d) Ability to design and conduct complex mechanical engineering experiments as well as to analyze and interpret the experimental data.

e) Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

f) Ability to assess impact of contemporary social issues on professional practice

g) Ability to recognize the sustainability and environmental impact of the engineering solutions.

h) Ability to follow prescribed norms, responsibilities and ethics in engineering practices.

i) Ability to work effectively as an individual and in a team.

j) Ability to communicate effectively through oral, written and pictorial means with engineering community and the society at large.

k) Ability to recognize the need for and to engage in life-long learning

l) Ability to understand and apply engineering and management principles in executing projects.
Course Outcome: At the end of the course, the students will be able to:

CO1. Identify and formulate elementary level engineering problems related to particle mechanics, in conceptual form as well as in terms of mathematical and physical models and to solve problems dealing with forces in a plane or in space and equivalent force systems.

CO2. Solve real life problems by using mathematics, physical laws and theorems.

CO3. Utilize scalar and vector analytical techniques for analyzing forces in statically determinate structures and to analyze and design a bridge in a safe and economical way using the knowledge gained from trusses and frames.

CO4. Apply the basic principles of energy methods to the analysis of particle subjected to forces.

CO5. Apply fundamental concepts of kinematics and kinetics of particles to the analysis of simple, practical problems.

Prerequisite: Nil

Concurrent Forces in a Plane:
Introduction to Engineering Mechanics, Free-body diagrams, Composition and resolution of forces, Equilibrium of concurrent forces in a plane, Methods of projections, Methods of moments

Friction:
Static friction, Laws of dry friction, Applied of friction in inclined plane, Wedge friction, Belt friction

Parallel Forces in a Plane:
Parallel forces acting in the same and opposite directions, General case of parallel forces in a plane, Centre of parallel forces, Centroid and Centre of gravity, Theorem of Pappus, Centre of composite plane figures and Curves, Distributed forces in a plane.

Moment of Inertia:
MI of plane figures, Parallel Axis Theorem, Perpendicular axis theorem and MI of composite figures.

Force analysis of Plane Trusses and Frames:
Methods of joints, Method of Sections and Method of members.

Principle of Virtual work:
Equilibrium of Ideal Systems, Virtual work.

Kinematics of Rectilinear Motion:

Kinematics of Curvilinear Motion:
Normal and Tangential acceleration, Motion of a Projectile, Work and Energy in curvilinear motion.

Rotation of a rigid body:
Kinematics of rotation, Rotation under the action of a constant moment.
Text Book

Reference Books
1. Engineering Mechanics (Statics and Dynamics) - Bear and Johnson, TMH

ME2001 ENGINEERING THERMODYNAMICS Cr-4

Course Outcome: At the end of the course, the students will be able to:

CO1. Comprehend terminology related to thermal engineering.
CO2. Recognize the need of learning thermodynamics.
CO3. Appreciate the 1st law in cyclic and acyclic processes.
CO4. Interpret the 2nd law in applications related to heat engine, heat pump and refrigerators.
CO5. Read and comprehend steam table and Mollier chart in solving complex thermal problems.
CO6. Compute availability.

Prerequisite: Mathematics-I (MA-1001)

Basic concepts and definitions:
Scope of thermodynamics, Macroscopic and microscopic approaches, Definition of fixed mass (closed system) and control volume (open system), Properties (extensive and intensive), State and representation on a property diagram, process and its representation, cyclic process (or cycle) and its representation, Characteristics of properties (point and path function), Reversible and irreversible processes, Thermal, mechanical and chemical equilibrium, thermodynamic equilibrium, Zeroth law of thermodynamics, Forms of energy, energy transfer by heat, forms of work (electrical and mechanical), energy transfer by work, conservation of mass in a control volume.

First law of thermodynamics:
Moving boundary work (PdV work), PdV work for different processes, First law for closed systems (for cyclic and non-cyclic processes), introduction of internal energy as a thermodynamic property, flow work and energy of a flowing fluid, first law for control volumes (open systems) and introduction of enthalpy as a thermodynamic property, Application of first law to different processes of fixed masses (closed systems) and control volumes.

Second law of thermodynamics:
Kelvin-Planck and Clausius statements of second law, Reversible and irreversible processes, Irreversibilities, Carnot principles, Clausius inequality, definition of entropy and its evaluation for various processes of pure substances, principle of increase of entropy, Entropy generation.

Pure substances:
Definition of pure substance, p-V and T-v diagrams for pure substances, specific volumes of saturated liquid, wet vapor and superheated vapor. Use of steam tables in finding internal energy and enthalpy of steam at different conditions.

Thermodynamic property relations:
Ideal gases and their p-V-T relation, The Maxwell relations, The Clapeyron’s equation, Change in internal energy, Change in internal enthalpy, the T-ds relations, Relation between specific heats, isothermal compressibility and volume expansivity, the Joule-Thomson coefficient.

Exergy:
Available energy or Exergy, Useful work, availability for closed systems, flow availability, irreversibility, Second law efficiency.
Text Book:

Reference Books:
3. Engineering Thermodynamics, Gordon Rogers and Yon Mayhew, Pearson Education Ltd
4. Engineering Thermodynamics ,Krieth, CRC Press
5. Engineering Thermodynamics , Jones and Dugan, PHI Learning Pvt. Ltd.

ME2002 MACHINE DYNAMICS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Classify various simple mechanisms and explain their inversions.
CO2. Analyze velocities and accelerations of mechanisms.
CO3. Illustrate Hook’s joint, Davis and Ackerman Steering gears. Compound pendulum, Bifilar and Trifler suspension.
CO4. Assess the effect of friction on mechanisms and the kinematics of cam and followers.

Prerequisite : Kinematics & Kinetics of Machines (ME-2009)

Force analysis:

Gyroscopic:
Gyroscopic couple of plane disc. Analysis of the forces on bearings due to the forced processing of rotating disc mounted on shafts. Gyroscopic effects on a two wheel and four wheel vehicle. Gyroscopic stabilization with reference to practical application.

Governors:

Balancing:
Balancing of revolving masses in the same planes and different planes. Partial balance of Locomotives. Variation of tractive efforts, swaying couple. Primary and Secondary balance of multicylinder engines.

Free Vibration:
Free vibration of single degree system without and with damping, Equilibrium Method, Energy method, stiffness of spring elements, viscous damping, Logarithmic decrement.

Forced Vibration:
Equation of motion, Dynamic amplifier, Vibration isolation and transmissibility, transverse vibration of shafts carrying a point load, uniformly distributed load and several loads. Dunkerly’s method and energy method, whirling of shafts, Two rotor systems.

Toothed Gears: Theory of shape and action of tooth properties and methods of generation of standard tooth profiles, Standard proportions, Interference and under cutting, methods of elimination of interference, minimum number of teeth to avoid interference.
Lower Pairs:
Hook’s joint, Davis and Ackerman Steering gears.

Text Book:
1. Theory of Machines, Sadhu Singh, Pearson

Reference Books:
1. Theory of Machines, Shigley J, TMH
3. Theory of Mechanism and machines, Sharma & Purohit, PHI

ME2003 FLUID MECHANICS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Explain fluid properties and determine hydrostatic pressure using manometric data
CO2. Determine the total pressure and centre of pressure
CO3. Demonstrate stability of floating bodies and types of flow. visualize different motion.
CO4. Apply Bernoulli’s equation in moving fluids to find flow rate.
CO5. Solve hydraulic pipe flow problems and hence calculate hydraulic and energy grade lines.

Prerequisite : Mathematics-I (MA-1001)

Fundamental Concepts:
Definition of a fluid, Macroscopic and Microscopic view points, the concept of continuum, concept of pressure and stress in a fluid, Properties of a fluid.

Fluids under Rest:
Fundamental equation and its solution (constant density and constant temperature solutions), Units and scales of pressure measurement, Manometers, Hydrostatic thrusts on submerged surfaces (plane and curved), Buoyancy, Stability of unconstrained bodies in fluids, Fluids under relative equilibrium.

Kinematics of Fluid Flow:
Scalar and vector fields, Description of fluid motion, variation of flow parameters in time and space, Material derivative and acceleration, Stream lines, path lines and streak lines, Translation, Rate of deformation and Rotation. Derivation of Continuity Equation in Cartesian coordinates (Control mass system approach and Control volume approach). Stream function, constancy of stream function on a streamline, physical significance, Velocity Potential, Relationship between velocity potential and stream function.

Dynamics of Inviscid Flows:
Equation of motion for inviscid flow in Cartesian coordinates, Pressure differential between two points (steady, unsteady along a streamline and irrotational flow). Euler’s equation o motion in streamline coordinates. Mechanical energy conservation and its application to vortex flow (free and force vortex flow), pressure distribution in free and forced vortex flow. Derivation of Bernoulli’s equation from Euler’s equation, Applications of Bernoulli’s equation for measurement of flow rate through venturimeter, orificemeter, and flow nozzles, concept of static and stagnation pressures and application of pitot tube in flow measurements.
Dynamics of Viscous Flows:
Conservation of linear momentum in differential form, viscous flows through pipes: concept of friction factor in a pipe flow, variation of friction factor, losses due to geometric changes (sudden enlargement, exit loss, sudden contraction, and entry loss), concept of flow potential and flow resistance, flow through branched pipes (pipes in series and parallel), losses in pipe bends, losses in pipe fittings, power transmission by a pipeline.

Text Book:

Reference Books:

ME2007 MATERIAL SCIENCE AND ENGINEERING Cr-3

Course Outcome: At the end of the course, the students will be able to:
CO1. Recognize appropriate material for a particular engineering application.
CO2. Develop and change the chemical, physical and mechanical properties of steel and its alloys for different structural applications.
CO3. Select different ferrous materials for different industrial and day to day life application.
CO4. Change the mechanical properties of steel with or without change in chemical compositions.
CO5. Use the technique to prevent corrosion of different ferrous and non ferrous alloys

Prerequisite : Chemistry (CH-1003)

Introduction of Engineering Materials:
Materials Classification, Engineering requirements of materials, recent development in metallic and non metallic materials.

Structure of Materials:
Fundamental concepts, bonding forces and energies, unit cells, crystal structures, crystal systems, Crystallographic plane and directions, single and poly-crystalline materials, non-crystalline materials.

Structure property relationship:
Defects in crystals – point defects, line defects (dislocations), surface defects and volume defects, mechanical properties of materials ( tensile, hardness, creep and fatigue), strengthening mechanism of metals, electrical properties, thermal properties, magnetic properties and optical properties.

Phase Diagram and Phase transformation of metals and alloys:
Metallic and non-metallic Materials:
Aluminum, Magnesium and Titanium alloys and their application, Structural classes of alloy steels, Ordinary, improved and quality carbon structural steels, alloy structural steels, tool steels, wear-resistant steels, stainless and acid resistant steels, corrosion resistant steels, Magnetic steels. Pig iron, Grey cast iron, White cast iron, malleable cast iron, SG (spheroidal graphite) iron, ceramics, polymers and composites.

Materials Selection and Design Considerations:
Introduction, case studies to select material for Torsionally-stressed cylindrical shaft, Automotive valve spring, Anatomy of Hip joint, Integrated circuit and etc.

Economic, Environmental, and societal issues in materials Science and Engineering:
Corrosion & its Prevention, Component design, materials, manufacturing techniques, recycling issues.

Text Book:
1. Materials Science and Engineering, William D. Callister, Jr. John Wiley & Sons publications
2. Callister’s Materials Science and Engineering Adapted By R. Balasubramaniam, Wiley India, Edition - 2010

Reference Books:

ME2008 FLUID DYNAMICS AND HYDRAULIC MACHINES Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Differentiate Boundary layer thickness, displacement thickness, Momentum thickness, and energy thickness.
CO2. Explicate pressure drag and friction drag on stream lined and bluff bodies.
CO3. Aapply Raleigh’s method and Buckingham theorem for dimensional analysis and model study.
CO4. Find out efficiency of Pelton, Francis, Kaplan turbines using velocity triangle.
CO5. Describe the characteristics curves of centrifugal pump and reciprocating pump.

Prerequisite : Fluid Mechanics (ME-2003)

Boundary Layer Theory:
Boundary layer growth over a flat plate, Boundary layer thickness, displacement thickness, Momentum thickness, and energy thickness, Laminar and Turbulent boundary layer, Separation of boundary layer.

Drag and Lift:
Drag and Lift coefficient, pressure drag and friction drag on stream lined and bluff bodies, Drag over flat plate, Local and average skin friction drag coefficient. Profile drag, Circulation, Lift and Magnus effect.

Dimensional Analysis and Model study:
Dimensional homogeneity, dimensional analysis, Raleigh’s method and Buckingham theorem. Superfluous and Omitted Variables, Similarity laws and model studies, Distorted models.

Forces on vanes:
Dynamic pressure on fixed and moving flat plates and curved vanes, work done and efficiency.
Turbines:
Classification, Impulse and reaction type, Outward and inward flow, mixed and axial flow turbines, Study of Pelton, Francis and Kaplan turbines, Blade angle, velocity triangle. Specific speed, and unit quantities, Governing of turbines, Draft tubes, Cavitations in reaction turbines, Principles of similarity applied to turbines.

Centrifugal Pump:
Principles, classifications, Blade angle, velocity triangle, efficiency of centrifugal pump, specific speed, Characteristics, curves, Multistage pumps- pumps in series and parallel, Principle of similarity applied to pumps, cavitations in pumps, NPSH.

Reciprocating pump:
Principle of working, slip, work done effect of acceleration and frictional resistance, separation, air vessels.

Text Book:

Reference Books:

ME2009 Kinematic and Kinetics of Machines Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Classify various simple mechanisms and explain their inversions.
CO2. Analyze velocities and accelerations of mechanisms.
CO3. Illustrate Hook’s joint, Davis and Ackerman Steering gears. Compound pendulum, Bifilar and Trifler suspension.
CO4. Assess the effect of friction on mechanisms and the kinematics of cam and followers.

Prerequisite: Mathematics-I (MA-1001)

Simple Mechanisms:

Velocity Analysis:
Velocity of a point in a link by relative velocity methods and instantaneous center method, Numbers and types of instantaneous centers in a mechanism. Location of instantaneous centers. Kennedy’s theorem, Velocities of four-bar and slider crank mechanisms.

Acceleration Analysis:
Acceleration of point on a link, Acceleration diagram of a link, Acceleration in the slider crank and four bar mechanism. Klein’s construction, Coriolis’ components of acceleration.
Friction:
Friction of a square threaded screw and V-threads, Friction of journal, pivot and collar bearings, single plate, multi plate , conical clutches ,Centrifugal clutch.

Brakes and Dynamometer:
Block, internally expanding and Disc Brakes, Absorption and Transmission Dynamometers, Pony Brakes, Rope Brake, Belt Transmission and torsional Dynamometer.

Belt and Rope and Chain Drive:
Velocity ratio, Effect of belt thickness and slip on velocity ratio, Length of belt, Ratio of driving tensions, Power transmitted by belt ,Centrifugal tension .Maximum power transmitted by belts, Creep and initial tension, V-belt. Ratio of tensions in rope drive. Chain length, angular speed ratio and Classification of chains.

Gear Trains: Simple, compound, Riveted and Epicyclic Gear Trains, Calculation of velocity ratio.

Cams:
Types of cams and followers, Displacement velocity and acceleration-time curves for uniform velocity, uniform acceleration and deceleration, simple harmonic motion and cycloid motion, Graphical construction of cam profiles for different types of followers, Cams with specified contours.

Text Book:

Reference Book:
1. Theory of Machines, J. Shigley, TMH
2. Machines and Mechanisms: Applied Kinematics Analysis, David H Myszka, PHI

ME2010 BASIC MANUFACTURING PROCESSES Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Understand and select the casting process for a particular industrial product.
CO2. Identify the suitable forming process for different material and product.
CO3. Identify the best welding technique for joining of various components and to produce defect free products.
CO4. Apply powder metallurgy process to produce powder of various materials and to manufacture new composite material.

Prerequisite: Chemistry (CH-1003)

Foundry Process:
Pattern making, pattern materials, allowances, types of pattern, sand casting types, sand cast, moulding procedure, types of sand, gates and riser (basic design considerations) essential properties of moulding sand, core making, types of cores. Essential qualities, core mixtures and binder sand testing. Mould and core hardness test, fineness test, clay content test, permeability test, moisture content test, sand conditioning. Cleaning of casting and defects in casting, die casting. Precision investment casting, shell moulds, centrifugal casting processes, permanent moulds casting, dies casting.

Rolling: Types of Rolling, Rolling equipments hot and cold rolling, General deformation pattern, Pressure and forces in rolling. Distribution of roll pressure, angle of bite, effect of rolling on microstructure, Rolling defects, Numerical on rolling load and power required for reduction, Thread rolling.

Forgings: Smith forging, Drop forging, press forging & Machine forging, Description of Presses and hammers, forging defects.

Extrusion: Direct, Indirect and impact extrusion and their applications, Extrusion defects. Determination of extrusion force.


Sheet metal working:
Blanking, piercing, coining, embossing, bending, deep drawing ans spinning.

Powder Metallurgy:
Preparation of powder, properties of powder, fabrication methods & procedure, applications, advantages.

Fabrication Processes:

Text Books:

Reference Books:
2. Principle of Manufacturing Materials and Processes: J.S. Cambell, TMH

ME2011 THERMODYNAMICS AND HYDRAULICS Cr-4

Course Outcome: At the end of the course, the students will be able to:

CO1. Develop an intuitive fundamental understanding of thermal-hydraulic systems
CO2. Determine the thermodynamic and physical properties of numerous substances
CO3. Apply the first and second laws of thermodynamics to several engineering devices
CO4. Develop fundamental understanding of fluid machineries.
CO5. Apply fluid dynamics principles to numerous fluid mechanical systems
Prerequisite: Mathematics-I (MA-1001)

Thermodynamics:
First law of thermodynamics, internal energy, enthalpy, different thermodynamic processes, Second law of thermodynamics, entropy, carnot cycle, properties of steam, use of steam table and Mollier chart, Rankine cycle, reheat and regeneration.

Steam turbine:
Types, working principle of impulse and reaction turbines, work done and efficiencies.

Gas turbine:
Classification, working principle of gas turbine, Brayton cycle, gas turbine cycle with intercooling, reheat and regeneration.

IC engines:
Otto, Diesel & Dual cycle, S. I. and C. I. engines, 2 stroke & 4 stroke engines, indicator diagram and power measurement.

Fluid dynamics:
Introduction, Euler’s equation, Bernoulli’s equation. Practical applications of Bernoulli’s equation- Venturimeter, Orificemeter, Pitot tube.

Hydraulic turbines:
Types, working principle of Pelton, Francis, Kaplan and Propeller turbines, different heads and efficiencies, work done & efficiency of turbines. Specific speed equation and specific discharge equation.

Centrifugal pump:
Classification, construction, work done, efficiencies, cavitation.

Reciprocating pump:
Classification, construction, working, work done, slip and coefficient discharge.

Text Book:
2. Fluid Mechanics and Hydraulics Machines: R.K. Rajput, S. Chand

Reference Books:
2. Hydraulics and Fluid Mechanics, P.N. Modi and S.M. Seth
3. Introduction to Thermal and Fluid Engineering, Allan D Kraus, James R Welty, Abdul Aziz, CRC Press
Course Outcome: At the end of the course, the students will be able to:

CO1. Analytically evaluate various types of stresses in different structural elements.
CO2. Estimate two-dimensional stresses and strains analytically.
CO3. Draw shear force and Bending Moment diagrams in simply supported and cantilever beams subject to various loads.
CO4. Evaluate the bending stress in simple and composite beams.
CO5. Calculate the stresses in thin shells and circular shafts subjected to combined bending and twisting.
CO6. Find out the slope and deflection of simply supported beams and cantilevers.

Prerequisite: Engineering Mechanics (ME-1001)

Simple stress and strain:
Concept of stress: Definition, Reason of stress phenomenon, normal stress and shear stress; Concept of strain: Types, Stress strain diagram and its features. Stress strain diagram for ductile and brittle materials, Stress and strain in composite rods, Stress and strain in bolt and nut assembly, Stress due to self-weight of members, Stress in nuts and bolts, Thermal stress.

Compound stress and strain:
Two-dimensional stresses, principal stress, principal planes, Mohr’s circle for the stresses, strain analysis, principal strains.

Shear force and bending moment:
Types of support and beams, Shear force (SF), Bending Moment (BM), Relation between load, SF and BM. Shear force diagram and Bending Moment diagram of beams subject to concentrated and distributed load. Beams with overhangs, Beams subjected to couples.

Bending and shear stress:
Theory of simple bending of initially straight beams. Distribution of normal and shear stresses in different sections. Composite beams, carriage springs.

Strain Energy:
Strain Energy, Resilience and Strain Energy due to Axial load, Bending Moment and Twisting Moment.

Slope and deflection:
Slope and deflection of beams by double integration method, Macaulay’s method and moment area method, Principle of Virtual Work, Unit load and Unit couple method for determining slope and deflection of beams, Castigliano’s theorem, Maxwell’s theorem of Reciprocal Relations.

Theories of Failure:

Torsion:
Torsion in solid and hollow circular shafts, Torque and Horse Power transmitted by solid and hollow shafts, combined bending and Torsion, close coiled helical springs, strain energy in Torsion, Combined bending and torsion.
Stresses in cylindrical and spherical shells:
Stresses in thin cylinders and thin spherical shell under internal pressure, Thick cylinders subjected to internal and external pressures, compound cylinders, Membrane stress in shells, Application to cylindrical, spherical and conical shells.

Columns: Definition of a column, types of failure in a column, definition of the critical load of a column, Slenderness ratio of a column, Influence of end conditions and effective length, Design of eccentrically loaded columns.

Text Book:

Reference Books:
1. Strength of Materials, Lehri & Lehri, Kataria,

ME2014 ENGINEERING METROLOGY AND MEASUREMENTS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Explain limit, fit & tolerance and design gauges using Taylor’s Principle.
CO2. Envisage the principle of comparators, sine bar & slip gauges and perform angle measurement using standards of measurement.
CO3. Identify statistical quality control using control charts and acceptance sampling.
CO4. Analyze reliability data and different hazard models


Metrology:
Basics Concepts:

Comparators:

Inspection of Screw Thread Elements:

Statistical Quality Control:
Frequency distribution, process capability, control charts, X charts, R Charts, P-charts, C- chart. Acceptance sampling, O. C. curves, Sampling plan & acceptability, Design of Experiment. Reliability: Definitions & field data analysis, Hazard models: Constant hazard & linearly increasing hazard models, Bath-Tub Curve, System reliability and reliability improvement, Availability, Maintainability.
Measurement:

Basic Concepts:
Hysteresis, Linearity, Resolution, Threshold, Drift, Transducers classification, Quality attributes of transducers, Mechanical amplification.

Measurement of Force, Torque and Strain:
Direct methods of force measurement, Elastic members: Load cells, Cantilever beams, Proving rings, Differential transformers, Torsion bar dynamometer, Servo controlled dynamometer, Absorption dynamometer, Mechanical strain gages, Theory of strain gage, Gage factor, Methods of strain measurements, Strain gauge bridge arrangement.

Measurement of Temperature and Pressure:
Methods of measuring temperature, Thermocouples, Law of thermocouples, Thermistor, Pyrometry, IR Thermography, Methods of pressure measurement, Static pressure measurement, Elastic pressure transducers, Dead weight pressure gauges, Measurement of vacuum, Measurement of high pressure.

Modern Measurement Techniques:

Text Books:

Reference Books:

ME2018 THERMODYNAMICS & FLUID MECHANICS Cr-4

Course Outcome: At the end of the course, the students will be able to:

CO1. Develop an intuitive fundamental understanding of thermo-fluid systems
CO2. Determine the thermodynamic and physical properties of numerous substances
CO3. Apply the first and second laws of thermodynamics to several engineering devices
CO4. Apply control volume analysis to numerous fluid mechanical systems
CO5. Analyse simple, incompressible and inviscid fluid flows, such as pipe and pump flow systems
CO6. Develop basic understanding of fluid machineries.

Prerequisite: Mathematics-I (MA-1001)

The Thermal/Fluid Sciences: Introductory Concepts
**Thermodynamics**

**Preliminary Concept:**

**Steam Properties:**
Constant pressure formation of steam, Enthalpy and specific volume of dry, wet and superheated steam. Use of Mollier chart.

**Gas Power Systems:**

**Vapor Power and Refrigeration Cycles:**

**Fluid Mechanics**

**Fluid Properties:**
Physical properties of fluids, Types of fluid, Hydrostatic Law, Measurement of pressure by manometers. Total pressure and centre of pressure on horizontal, vertical and inclined surfaces submerged in liquid.

**Buoyancy and Floatation:**
Centre of buoyancy, Meta center & meta-centric height, Analytical method for metacentric height, Stability of floating and submerged bodies, Oscillation of a floating body.

**Dimensional Analysis and Model study:**
Dimensional homogeneity, dimensional analysis, Raleigh’s method and Buckingham theorem. Superfluous and Omitted Variables, Similarity laws and model studies, Distorted models.

**Flow in Pipes and Pipe Networks:**

**Fluid Machineries:**

**Text Book:**

**Reference Books:**
2. Engineering Thermodynamics, Parthasarthi Chattopadhyay, 1st Ed., Oxford Univ. Press
Course Outcome: At the end of the course, the students will be able to:

CO1. Analyze Otto, Diesel and Dual Combustion cycles.
CO2. Identify the need for Carburetors, Fuel pumps and nozzles, fuel injectors.
CO3. Analyze Fuel knocks and suggest controlling measures.
CO4. Apply engine power measurement methods and obtain Performance characteristic curves.
CO5. Categorize cooling, lubrication and ignition systems in IC engines.

Prerequisite: Engineering Thermodynamics (ME-2001)

Introductions:
Classification of I.C. Engines. Fundamental difference between SI and CI engines, Comparison of two stroke and four stroke engines. Otto, Diesel and Dual cycle. Valve timing diagram, Properties and rating of IC engine, fuels, Additives and non-petroleum fuels.

Carburetion and Fuel injection:
Function of carburetors, Description and principle of simple carburetor and its drawback, petrol injections, Requirements of diesel injections system. Types of injection systems, Fuel pumps and nozzles, types of fuel injections, Spray formation, penetration and direction.

Combustion of Fuels:
Stages of SI engine combustion, Effect of engine variables on ignition lag and flame propagation, fuel knock, control of knock. SI engine combustion chamber stage of diesel combustion, variables affecting delay period. Diesel knock and methods of control. CI engine combustion chambers.

Supercharging:
Thermodynamic cycle with supercharging and its effect. Efficiency of supercharging engines Methods of supercharging and scavenging of two stoke engines.

Test and Performance:
Fuel air and power measurement methods. Performance of SI and CI engines, Characteristic curves, Governing of speed.

Engine Emission and Control:

Cooling Lubrication and ignition systems:
(a) Air cooling and water cooling systems effects of cooling on power output and efficiency.(b) Properties of lubricants additives lubricating systems.(c) Battery, Magnet ignition systems ignition timing.

Gas Turbines:

Gas Turbine cycles for Aircraft Propulsion:
Criteria of performance, Intake and propelling nozzle efficiencies, simple turbojet cycle, turbofan and turboprop engine.
Introduction to Alternative Fuels: LPG, LNG, CNG, Alcohol, Hydrogen, Vegetable oils and Biogas.

Text Books:
1. IC Engines, V Ganeshan, TMH, 4th edition
2. Gas Turbines, V Ganeshan, TMH, 3rd edition

Reference Book:
1. IC Engines, Mathur and Sharma, Dhanpat Rai & Sons
2. IC Engines, S.P. Sen, Khanna Publishers
3. IC Engines, Gill and Smith, OXFORD & IBH
5. Gas Turbine Theory, Cohen, Rogers and Saravananmutto, Pearson Education

ME3009 FUNDAMENTALS OF MACHINE DESIGN Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Identify basic requirement for machine elements, machines and manufacturing considerations in design.
CO2. Analyze and apply the domain knowledge in practical problems. Besides, the complex practical problems can be simulated and solved using engineering tools such as ANSYS.
CO3. Design and determine geometrical dimensions of a component subjected to complex stress system.
CO4. Implement and design the domain knowledge in practical systems.
CO5. Ability design the component subjected to static and variable loads.
CO6. Determine the life of component subjected to complex loading.
CO7. Design, model and solve using modern engineering tools.

Prerequisite: Mechanics of Solids (ME-2012)

*Standard Design Data Books are allowed during examinations

Introduction:
Basic requirement for machine elements and machines, Design procedure, Design Synthesis, Use of standards in design, Selection of engineering materials, Selection of factor of safety, Manufacturing considerations in design, Various stresses in machine elements.

Design of fastening elements:
Design of riveted joints (Methods of riveting, Application to Boiler Drum), Design of welded joints (strength of butt, transverse and parallel fillet weld, circular fillet weld subjected to torsion and bending, axially loaded unsymmetrical, eccentrically loaded welded joint), Design of bolted joints (types of screw fastening/locking devices, bolts of uniform strength, eccentrically loaded (in-plane, out-plane) bolted joints. Design of cotter joints, Design of knuckle joints.

Design of transmission elements:
Design of shafts (types of shaft, shafts subjected to torsion, bending and combined loading, design consideration/application as per ASME code), Design of keys (types of keys, design of sunk key), Design of couplings (types of couplings, protected type rigid and bushed-pin- type flexible coupling), Design of belt (selection of flat/ V-belt from manufactures catalogue).
Design of springs:
Closed coil helical springs of circular section, spiral spring, Leaf springs.

Design of levers & brackets:
Hand lever, foot lever, bell crank lever, rocker arm, wall brackets.

Text Books:
1. Design of Machine Elements - VB Bhandari (TMH), 3rd Ed.

Reference Books:
1. Machine Design - Sharma/Agarwal (katson publishing House)
4. Mechanical Design - of Machines, Maleev/Hartman (CBS)

ME3010 METAL CUTTING AND CUTTING TOOL DESIGN Cr-4

Course Outcome: At the end of the course, the students will be able to:

CO1. Identify the necessity of “manufacturing”, purpose & principle of machining and To demonstrate tool geometry and define tool angles in different systems

CO2. Categorize between orthogonal and oblique cutting and chip flow deviation. illustrate the mechanism of chip formation in machining ductile and brittle materials and able to conduct complex mechanical engineering experiments to analyze and interpret the experimental data.

CO3. Explain the benefits and the purposes of determining cutting forces and able to conduct complex mechanical engineering experiments to analyze and interpret the experimental data.

CO4. Assess failure of cutting tools, mechanisms and pattern of tool wear, the essential properties of cutting tool materials, and assess tool life, Machinability & economics of machining.

CO5. Design cutting tool, form tool, press tool, broach, twist drill, press tool etc.

Prerequisite: Basic Manufacturing Processes (ME-2010)

Introduction to machining:
Manufacturing: need and concept, purpose, classification and principles. Machining: purpose and principle, Aims & objective of machining & manufacturing industries, Generation of surfaces in machining. Constraints in fulfilling the machining objectives and control over the machining constraints.

Geometry of cutting tools:
General configuration of cutting edges of tools, concept of rake and clearance angles, Description of tool geometry: Tool-in-hand system, ASA, ORS, NRS Systems, Geometry of multiple-point cutting tools, Conversion of tool angles.

Mechanism of machining:
Mechanism of chip formation in machining ductile and brittle materials, classification and characteristics of chips, chip reduction coefficient and cutting ratio, shear angle, cutting strain, velocity relationship and Kronenberg relationship, effect of cutting variables on chip reduction co-efficient, Built-up-edge (BUE) formation, orthogonal cutting and oblique cutting, causes of chip flow deviation and angle of deviation, effective rake angle, effects of oblique cutting in chip flow, chip-tool contact length.
Mechanics of metal cutting:

Needs & purposes of determining cutting forces; force system during turning & their significances; Merchant circle diagram: its use, advantages & limitations; development of mathematical expressions for cutting forces using MCD, stress in conventional shear plane, energy of cutting process, Ernst-Merchant angle relationship, Lee-shaffer’s relationship, chip breaking effect and chip breakers; Tool dynamometry: turning tool dynamometer, drill dynamometer.

Failure, wear, tool life and cutting tool materials:

Causes and modes of failure of cutting tools; Mechanism & pattern of cutting tool wear; Form stability; Criteria of flank and crater wear; Tool life-definition in R&D & shop floor; evaluation of tool life, Taylor’s tool life equation, role of different machining parameters on tool life and surface finish, economics of machining, Gilbert’s model, concept, definition & criteria of judgment of machinability, Factors affecting machinability, tool Materials & chronological development, location and causes of heat generation in machining, cutting fluid & its effect; Surface integrity in machining: superficial layer and surface integrity, surface roughness evaluation, surface roughness measurements.

Advanced Machining Processes:

High speed machining; Dry and semi-dry machining; hard machining; High performance and high efficiency machining; multitasking and one-pass machining; ultrasonically and thermally assisted machining; Micro-machining.

Cutting Tool design:

Design of single point cutting tool; Design of broach tool; Form tools; Boring tools, Reamers, Twist drill and Milling cutters.

Text Books:


Reference Books:


ME3011 HEAT TRANSFER Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Analyze the mechanism of conduction and its application to thermal and energy systems.
CO2. Solve the complex problems of convection heat transfer in fluids for implementation in various industrial and scientific systems.
CO3. Access the phenomena of boiling and condensation applicable to design of industrial and thermal systems.
CO4. Develop an efficient heat exchange process for design and fabrication of heat exchangers used in various industrial purposes.
CO5. Formulate an analysis of radiation heat exchange process in various thermal and energy systems for the solution of heat transfer problems.
Prerequisite : Mathematics-I (MA-1001)

Introduction:
Scope of the subject, the three modes of heat transfer-conduction, convection and radiation. Fourier conduction equation, Newton’s law of cooling and Stefan-Boltzmann equation for black body radiation. Simultaneous heat transfer mechanisms.

Conduction: Mechanism of conduction: Derivation of the generalized heat conduction equation in Cartesian coordinates, polar cylindrical and polar spherical coordinates. Different types of boundary conditions encountered in heat conduction problems.

Solution of the one dimensional steady state heat conduction equation with constant thermal conductivity and without internal heat generation in Cartesian coordinates. Extension of the solution to composite walls by electrical analogy. Thermal contact resistance, Effect of variable thermal conductivity on temperature distribution in plane wall.

Solution of the one dimensional steady state heat conduction equation with constant thermal conductivity and without internal heat generation in Cylindrical and Spherical coordinates. Extension of the solution to composite cylinders/spheres by electrical analogy. Critical thickness of insulation.

Heat transfer from fins (only longitudinal fins with constant cross sectional area), Fin efficiency and effectiveness.

Convection:
Mechanism of convection and basic concepts: Dimensional analysis for forced and free convection, Nusselt number.
Concept of thermal boundary layer, Prandtl number, Expressions for local and average values of heat transfer coefficients for a flat plate.
Experimental correlations for forced and free convection for various geometries.

Fundamentals of Thermal Radiation:
Blackbody radiation, Planck’s law, Spectral and total emissive power, Wein’s displacement law, Spectral and total intensity of radiation, Radiation properties: emissivity, absorptivity, reflectivity and transmissivity, Kirchoff’s law.

Radiant heat transfer:

Heat exchangers:
Types of heat exchangers and heat exchanger configurations. The overall heat transfer coefficient and fouling factor. LMTD and effectiveness-NTU analysis of heat exchangers.

Text Book:

Reference Books:
**ME3012 DESIGN OF MACHINE ELEMENTS**  

**Course Outcome:** At the end of the course, the students will be able to:

CO1. Analyze and apply the domain knowledge in practical problems. Besides, the complex practical problems can be simulated and solved using engineering tools such as ANSYS.

CO2. Design and determine geometrical dimensions of a component subjected to complex stress system.

CO3. Implement and design the domain knowledge in practical systems.

CO4. Ability design the component subjected to static and variable loads.

CO5. Determine the life of component subjected to complex loading.


**Prerequisite : Fundamentals of Machine Design (ME-3009)**

**Design against fatigue load:**


**Design of IC Engine Components:**

Cylinder liners & Piston, Connecting rod, Crankshaft, Valve mechanism, Demonstration of temperature and stress/strain distribution in IC Engine components using ANSYS (optional).

**Design of Gear Drives:**

Design of spur gear, Design of Helical gear (equivalent spur gear and virtual number of teeth, force analysis and design of helical gear by AGMA method), Design of bevel gear.

**Sliding and Rolling contact bearings:**

Basic modes of lubrication, viscosity index, Petroff’s & McKee’s Equation, Selection of Lubricants, Theory of film (Stribeck’s Equation), Static and dynamic load carrying capacity, equivalent bearing load, selection of bearing life from manufacturer’s catalogue. Demonstration of a typical bearing failure.

**Strategies in design of machine elements:**

Design optimization for functional life and cost using ANSYS/ MATLAB/ NASTRAN/ DOE.

**Text Books:**

1. Design of Machine Elements: VB Bhandari (TMH)

**Reference Books:**

1. Mechanical Engineering Design, Shigley J E, Mischiee C R (TMH)
Course Outcome: At the end of the course, the students will be able to:

CO1. Recognize the natural refrigeration processes and limitations thereof.
CO2. Compute COP, power required and mass of refrigerants in theoretical and actual refrigeration systems.
CO3. Compute moist air properties using fundamental science based formulae and psychrometric chart.
CO4. Comprehend the components and their interaction in air conditioning systems.
CO5. Prescribe primary data for air-conditioning for predefined requirements.
CO6. Comprehend environmental concerns related to modern refrigeration and air-conditioning practices.

Prerequisites: Engineering Thermodynamics (ME-2001) & Heat Transfer (ME-3011)

Introduction to Refrigeration:
Reversed Carnot Cycle, Reversed Brayton Cycle, Vapour compression cycle, Units of refrigeration, Coefficient of performance.

Refrigerants:
Classification of refrigerants: Halocarbon compounds, Azeotrope, Hydrocarbons, Inorganic compounds, Properties of refrigerants, Comparison of common refrigerants, uses of important refrigerants.

Air Refrigeration system:
Open Air refrigeration cycle, Closed or dense Air refrigeration cycle, Air refrigerator working on Reversed Carnot cycle, Air refrigerator working on Bell-Coleman cycle, Methods of Air refrigeration systems, Simple Air cooling system, Simple Air Evaporative cooling system, Boot-strap Air cooling system, Boot-strap Air Evaporative cooling system, Regenerative Air cooling system.

Vapour Compression system:
Types of Vapour Compression Cycle, Actual vapour compression cycle, T-s and P-h diagram simple saturation cycle, super heated and sub-cooled cycle, Effect of suction pressure and discharge pressure on performance.

Multistage compression and multi-evaporator system:
Different arrangements of compressors and intercooling, multistage compression with intercooling, Multi-evaporation system, dual compression system.

Vapour Absorption system:
Simple Ammonia Absorption system, improved vapour absorption system, Electrolux system, Comparison of vapour absorption system with vapour compression system.

Psychometrics:
Properties of air-vapour mixtures, Psychometric chart, Law of air-water vapour mixture, Enthalpy of mixture, simple heating and cooling, Humidification, Dehumidification mixture of air streams.

Requirements of comfort Air conditioning:
Oxygen supply, Heat removal, Moisture removal, Air-motion purity of air, Thermodynamics of human body, Comfort and comfort chart, Effective temperature, factors governing optimum effective temperature.
Air conditioning system:

Processes in air conditioning, summer air conditioning, winter air conditioning and year round air conditioning, cooling load calculation.

Refrigerant Compressor:

Classification of Compressor, Reciprocating Compressor, Work done by a single stage reciprocating Compressor, Hermetic Sealed Compressor, Rotary compressor, Centrifugal Compressor.

Text Books:


Reference Books:


ME3015 MANUFACTURING PROCESSES & DESIGN Cr-4

Course Outcome: At the end of the course, the students will be able to:

CO1. Understand the different basic machining processes and machine tools.
CO2. Apply the different non-traditional machining processes for up growing high strength materials with complicated and miniaturized product manufacturing.
CO3. Understand the industrial automation with computer controlled machines and industrial robots.
CO4. Design the work holding and tool guiding devices for mass production.
CO5. Design the forging dies.
CO6. Define sequence of operations leading to optimized time and cost.

Prerequisite: Basic Manufacturing Process (ME-2010)

Conventional Machine Tools & Machining Processes:

Non-conventional machining:
Classification and principles of non-conventional machining processes such as AJM, USM, EDM, ECM, PAM, LBM and EBM.

Manufacturing process Automation:
Introduction to industrial automation and control, NC & CNC, part programming, DNC, CNC and adaptive control, Industrial robot application, robot anatomy, coordinate system, work envelope, grippers, actuators, sensors, automated guided vehicles (AGV) system.
**Jigs and Fixtures:**

**Press Tool Design:**
Press working equipment and operations, Press selection, Shearing principle, Stock strip layout, Pressure calculation, Blanking and Piercing die design, design procedure for progressive and compound dies, Wire drawing and deep drawing.

**Forging Die Design:**
Forging equipments, Drop forging, Press forging and upset forging, Die design for machine forging and upset forging, Selection of sizes of forging equipments, Materials and manufacture of forging dies.

**Process Planning:**
Contents of process plan, process operations, steps in process planning, planning and tooling for low cost processing.

**Text Books:**

**Reference Books:**
1. Fundamental of Tool design, F. W. Wilson, ASTM

**ME3017 INDUSTRIAL ENGINEERING & OPERATIONS RESEARCH**  
**Cr-3**

**Course Outcome:** At the end of the course, the students will be able to:

- CO1. Apply mathematics, science, and engineering
- CO2. Design, develop, implement and improve integrated systems that include people, materials, information, and equipment
- CO3. Formulate and solve linear programming problems.
- CO4. Recognize types of transportation and assignment problems and apply solution techniques.

**Prerequisite : Mathematics-I (MA-1001)**

**Production, Planning and Control:**
Introduction, Types of Production processes (Project/Job, Batch, Mass/Line, Continuous), Production, Planning & Control (PPC) and its functions, Aggregate Production Planning (Chase, Level, and Mixed Strategy).
**Forecasting and Its Techniques:**
Introduction, Errors in forecasting, Qualitative and Quantitative forecasting; Simple Moving Average, Weighted Moving Average, Exponential Smoothening, Linear Regression Techniques.

**Inventory Control:**
Inventory Control: Different stock limits, Relevant Costs, P & Q Systems of Inventory, EOQ & EBQ Models with shortages and without shortages, ABC Analysis, Material Requirement Planning Calculations

**Scheduling:**
Operations scheduling, Job shop scheduling, Priority dispatching rules, Johnson’s rule, n jobs with 2&3 machines, Queuing theory, JIT, TQM

**Operations Research:**
Introduction to Linear Programming (LP), Graphical Method, Simplex Method, Big M and Duality, Transportation Problems, Assignment Problems, Project Management-CPM and PERT, Critical path, Crashing.

**Text Books:**
1. Production and Operation Management, R. Paneerselvam, Prentice Hall of India, 3rd edition,
2. Operation Research by Hira and Gupta, S. Chand

**Reference Books:**
5. Operation Research by S D Sharma

**ME3020 ADVANCED MANUFACTURING PROCESSES Cr-3**

**Course Outcome:** At the end of the course, the students will be able to:

CO1. Apply the different non-traditional machining processes for up growing high strength materials with complicated and miniaturized products.
CO2. Understand the challenging issues in production of micro dimensioned products.
CO3. Apply the advanced forming processes for production of precession parts.
CO4. Apply the different micro fabrication processes to produce micro components.
CO5. Understand the concepts of smart materials and their use to mankind.

**Prerequisite:** Basic Manufacturing Process (ME-2010)

**Non-conventional Machining:**
Classification of non-conventional machining processes, Basic Principles, features of equipment, process variables and application of AJM, USM, ECM, EDM, PAM, LBM, and EBM.

**Micro manufacturing:**
Scopes of micro manufacturing, size effect and tooling issues in micro manufacturing. Micro turning, micro grinding, Ultrasonic assisted micromachining, Abrasive jet micromachining.
Metal Forming processes:

Micro Fabrication processes:

Text Books:
2. Introduction to Micromachining, V.K. Jain, Narosa Publishing house , 2010

Reference Books:
2. High Velocity Forming of Metals, ASTM
4. Smart materials and Structures, Gandhi, M.V. and Thompson, B.S., , Chapman and Hall, 1992

ME3022 PRINCIPLES OF TURBOMACHINES Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Design and calculate different parameter for Turbomachines
CO2. Understand thermodynamic and kinematic behind Turbomachines
CO3. Provide prerequisite to fluid power courses.

Prerequisite : Fluid Dynamics & Hydraulic Machines (ME-2008)

Introduction:
Definition of Turbo-machines, classification, Euler’s equation for Turbo-machine, Energy Equation, Adiabatic Flow through Nozzles and diffusers, work and efficiency of Turbine and compressor stage.

Centrifugal Compressors and Fans:
Basic constructional features, velocity diagrams, slip factor, energy transfer, power input factor, stage pressure rise and loading coefficient, pressure coefficient, degree of reaction, Centrifugal compressor characteristic, surging, rotating Stall and Choking.

Axial Flow Compressors and Fans:
Basic constructional features, turbine versus compressor blades Advantages of axial flow compressors, working principle, velocity triangle, elementary theory, stage work, work done factor, stage loading, degree of reaction; vortex theory, simple design calculations, introduction to blade design, cascade test, compressibility effects, operating characteristics.
Centrifugal Pumps:
Basic constructional features, work done and velocity triangles, pump losses and efficiencies, minimum starting speed, specific speed, model testing of pumps, pumps in series and parallel, net positive suction head, priming, cavitation, performance curve.

Axial Pump:
Description, velocity triangles, work done on the fluid, energy transfer, axial pump characteristics, cavitation.

Radial Flow Turbine:
Basic constructional features, stage velocity triangle, Enthalpy-Entropy Diagram, Stage losses, performance characteristics.

Axial Flow Turbine:
Basic constructional features, velocity triangle, single impulse stage, multi-stage velocity compounded, multi-stage pressure compounded, reaction stage, blade to gas speed ratio, losses and efficiency, work done factor, low hub-tip ratio stages, performance characteristic.

Text books:
2. Turbines Compressors and Fans, S. M. Yahya, Tata McGraw-Hill Education

Reference Books:
4. Turbo Machinery Basic Theory and Application, Logan E.J.
7. Gas Turbines, V Ganesan, Tata MacGarw Hill Education.

ME3024 MECHANICAL VIBRATION AND NOISE ENGINEERING Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Understand damping, natural frequency and resonance.
CO2. Model and write mathematical equation of a vibration system.
CO4. Select and implement the best noise control technique.

Prerequisite: Machine Dynamics (ME-2002)

Two Degree of Freedom Systems:
Multi-Degree of freedom system:
Derivation of Equations, Influence coefficients, Eigen values and Eigen vectors, Calculation of Natural Frequencies by Rayleigh, Stodala, Matrix iteration and Holzer-Methods.

Torsional Vibration:
Multi-rotor systems, geared system and branched system

Vibration of continuous system:
Vibration of strings, free longitudinal vibration of prismatic bars, Lateral vibrations of uniform beams.

Introduction to acoustics:
Propagation of acoustic disturbances, the decibel scale for the measurement of sound pressure, Acoustic energy density and intensity, the wave equations, acoustic impedance.

Human Response to sound:
Noise effects, auditory response, Ratings and Regulations.

Noise control:

Text Book:
1. Mechanical Vibrations and Noise Engineering, Ashok G. Ambekar, PHI.

Reference Books:
1. Theory of Vibration and Application, William T. Thomson, CBS
2. Textbook of Mechanical Vibrations, Rao.V. Dukkipati, PHI

ME3026 MECHATRONICS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Select and apply the knowledge, techniques, skills and modern tools in mechatronics engineering technology.
CO2. Apply concepts of circuit analysis, analog and digital electronics, automation and controls, motors, electric drives, power systems, instrumentation, and computers to aid in the design, characterization, analysis, and troubleshooting of mechatronics systems.
CO3. Apply the different drive systems for actuation of various parts and components of a system.
CO4. Understand the different controllers used in industries, machines and industrial robots.

Prerequisites : Basic Electronics (EC-1001) & Fluid Mechanics (ME-2003)

Introduction:

Drives:
Stepper motors, servo drives. Ball screws, linear motion bearings, cams, systems controlled by camshafts, electronic cams, indexing mechanisms, tool magazines, transfer systems.
Hydraulic systems:
Flow, pressure and direction control valves, actuators, and supporting elements, hydraulic power packs, pumps. Design of hydraulic circuits.

Pneumatics:
Production, distribution and conditioning of compressed air, system components and graphic representations, design of systems.

Controllers:
Description of PD, PI and PID controllers. CNC machines and part programming. Industrial Robotics.

Textbooks:

Reference Books:

ME3028 SUPPLY CHAIN MANAGEMENT Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. To analyze the manufacturing operation of a firm
CO2. Apply sales, operations planning, MRP and lean manufacturing concepts.
CO3. Apply logistics and purchasing concepts to improve the supply chain operation.
CO4. Apply quality management tools for process improvement.

Prerequisite : NIL

Introduction:
Understanding the supply chain, decision phases in supply chain, process view of supply chain, supply chain flows.

Drivers & Obstacles of Supply Chain Performance :
Supply chain performance: Strategic fit and scope; Supply chain drivers, Obstacles to Achieving Strategic fit.

Design the Distribution Network:
Designing the distribution network, role of distribution, factors influencing distribution, design option for distribution.
Network Design:
Network design in the SC, factors influencing network design, models for facility location.

Transportation in Supply Chain:
Transportation in the supply chain, factors affecting transportation decisions, modes of transportation and their performance.

Pricing in Supply Chain:
Pricing and revenue management in the SC, Sourcing decision in SC, supplier selection, supplier assessment.

Coordination in Supply Chain:
Coordination in the SC, Lack of coordination and the bullwhip effect, Supply chain information system, E-business and supply chain.

Text Book:

Reference Books:

ME 3030 PRODUCT LIFECYCLE MANAGEMENT Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Identify and analyse the product design and development processes in manufacturing industry and to define the components and their functions of product design and development processes and their relationships from concept to customer over whole product lifecycle.

CO2. Analyse, evaluate and apply the methodologies for product design, development and management and to undertake a methodical approach to the management of product development to satisfy customer needs.

CO3. Generate an innovative idea for product design in a systematic approach and apply the check the quality of the new design by using product design tools.

CO4. Understand the stages of product lifecycle management and the components of Product life cycle environment to integrate the various stages of PLM into engineering product ranges and portfolios that will eventuate into commercial success.

CO5. Integrate lifecycle management strategies and knowledge to develop new and/or formulate appropriate engineering design solutions in engineering environment

Prerequisite: Industrial Engineering & Operations Research (ME-3017)

Fundamentals of Product Development:
Trend analysis, competitive landscape, PESTLE Analysis, Overview of Products and services, Types of Product development, Overview of Product development methodologies, Product development Planning and Management,
Generic Product Development Process:


Product design tools and technology:

Theory of inventive problem solving, General Theory of Innovation and TRIZ, Value engineering Applications in Product development and design, Model-based technology for generating innovative ideas, Quality aspects in product design, Failure mode effect analysis.

Product Life Cycle Management:

System architecture, Information models and product structure, functioning of the system. Significance of PLM, Customer Involvement.

Product life cycle environment:


Components of Product Life Cycle Management:

Different phases of product lifecycle and corresponding technologies, Foundation technologies and standards (e.g. visualization, collaboration and enterprise application integration), Core functions (e.g., data vaults, document and content management, workflow and program management), Functional applications (e.g., configuration management) Product organizational structure, Human resources in product lifecycle, Methods, techniques, Practices, Methodologies, Processes, System, components in lifecycle, slicing and dicing the systems, Interfaces, Information, Standards, Examples of PLM in use.

Text Books:

Reference books:
ME3032  INTRODUCTION TO FLUID MECHANICS AND HEAT TRANSFER  Cr-3

**Course Outcome:** At the end of the course, the students will be able to:

CO1. Understand the concept of heat and fluid flow phenomena.
CO2. Express the mathematical formulation of a physical problem.
CO3. Think for a solution to cooling or heating in industrial equipment.
CO4. Analyze and develop the different techniques for thermal energy storage.

**Prerequisite : Mathematics-I (MA-1001)**

**Introduction:**
Properties of fluids, Types of fluids, Types of fluid flow, modes of heat transfer, Laws of heat transfer.

**Kinematics of fluid flow:**
Streamlines, path line & streak lines, stream tube, Types of fluid flow, Continuity equation of motion in three-dimensions, Local and convective acceleration, Velocity potential function and stream function, Vorticity and circulation, Vortex flow, Equation of forced vortex flow and free vortex.

**Dynamics of fluid flow:**
Euler’s equation of motion, Bernoulli’s equation from Euler’s equation, Practical applications of Bernoulli’s equation—Venturimeter, Orifice meter, Pitot tube.

**Conduction Heat Transfer:**
Derivation of the general 3-dimensional heat conduction equation with variable thermal conductivity and internal heat generation in Cartesian coordinates. Transformation of the conduction equation into polar cylindrical and polar spherical coordinates, different types of boundary conditions encountered in heat conduction. Solution of the one dimensional steady state heat conduction equation with constant thermal conductivity and without heat generation in Cartesian, Cylindrical and Spherical coordinates. Extension of the solution to composite walls/cylinders/spheres by electrical analogy. Effect of variable thermal conductivity., Introduction to numerical solution of the heat conduction equation.

**Convection Heat Transfer:**
Conservation equations for mass, momentum and energy for two dimensional steady state flow in Cartesian, cylindrical and spherical coordinates. Non dimensionalization of the conservation equations.

**Boundary Layer:**
Hydrodynamic and thermal boundary layer concepts, Boundary layer growth over a flat plate, Boundary layer thickness, displacement thickness, Momentum thickness, and energy thickness, Laminar and Turbulent boundary layer, Boundary layer equations, momentum integral and energy integral equations for boundary layer flow over a flat plate. Solution of the integral equations to derive expressions for drag and heat transfer coefficients. Average values of drag and heat transfer coefficients. Experimental correlations for forced and free convection for various geometries.
Radiation Heat Transfer:

Radiation properties, emissive power and emissivity, Kirchoff’s identity. Planck’s relation for monochromatic emissive power of a black body, Stefan-Boltzman law and Wein’s displacement law, Radiation shape factor, Relation for shape factor and shape factor algebra.

Text Books:
1. Fluid Mechanics, Modi & Seth

Reference Books:

ME4031 POWER PLANT ENGINEERING Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Understand the location and layout of power plants.
CO2. Understand the basic principles of physics and mathematical expression used in power generation by steam turbines.
CO3. Understand the principles for improving the efficiency and speed of steam turbines with minimum consumption of water, coal and other resources.
CO4. Get placement in organization to manage coal based power plants in the country.

Prerequisites: Engineering Thermodynamics (ME-2001) & Fluid Dynamics & Hydraulic Machines (ME-2008)

Sources of energy:
Fuel, water, wind and nuclear reactors, principal types of power plants and choice of power plants, power plant layouts.

Analysis of steam cycles:
Introduction, Classification of power plant cycles, Carnot cycle, Rankine cycle, Modified Rankine cycle, Reheat cycle, Regenerative cycle, Binary vapour cycle, Its engineering applications.

Generation of steam:
Boilers and its mountings and accessories, combustion equipment, Air supply systems for combustion, fuel and ash handling systems, dust collectors.

Flow of steam through nozzles:
Continuity, energy and momentum equations, nozzle shape for different applications, Outer velocity, throat and exit areas for flow without and with friction, choked flow and critical pressure ratio, effect of variations in nozzle back pressures, super saturated flow in nozzles. Types of steam turbines, axial variation of pressure and velocity through various types of turbines.

Performance characteristics:
Power, efficiency and other related calculations for simple impulse, pressure compounded impulse and velocity compounded impulse turbines using velocity triangles. Reaction turbines and degree of reaction. Parsons’ turbines,
Power, efficiency and other related calculations for reaction turbine. Internal losses in steam turbines and reheat factor. Governing of steam turbines.

**Steam condensers and cooling tower for power plant application:**
Surface condensers, condenser vacuum and vacuum efficiency, maintaining vacuum by air pumps, sources of air leakage into the condenser, Dalton’s law of partial pressures applied to steam and air mixtures, Air pump capacity for wet and dry air pumps, Cooling water requirements, Cooling towers.

**Introduction to Nuclear power plants:**
Nuclear fuels, Chain reaction, Neutron balance, coolants, Reflectors, Moderators, control rods, types of reactors, Boiling water reactors, pressurized water reactors.

**Text Book:**

**References:**

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**ME4032 FLEXIBLE AND SUSTAINABLE MANUFACTURING Cr-3**

**Course Outcome:** At the end of the course, the students will be able to:

CO1. The philosophy of Group Technology and its importance in grouping components and machines.
CO2. The concept of flexibility, its advantages in manufacturing and different types of FMS and their layouts.
CO3. The importance of green, intelligent and web based manufacturing

**Prerequisite : Basic Manufacturing Processes (ME-2010)**

**Introduction:**
FMS definition and classification of manufacturing systems, Automated production cycle, Need of flexibility, Concept of flexibility, Types of flexibilities and its measurement.

**FMS Equipment:**
Why FMS, Factors responsible for the growth of FMS, FMS types and applications, Economic justification for FMS, Functional requirements for FMS equipments, FMS processing and QA equipment, e.g., turning and machining centers, Co-ordinate measuring machines, Cleaning and deburring machines, FMS system support equipment, Automated material handling and storage equipment, cutting tool and tool management, Work holding considerations, Fixture considerations in FMS environment.

**Group Technology:**
GT concepts, Advantages of GT, Part family formation-coding and classification systems; Part machine group analysis, Methods for cell formation, Use of different algorithms, mathematical programming and graph theoretic model approach for part grouping, Cellular vs FMS production.
Sustainable Manufacturing:

Introduction, importance and scope in the present scenario, green manufacturing, intelligent manufacturing, web based manufacturing, virtual manufacturing, lean and agile manufacturing.

Text Book:


Reference Books:

1. Flexible Manufacturing Cells and Systems, W.W. Luggen Prentice Hall India

ME4033 FUNDAMENTALS OF FINITE ELEMENT METHOD Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Know interpolation models, convergence requirements, global and local coordinate system.
CO2. Know higher order elements in term of natural co-ordinate system, isoparametric formulations and numerical integration.
CO4. Apply in solid mechanics and heat transfer problems.

Prerequisites: Mathematics-I (MA-1001) and Mechanics of Solids (ME-2012)

Introduction:
Overview of FEM, General description of FEM, Engineering Application of FEM.

Basic Procedure:

Discritization of domain, interpolation models, simplex, complex and multiplex elements, selection of the order of the interpolation, convergence requirements, linear interpolation polynomials in Global and local co-ordinate system.

Higher Order and Isoparametric Elements:

Higher order elements in terms of Natural co-ordinate system, one dimensional elements using classical interpolation polynomials, two dimensional elements using classical interpolation polynomials, Isoparametric elements, numerical integration.

Derivation of Element Matrices and Vectors:


Assembly of Element Matrices and Derivation of System Equations:

Co-ordinate transformations, Assemblage of Element equations, Incorporation of boundary conditions.
**Application to Solid Mechanics and Heat Transfer Problems:**

Formulation of solid and structural mechanics, formulation of FE equations (Static Analysis), application to (Truss Elements, Beam Elements, Triangular Elements, Tetrahedral Elements).

**Text Book:**


**Reference Books:**

1. Concept and Application of FEM, R D Cook, D S Malkus (Wiley edition)  

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**ME4035 COMPUTER CONTROLLED MANUFACTURING SYSTEM**  
**Cr-3**

**Course Outcome:** At the end of the course, the students will be able to:

CO1. Understand the latest developments and the main elements in computer integrated manufacturing systems.  
CO2. Create awareness about the implementation techniques for GT and CAPP.  
CO3. Classify and distinguish NC, CNC and DNC systems.  
CO4. Develop manual and APT part programs for 2D complex profiles, automated tool paths and G-codes for machining components and test the programs through simulation.  
CO5. Apply modern computational, analytical, simulation tools and techniques to face the challenges in manufacturing.

**Prerequisite : NIL**

**Fundamental of Manufacturing and automation:**

Types of production, Objectives of a manufacturing system, production concepts and mathematical models, automation strategies.

**Process planning:**


**Numerical Control production System:**

Numerical control, coordinate system and machine motion, Types of NC system, machine tool applications, problems of conventional NC, CNC, DNC.

**Part Programming:**

Basics of NC programming, mathematics of tool paths, machining forces, Tool offsets, programming steps, NC programming Languages, G-Code and M-Code, APT Programming, CAD/CAM NC programming. Rapid prototyping

**Computer Networks for manufacturing:**

Hierarchy of computers in manufacturing, local area networking, manufacturing automation protocol.
The Future automated Factory:
Trends in manufacturing, The future automated factory.

Text Books:
2. CAD/CAM, Ibrahim Zeid, TMH

Reference Books:
1. Computer Integrated Manufacturing, Paul Ranky Prentice Hall of India

ME4037 TOTAL QUALITY MANAGEMENT Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Provide knowledge to understand the philosophy and core values of Total Quality Management (TQM)
CO2. Understand total quality concept and techniques for managing, controlling, and improving quality
CO3. Choose appropriate statistical techniques for improving processes;
CO4. Write reports to management describing processes and recommending ways to improve them;
CO5. Develop research skills that will allow them to keep abreast of changes in the field of Total Quality Management;
CO6. Emphasise the process of learning and discovery rather than the presentation of fact.

Prerequisite: Industrial Engineering & Operations Research (ME-3017)

Definition of Quality, Dimensions of Quality, Quality Planning, Quality Costs - Analysis Techniques for Quality Costs, Basic Concepts of Total Quality Management, Historical Review, Principles of TQM, Leadership - Concepts, Role of Senior Management, Quality Council, Quality Statements, Strategic Planning, Deming Philosophy, Barriers to TQM Implementation


Statistical Quality Control, The Seven Tools of Quality, Measures of Central Tendency and Dispersion, Population and Sample, Normal Curve, Control Charts for variables and Attributes, Process Capability, Concept of Six Sigma, New Seven Management Tools.

Text Book:

Reference Books:

ME4039 FUNDAMENTALS OF COMPUTATIONAL FLUID DYNAMICS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Make the mathematical interpretation of the physical problems.
CO2. Understand the basic algorithm and think to develop suitable algorithms.
CO3. Choose suitable discretization techniques for a particular problem.
CO4. Analyze the different numerical solution methods and choose the suitable method.
CO5. Understand the advantages of numerical solution before attempting experimental solutions

Prerequisite: Introduction to Fluid Mechanics & Heat Transfer (ME-3032)

Introduction:

Mathematical Formulation:

Discretization Methods:

Finite Difference Formulation:
Steady one dimensional conduction problem, Unsteady one dimensional conduction problem (simple explicit method, simple implicit method, Crank-Nicolson method), Two dimensional heat conduction problem, Convection diffusion problem.

Finite Volume Formulation:
Steady one dimensional conduction problem, Unsteady one dimensional conduction problem, Two dimensional conduction problem, Steady one dimensional convection diffusion problem (upwind scheme), Two dimensional convection diffusion problem.

Flow field calculation:
Discretization of the momentum equation, Staggered grid, SIMPLE algorithm, SIMPLER algorithm.

Solution Methods:
Direct vs Iterative methods, Gauss-Seidel Method, SOR method, Tri-Diagonal Matrix (TDMA) algorithm.
ME4049 ADVANCED MECHANICS OF SOLIDS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Know the application of fixed and continuous beams.
CO2. Evaluate the shear centre for symmetrical and unsymmetrical beams.
CO3. Know the application of curved beams and concepts in the theory of elasticity.
CO4. Evaluate the stress analysis by photo elastic method, stress optic law and brittle coating method.

Prerequisite: Mechanics of Solids (ME-2012)

Fixed and continuous beams:
Fixed and continuous beams.

Curved Beams:
Bending of Beams with small initial curvature, strain energy of beam with small initial Curvature, Deflection of beam with small initial curvature, curved beam with large initial curvature.

Shear Centre:
Shear centre for sections symmetrical about both axes, shear centre for section symmetrical about one axis.

Unsymmetrical Bending:
Unsymmetrical Bending stress at any point in cross-section, sign convention, Direction of neutral axis, Determining stress and deflection in Beams with unsymmetrical bending.

Basic concepts in theory of Elasticity:
Basic concepts in theory of Elasticity (Theoretical approach in Cartesian co-ordinates only), stress at a point. Notation for stress, sign convention for stress. Differential equations of equilibrium, strain components, compatibility equations.

Engineering Stress Analysis:
Two-dimensional photo elastic method of Stress analysis, Stress optic law, Light and dark field in polariscope. Isochromatic fringe pattern: stress determination by Brittle Coating method.

Text Book:

Reference Books:
2. Strength of Materials: Dr Sadhu Singh
3. Strength of materials, Beer and Johnson TMGH.
Course Outcome: At the end of the course, the students will be able to:

CO1. Select different sensors and actuators for body parts of robot.
CO2. Analyze the kinematics of robot.
CO3. Control robot by programming.
CO4. Select the best robotics applications and be able to justify the overall advantages to industry.

Prerequisite: NIL

Introduction:
Definition of a Robot, Basic Concepts, Robot configurations, Types of Robot drives, Basic robot motions, Point to point control and Continuous path control.

Components and Operation:
Basic control system concepts, Control system analysis, Robot actuation and feedback, Manipulators, direct and inverse kinematics, Coordinate transformation, Brief Robot dynamics, Types of Robot and Effectors, Robot/ End and Effectors interface.

Sensing and Machine Vision:
Range sensing, Proximity sensing, Touch sensing, Force and Torque sensing. Introduction to Machine vision, Sensing and Digitizing. Image processing and analysis.

Robot Programming Methods:
Languages, Capabilities and limitation, Artificial intelligence, Knowledge representation, Search techniques in A I and Robotics.

Industrial Applications:

Text Book:

Reference Books:
3. Robotics; control, sensing, vision and intelligence, K. S. Fu, R. s. Gonzalez and C. S. G. Lee, TMH
ME4051  ROBOTICS AND FLEXIBLE MANUFACTURING SYSTEM  Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Understand the use of robots and design the robotic path generation
CO2. Use the different drive systems for different robot application and analyze the sensing and vision of a robot
CO3. Understand the need of flexible manufacturing and the application of robot in it.
CO4. Select appropriate tooling for manufacturing the part in integrated environment.

Prerequisite: NIL

Introduction:
Definition, robotic system, symbols, description of position and orientation, transformation of coordinate frames, joint variables, D-H algorithm.

Kinematics of manipulators:
Direct and inverse kinematics, velocity and static forces, dynamics of manipulator.

Robot drives, actuators and control:
Drive systems, pump classification, pneumatic system, electrical drives, piezoelectric actuators, drive mechanisms.

Robot end effectors:
Classification of end effectors, types of grippers, drive system for grippers, active and passive grippers.

Sensors and robot vision:
Need of sensing systems, sensory devices, types of sensors, robot vision system

Robot languages and programming:
Classifications, computer control and robot software, VAL system and language.

Group technology and FMS:
Benefits of group technology, flexible manufacturing system, FMS work station, planning and analysis, application of FMS.

Computer integrated manufacturing (CIM):
Computer aided process planning, computer integrated production planning system, material requirement planning, manufacturing resource planning.

Text Books:

Reference Books:
2. Fundamentals of robotics Analysis & Control, Robert J. Schilling, PHI,
3. Robotics; control, sensing, vision and intelligence, K. S. Fu, R. s. Gonzalez and C. S. G. Lee, TMH
**ME4053 FLUID POWER ENGINEERING AND CONTROL**

**Course Outcome:** At the end of the course, the students will be able to:

- **CO1.** Understand the basic principles of fluid power and symbols.
- **CO2.** Understand the working of various components of hydraulic systems.
- **CO3.** Understand the designing procedures for the hydraulic power circuits.
- **CO4.** Understand the fundamentals of pneumatic systems and their components.
- **CO5.** Understand the designing procedures for the pneumatic power circuits.
- **CO6.** Understand the concepts of fluidics, PLC’s, and their applications in designing fluidic control devices.

**Prerequisite:** Fluid Mechanics (ME-2003)

**Fluid power systems and fundamentals:**

Introduction to fluid power, Advantages of fluid power, Types and applications of fluid power systems, Properties of hydraulic fluids, General fluid types, Fluid power symbols.

Basics of Hydraulics: applications of Pascal’s Law, laminar and turbulent flow, Reynolds’s number, Darcy’s equation, Losses in pipes, valves and fittings.

**Hydraulic systems and components:**

Sources of hydraulic power: Pumping theory, Pump classification, Gear pump, Vane pump, Piston pump and Variable displacement pumps, construction and working of pumps, Pump performance.

Fluid power actuators: Linear hydraulic actuators—Types of hydraulic cylinders, Single acting, Double acting special cylinders like tandem, rodless, telescopic, cushioning mechanism, Construction of double acting cylinder, Rotary actuators – Fluid motors, Gear, Vane and Piston motors.

**Design of hydraulic circuits**

Construction of Control Components: Director control valve, 3/2 way valve, 4/2 way valve, shuttle valve, check valve, pressure control valve, pressure reducing valve, sequence valve, flow control valve, fixed and adjustable, electrical control solenoid valves, Relays, ladder diagram.

Accumulators and Intensifiers: Types of accumulators, Accumulators circuits, sizing of accumulators, intensifier, Applications of Intensifier, Intensifier circuit.

**Pneumatic systems and components**

Pneumatic Components: Properties of air, Compressors, Filter, Regulator, Lubricator unit, Air control valves, Quick exhaust valves and pneumatic actuators.

Fluid power circuit design, Speed control circuits, synchronizing circuit, Penumo hydraulic circuit, Sequential circuit design for simple applications using cascade method.

**Design of pneumatic circuits**

Servo systems: Hydro mechanical servo systems, Electro hydraulic servo systems and proportional valves.

Fluidics: Introduction to fluidic devices, simple circuits, Introduction to electro hydraulic pneumatic logic circuits, ladder diagrams, PLC applications in fluid power control, Fluid power circuits, failure and troubleshooting.
Text Book:

Reference Books:

ME4054 BIOMECHANICS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Apply principle of mechanics to model human body.
CO2. Analyze motion of leg parts and hand parts to develop artificial limbs.
CO3. Find out the stress produces in different body parts during physical activities in daily life.
CO4. Design and develop set up for physiotherapy applications.

Prerequisite: Engineering Mechanics (ME-1001)

Introduction:
Mechanics, Biomechanics, Basic Concepts, Newton’s Laws, Dimensional Analysis, Systems of Units, Conversion of Units, Mathematics, Scalars and Vectors, Modelling and Approximation, Generalized Procedure, Scope of the Text, Notation.

Statics Analyses of System in Equilibrium:


Applications of Statics to Biomechanics:


Stress and Strain:


Mechanical Properties of Biological Tissues:

Viscoelasticity, Analogies Based on Springs and Dashpots, Empirical Models of Viscoelasticity, Time-Dependant Material Response, Comparison of Elasticity and Viscoelasticity, Common Characteristics of Biological Tissues,
Biomechanics of Bone, Biomechanics of Tendons and Ligaments, Biomechanics of Skeletal Muscles, Biomechanics of Articular Cartilage.

**Introduction to Dynamics & Linear Kinematics:**

Dynamics, Kinematics and kinetics, Linear, angular, and General Motions, Distance and Displacement, Speed and Velocity, Acceleration, Inertia and Momentum, Degree of Freedom, Particle Concept, Reference Frames and Coordinates Systems, Prerequisites for Dynamic Analyses. Uniaxial Motion, Position, Displacements, Velocity and Acceleration, Dimensions and Units, Measured and Derived Quantities, Uniaxial Motion with Constant Acceleration.

**Text Book:**

1. Fundamentals of Biomechanics – Nihat OZkaya and Margareta Nordin (Springer), 2 nd Ed.

**Reference Books:**

1. Fundamentals of Biomechanics-Duane Knudson . (Springer)
2. Text book of Biomechanics and exercise therapy- Dr. C.Nagavani

**ME4055 SOLAR ENERGY SYSTEMS Cr-3**

**Course Outcome:** At the end of the course, the students will be able to:

- **CO1.** Learn the fundamentals of solar energy conversion systems, available solar energy, solar applications.
- **CO2.** Learn about PV technology principles and techniques of various solar cells /materials for energy conversion.
- **CO3.** Learn how to advance the current technology of the solar energy systems for making the process economical, environmentally safe and sustainable.

**Prerequisite :** NIL

**Solar radiation:**

Sun as the source of radiation, Sun-Earth relationships, solar constant, solar radiation at the earth’s surface, depletion of solar radiation, measurement of solar radiation, solar radiation data, solar time, solar radiation geometry, solar radiation on tilted surfaces.

**Solar collectors:**


**Applications of solar thermal technology:**


**Solar photovoltaic systems:**

Fundamentals of solar cells, P-N junction photodiode, photovoltaic conversion - description and principle of working of a solar cell, cell structure, solar module and panel, I-V characteristics of a PV module, maximum power point, cell efficiency, fill factor, SPV system classification, SPV system components, SPV applications.
Solar energy storage and economic analysis:
Storage of solar energy: thermal storage-sensible and latent heat storage, electrical storage and chemical Storage. Economic Analysis: Initial and annual costs, definition of economic terms for a solar system, present worth calculation, repayment of loan in equal annual installments, annual savings, cumulative savings and life cycle savings, payback period, clean development mechanism.

Text book:

Reference books:

ME4056 MECHATRONIC SYSTEMS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Select and apply the knowledge, techniques, skills and modern tools in mechatronics engineering technology.

CO2. Apply concepts of circuit analysis, analog and digital electronics, automation and controls, motors, electric drives, power systems, instrumentation, and computers to aid in the design, characterization, analysis, and troubleshooting of mechatronics systems used in industries as well as home appliances.

CO3. Apply the different drive systems for actuation of various parts and components of a system.

CO4. Understand the different controllers used in industries, machines and industrial robots.

Prerequisite : Basic Electronics (EC-1001)

Introduction:
Definition of mechatronics, need of mechatronics system, Examples of mechatronics systems in manufacturing, products, design. Review of fundamentals of electronics. Data conversion devices, sensors and transducers, (pressure, velocity, level, light, accelerometers, gyros, compass, encoders, strain gauges, LVDT, potentiometer), smart sensors, micro sensors, transducers, signal processing devices, relays, contactors and timers. Signal conditioning basics, filtering, protection, pulse width modulation, opamps and their applications, Microprocessors (8085 and Arduino) micro controllers for sensing, actuation and control, and PLCs. Digital data, analog data, AD-DA conversion, demonstration on data acquisition systems using NI LabVIEW)

Logic circuits:
Digital logic, logic gates, application of logic gates, sequential logic Basic modelling of systems, first order systems, second order systems, performance measure of second order systems

Drives:
Switching, solenoids, stepper motors, servo drives. Ball screws, linear motion bearings, cams, systems controlled by camshafts, electronic cams. (Programming a servomotor using NI Labview)

Pneumatics and Hydraulic actuation systems:
Flow, pressure and direction control valves, actuators, and supporting elements, hydraulic power packs, pumps, production, distribution and conditioning of compressed air, system components and graphic representations, design of systems.
Controllers:
Close loop and open loop systems, description of PD, PI and PID controllers. CNC machines and part programming. Introduction to Robotics, forward and invers kinematics (Demonstration on programing robot and CNC part programming).

Text Books:

Reference Books:

ME4057 PRODUCTION AND OPERATIONS MANAGEMENT Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Describe (identify/write) the various components that make up the manufacturing planning and control system and the interaction among them.

CO2. Develop the models that are applicable for supply chain inventory management, including those for quantity discounts, safety stocks, and order quantity and reorder point interactions.

CO3. Develop the algorithms that are appropriate for solving single-machine, two-machine, parallel-machines and flow shop scheduling problems.

CO4. Show how (i) the material requirement plans, manufacturing resource plans, and capacity requirement plans can be developed, and (ii) lot sizing decisions can be made for a manufacturing system.

Prerequisite: NIL

Module-I Overview of Operations Management

Introduction, Responsibilities of Production Manager, Strategic Decisions in Operations, Manufacturing Vs. Service Operation, Types of Production processes (Project/Job, Batch, Mass/Line, Continuous), Concept of FMS (Flexible Manufacturing System), Role of Production, Planning & Control (PPC), New Product Development & Process Design, Importance of operations in services, service classifications, service package, Distinctive characteristics of service operations.


Module-III Facility Location and Layout, Scheduling

Importance & Factors affecting the Plant Location, Single and Multi facility location Techniques (Centroid and Minimax method), Plant Layout & its classification, Relationship Diagram & Block Diagramming, Assembly Line of Balancing, Sequencing, 2 and 3 Machine cases: Johnson’s Rule, Job shop Scheduling: Priority dispatching Rules,

Module – IV Inventory Control, Quality Control

Inventory Control: Relevant Costs, P & Q Systems of Inventory, Basic EOQ Model, and Model with Quantity discount, Economic Batch Quantity. Safety Stock, Reorder Point, ABC Analysis, Material Requirement Planning, . Concept of Quality Management, Statistical Quality Control, X Bar, R and P Charts. Acceptance sampling,

Text Book:

Reference Books
1. Production and Operation Management, K. Aswathappa K. Shridhara Bhat
2. S.N. Charry, Production and operations management, TMH

ME4058 FINITE ELEMENT METHOD FOR ENGINEERS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Obtain an understanding of the fundamental theory of the FEA method.
CO2. Generate the governing FE equations for systems governed by partial differential equations.
CO3. Formulate with Rayleigh-Ritz and Galerkin Method.
CO4. Understand the use of the basic finite elements for structural applications using truss, beam
CO5. Understand the application and use of the FE method for heat transfer problems
CO6. Understand the application and use of the FE method for other engineering problems.

Prerequisite : Mathematics - I (MA-1001)

Introduction to FEM:

Introduction, Basic concepts of FEM, Comparison of Finite Element and Exact solutions, Applications of FEM.

Direct Formulation:


Basic Procedure:

General procedure of FEM, Elements and shape functions, Co-ordinate transformations: Global coordinates and natural coordinates,

Types of Elements:

One dimensional linear element, One dimensional quadratic element, Two dimensional linear triangular element (CST: Constant Strain Triangle), Isoparametric elements, Three dimensional elements.
**Finite Element Formulation:**


**Assembly of Element Matrices and Treatment of Boundary Conditions:**

Assemblage of element equations, Treatment of boundary conditions.

**Application to Engineering Problems:**

Application to structural bar problems, truss problems, heat conduction problems with various boundary conditions, electrical and magnetic field problems.

**Text Book:**


**Reference Books:**


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**ME4059 MECHANICS OF COMPOSITE MATERIALS**

**Course Outcome:** At the end of the course, the student will be able to:

- **CO1.** Understand the characteristics & application of a composite material and different manufacturing methods of laminated fiber-reinforced composite materials.
- **CO2.** Know the strength of a unidirectional lamina and strength of an orthotropic lamina.
- **CO3.** The macromechanical behavior of a lamina, stress-strain relation for anisotropic material.
- **CO4.** Know the micromechanical behavior of a lamina and to determine various elastic constants.
- **CO5.** Know about classical lamination theory and stress-strain variation in laminate.

**Prerequisite:** NIL

**Introduction:**

An overview of composites, Classification & characteristics of composite materials, Application and advantages of composites, advanced fibers, Fiber properties, Matrix materials, Fillers, Fabrication of polymer, metal, ceramic matrix composites.

**Elastic behavior of unidirectional lamina:**

Longitudinal behavior of unidirectional composites, Transverse stiffness and strength, Failure modes, expansion coefficients and transport properties.
Macro-mechanical behavior of a lamina:
Stress-strain relation for anisotropic materials, stiffness, compliances, and engineering constants for orthotropic materials. Stress-strain relation for plane stress in an orthotropic material.

Micro-mechanical behavior of a lamina:
Determination of elastic constants (E1, E2, µ12, G12)

Analysis of Laminated Composites:
Classical lamination theory, lamina stress-strain behavior, stress and strain variation in laminate, resultant laminate forces and moments.

Test methods:
Measurement of physical properties, Measurement of Mechanical properties, Flexural properties, Fracture toughness and Impact properties.

Text Book:

Reference Books:

ME4060 MECHANICAL MEASUREMENTS & CONTROL Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Identify significance of mechanical measurements and learn Basic transducer elements, signal conditioning elements and data presenting elements.
CO2. Apply different methods to measure Strain, vibration and shock, pressure and temperature.
CO3. Apply control system fundamentals to do mathematical modeling.
CO4. Analyze systems and errors in time domain and frequency domain

Prerequisite : NIL

Introduction to Generalized Mechanical Measurement System:
The significance of mechanical measurements.

Basic detector transducer elements:

Signal Processing:
Electrical Intermediate modifying devices, input circuitry, the simple current sensing circuit, the ballast circuit, the voltage-dividing potentiometer circuit. The voltage balancing potentiometer circuit. Resistance bridges.
Measurement of Strain:
The Electrical resistance strain gauge. The metallic resistance strain gage, Selection and installation factors for metallic strain gages, Circuitry, Metallic strain gage, The strain gage ballast circuit, the strain gage bridge circuit, Temperature compensation.

Measurement of Pressure:

Temperature Measurement:
Use of bimetals pressure thermometers. Thermocouples, Pyrometer, calibration of temperature measuring devices.

Vibration and Shock:
Measurement and test methods- Vibrometers and accelerometers, Elementary vibrometers and vibration defectors.

Measurement system modeling:
Description of open and closed loop control systems and their block diagrams. Use of block diagrams and signal flow graph to find the overall transfer function.

Basic characteristics of feedback control systems:

Frequency-response analysis:

Text Books:
2. Control systems Engineering: I. J. Nagpal and M. Gopal, New Age International Publishers,

Reference Books:
1. A course in mechanical measurement and instrumentation: A K Sawhney, P Sawhney, DR Co
2. Mechanical Measurements and Instrumentation, R K Rajput, S.K. Kataria & Sons
Course Outcome: At the end of the course, the students will be able to:

CO1. Know hydrostatic step bearings and application to pivoted thrust bearings.
CO2. Know hydrodynamic lubrication, Petroff’s equation, Reynold’s equations.
CO3. Evaluate the friction loss in concentric bearings, bearing modulus and Sommerfeld number.
CO4. Know the bearing pads and bearing materials.

Prerequisite: NIL

Study of various parameters:
Viscosity, flow of fluids, viscosity and its variation - absolute and kinematic viscosity, temperature variation, viscosity index determination of viscosity, different viscometers used.

Hydrostatic lubrication:
Hydrostatic step bearing, application to pivoted pad thrust bearing and other applications, hydrostatic lifts, hydrostatic squeeze films and its application to journal bearing.

Hydrodynamic theory of lubrication:
Various theories of lubrication, Petroff’s equation, Reynold’s equation in two dimensions - Effects of side leakage - Reynolds equation in three dimensions, Friction in sliding bearing, hydro dynamic theory applied to journal bearing, minimum oil film thickness, oil whip and whirl anti-friction bearing.

Friction and power losses in journal bearings:
Calibration of friction loss friction in concentric bearings, bearing modulus, Sommerfield number, heat balance, practical consideration of journal bearing design considerations.

Air lubricated bearing:

Types of bearing oil pads:
Hydrostatic bearing wick oiled bearings, oil rings, pressure feed bearing, partial bearings - externally pressurized bearings.

Bearing materials:
General requirements of bearing materials, types of bearing materials.

Text Book:
1. Fundamentals of Tribology, Basu, Sen Gupta and Ahuja, PHI

Reference Books:
1. Tribology in Industry: Sushil Kumar Srivatsava, S. Chand &Co.
Course Outcome: At the end of the course, the students will be able to:

CO1. Explain the plastic deformation of metals is achieved on industrial scale and analyze the behaviour of materials during forming processes.

CO2. Understand the concept of technological procedures in industrial manufacturing processes related to pressure shaping of metals and estimate the required forming loads and powers of different forming processes.

CO3. Explain the essence of each technological operation employed in industrial pressure shaping of metals

CO4. Integrate knowledge gained in this course to select and design a complete metal forming system.

Prerequisite: Basic Manufacturing Processes (ME-2010)

Introduction:
Fundamentals of plasticity, stress and strain, stress-strain relationship, yield criteria and flow rules, instability.

Fundamentals of Metal Forming:
Classification of forming processes, mechanisms of metal forming- lab method, limit analysis, upper bound and lower bound theorem, slip line solution, temperature of metal working, hot working, cold working; Friction and lubricants in metal forming

Rolling of Metals:
Rolling processes, forces and geometrical relationship in rolling, simplified analysis of cold and hot rolling, rolling load, rolling process variables, defects in rolling, torque and power calculations, friction hill.

Forging:
Classification of forging process, forging of plates and circular discs, forging load calculation, open-die and closed-die forging, stress and strain distribution in forging process, friction and lubrication in forging process.

Extrusion:
Classification of extrusion process, Analysis of Extrusion process, Extrusion load estimation, extrusion process parameters, extrusion of tubes and production of seamless pipes.

Drawing of tubes, rods and wires:
Wire drawing dies, tube drawing process, analysis of wire drawing, deep drawing and tube drawing, drawing force calculation.

Sheet Metal forming:
Forming methods, bending, stretch forming, spinning, hydraulic forming, forming limit criteria, defect in formed parts.

Text Book:

References Books:
2. Metal Forming Hand book, ASM
Course Outcome: At the end of the course, the students will be able to:

CO1. Understand the potential, availability and the properties of the alternate and renewable fuels.
CO2. Understand the basic principles of physics and the performance, combustion and emission characteristics of LPG, CNG and other alternate fuels in SI and CI engines.
CO3. Understand the basic principles of different renewable energy sources like solar, biomass, wind, geothermal, tidal, ocean and wave energy and its merits and demerits.
CO4. Keep our environment clean from different pollutions.
CO5. Get placement in organizations to manage alternate fuels and renewable energy based power generation in the country.

Prerequisite : NIL

Introduction to Renewable Energy:
Forms of energy, Fossil fuels and climate change, Renewable energy sources (direct and indirect uses of solar energy and non-solar energy), Importance of energy storage and distribution, Biological storage, Chemical storage, Heat storage, Electrical storage, Mechanical storage, Distribution of energy.

Solar Power Generation:
The nature and availability of solar radiation, Low temperature solar energy applications, Active solar heating, Passive solar heating, Solar thermal engines and electricity generation, Economics, potential and environmental impact.

Bio Power Generation:
Bioenergy past and present, Biomass as a solar energy store, Biomass as a fuel, Primary biomass energy sources: plant materials, Secondary biomass sources: wastes, residues, and co-products, Physical processing of biomass, Thermochemical processing, Biochemical processing, Vegetable oils and biodiesel, Environmental benefits and impacts, Economics, Future prospects for bioenergy.

Tidal and Wave Power Generation:
Nature of tidal source, Physics of tidal energy, Power generation from barrages, Environmental considerations for tidal barrages, Integration of electrical power from tidal barrages, Economics of tidal barrages, Tidal lagoons, Tidal streams/currents, Tidal current projects, Tidal current assessment, Physical principles of wave energy, Wave energy sources, Wave energy technology, Integration (wave energy for isolated communities and large electricity grids).

Wind Power Generation:
Energy and power in the wind, Characteristics of wind, Wind turbines (types, horizontal and vertical axis wind turbines), Linear momentum and basic theory, Dynamic matching, Blade element theory, Aerodynamics of wind turbines, Power extraction by a turbine, Electricity generation, Power from wind turbines, Environmental impact, Economics of energy generation, Commercial development and wind energy potential, Offshore wind energy.

Geothermal Power Generation:
The mining of geothermal heat, Source of heat, Physics of deep geothermal resources, Technologies for exploiting high enthalpy steam fields, Technologies for direct use of geothermal energy, Harnessing geothermal resources, Environmental implications, Economics and world potential.

Text Book:

Reference Books:
Course Outcome: At the end of the course, the students will be able to:

CO1. Understand the philosophy behind different maintenance techniques and select the best maintenance practices.
CO2. Use successfully different condition monitoring techniques to predict health of a machine.
CO3. Analyze and find out the root cause of defect in machine and system.
CO4. Apply different NDT methods to find out fault in machine and structure.

Prerequisite: Kinematics & Kinetics of Machines (ME-2009)

Maintenance strategies:
Breakdown, Preventive, Predictive and Proactive maintenance. Plant machinery classification, Condition based maintenance.

Transducers for condition monitoring:
Principles and application of accelerometers, velocity pickups, eddy current probes, stroboscopes, proximity probes, spike energy detector, laser vibrometer, condenser microphones, thermocouples, optical pyrometer, ultrasonic thickness detector, acoustic emission transducer.

Fundamentals of Signal processing:
Fast Fourier Transform (FFT) analysis, Sampling rate, Nyquist sampling theorem, aliasing, filters, A/D converter, Windowing.

Vibration Monitoring:
Measuring vibration: Signal forms, phase, overall and spectral vibration, Measurement point location, Transducer mountings.

Rotating machinery fault analysis:
Imbalance, Misalignments, Looseness, Oil whirl, Bent shafts, Coupling problem, Bearing defects, Gear defects.

Vibration level classification:
ISO standards, Peak and RMS levels, Time domain averaging, Trending fault data. Case studies based on vibration data and signature of machines.

Wear and Debris Analysis:

Temperature Monitoring:

Non Destructive Testing:
Faults that can be detected by NDT, Ultrasonic, Radiography Methods, Eddy Current Method, Acoustic Emission Method, Dye penetrant Method. Case studies based on available NDT data.
Advance Maintenance Practices:

Text Book:
1. Maintenance Engineering and Management, Sushil Kumar Srivastava, S.CHAND,

Reference Books:
1. Maintenance Engineering and Management, K.Venkataraman, PHI, 1st Edition
2. Plant Maintenance and Reliability Engineering, N.V.S. Raju, CENGAGE, 1st Edition

ME4068 INDUSTRIAL SAFETY Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Train students for industry professions
CO2. Provide Safety, Health & Environmental Awareness
CO3. Enhance knowledge, skills and develop good working environment to teach skills to avoid accidents and loss.

Prerequisite : NIL

Introduction to Industrial Safety:
History and development of safety movement, Need for safety, Safety legislation: Acts and rules, Safety standards and codes, Safety policy: safety organization and responsibilities and authorities of different levels.

Types of industries:
Light, heavy, high tech – manufacturing (iron and steel), process (oil refinery), service (hospital); Overview of a typical modern industry: activity flow, machineries, operations, parameters which could lead to accidents; ranges of temperatures and pressures, working media like fluids and gases, safety concerns (over pressure, gas leaks, etc.)

Areas of industrial safety:
Process safety, personnel safety, instrument safety, facility safety, environmental safety.

Accidents:
Accident sequence theory, Causes of accidents, Accident prevention and control techniques, Plant safety inspections, Job safety Analysis and investigation of accidents, First aid.

Financial costs:

Hazard Identification:
Identification of hazard, Categorization methods for elimination of hazard, Mechanical hazards; machine guarding, safety with hand tools/ portable power tools, Pressure vessel hazards and their control, Safety in material handling: hazards and safe Practices, safety with storage of materials, Electrical hazards: classification, safe work practices, Chemical hazards: laboratory safety, bulk handling of chemicals, Fire and explosion hazards, Fire detection, Prevention ,control, and extinguishments, Industrial layout, Industrial waste management.

Hazard analysis:
Checklist procedure, Preliminary hazard analysis, What if analysis, Failure mode effect analysis,
Hazard and operability (HAZOP) studies, Hazard analysis techniques: Fault tree analysis, Event tree analysis, General outline of DOW index, Risk estimation and management, Major hazard control, On-site and Off-site emergency preparedness.

Text Book:

Reference Books:

ME4069 COMPUTER INTEGRATED MANUFACTURING Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Understand the modern technologies and the engineering tools used for manufacturing engineering applications.
CO2. Understand the application of computers in the documentation, creation of database and use of CAPP system in industries.
CO3. Apply the knowledge in various fields of Computer Aided Manufacturing.
CO4. Develop manual and APT part programs for 2D complex profiles, automated tool paths and G-codes for machining components and test the programs through simulation.
CO5. Apply modern computational, analytical, simulation tools and techniques to face the challenges in manufacturing

Prerequisite: Basic Manufacturing Processes (ME-2010)

Automation and Computer Integrated Manufacturing:
Automation in production systems, Manufacturing support systems, Product cycle & Production development cycle, Types of production, Definition of CIM, Elements of CIM, Benefits of CIM.

Computer Aided Process planning:
Introduction, Variant, Generative, Forward and Backward Process planning, CAPP benefits, input format, Totally Integrated process planning systems, Expert process planning using Commercial systems: CAM-I, CAPP.

Computer Aided Manufacturing:
Introduction to CAM, CAD/CAM Integration, Constructional Features of CNC Machines, Tooling and Work Holding Devices, DNC.

Part Programming for CNC Machines:
Structure of CNC program, Coordinate system, G & M codes, cutter radius compensation, tool nose radius compensation, tool wear compensation, canned cycles, sub routines, do loop, mirroring features, Manual part programming for CNC turning and machining centre for popular controllers like Fanuc, Siemens, Generation of CNC program using CAM software.

Fundamentals of Networking:
Principles, techniques, networking methods, network standards, Ethernet, Internet, system security, remote systems, document and work flow management.
Factories of future:

Trends in manufacturing, The future automated factory.

Text Books:
2. CAD/CAM, Ibrahim Zeid, TMH

Reference Books:
1. Computer Integrated Manufacturing, Paul Ranky Prentice Hall of India

ME4071 AUTOMOBILE ENGINEERING Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Select and identify most appropriate chassis and engine for given mobility application.
CO2. Understand and model steering, braking and suspension systems for new vehicle.
CO3. Identify fault in vehicle subsystems and carry out troubleshooting.
CO4. Understand and select a suitable transmission and electrical system for automobiles.

Prerequisite: Kinematics & Kinetics of Machines (ME-2009)

Introduction:
Main units of automobile chassis and body, different systems of the automobile, description of the main parts of the engine, motor vehicle act.

Suspension System:
Function, types, leaf spring suspension system, coil spring suspension system, torsion bar, telescopic type shock absorber.

Transmission System:
Clutch: single plate, multi plate, centrifugal clutch, their functions; Gear box: Sliding mesh, constant mesh and synchromesh gearbox, design of 3 speed and 4 speed gear box, over drive, torque converter, semi and fully automatic transmission.; Hooks Joint: Hooks Joint, propeller, shaft, transmission system for two wheel and four wheel drives, Hotchkiss and torque tube drives; Differential and rear axle: differential, rear axles, types of rear axles, semi floating, three quarter floating and full floating types.

Braking System:
Hydraulic braking system, braking of vehicles when applied to rear, front and ill four wheels, theory of internal shoe brake, design of brake lining and brake drum different arrangement of brake shoes, servo and power brakes.

Front wheel Geometry and Steering System:
Camber, castor, Kingpin inclination, toe-in, center point steering condition for true rolling components of steering mechanism. Power steering system.

Electrical systems of an automobile:
Starting system, starting drive, generation system, ignition system other electrical system.

Power for propulsion:
Types of resistance, traction, tractive effort, power required for propulsion for vehicle.
Course Outcome: At the end of the course, the students will be able to:

CO1. Make the mathematical interpretation of the physical problems.
CO2. Understand the basic algorithm and think to develop suitable algorithms.
CO3. Choose suitable discretization techniques for a particular problem.
CO4. Analyze the different numerical solution methods and choose the suitable method.
CO5. Understand the advantages of numerical solution before attempting experimental solutions.
CO6. Apply the knowledge for the simulation of the industrial problems in commercial softwares.

Prerequisites: Fluid Mechanics (ME-2003) & Heat Transfer (ME-3011)

Introduction:
Methods of prediction: Experimental, Theoretical, Numerical, Classification of partial differential equations: Elliptic, Parabolic, Hyperbolic PDEs, an overview of finite difference, finite element and finite volume methods

Mathematical Formulation of Physical Phenomena:
Governing Equations: Mass Conservation Equation, Energy Equation, Momentum Equation, The general scalar transport equation, Different kinds of Boundary conditions, Initial condition

Discretization Methods:

Finite Difference Formulation:
Steady one dimensional conduction problem, Unsteady one dimensional conduction problem (simple explicit method, simple implicit method, Crank-Nicolson method), Two dimensional heat conduction problem, Convection diffusion problem, consistency, stability and convergence

Finite Volume Formulation:
Steady one dimensional conduction problem: Interface conductivity, Source Term Linerization, implementation of different kind of boundary conditions, Unsteady one dimensional conduction problem, Two dimensional conduction problem, Steady one dimensional convection diffusion problem (upwind scheme, exponential scheme, hybrid scheme, power-law scheme), Two dimensional convection diffusion problem.

Flow field calculation:
Solution of Navier-Stokes Equations for Incompressible Flows: Stream function vorticity and artificial compressibility methods, Staggered grid, SIMPLE SIMPLEC and SIMPLER algorithms

Solution Methods:
Direct vs Iterative methods, Gaussian Elimination, Gauss-Seidel Method, SOR method, Tri-Diagonal Matrix (TDMA) algorithm

Special Topics:
Numerical solution of phase change problems.

Text Book:
Reference Books:
3. Finite Difference Method, M. N. Ozisik, CRC.
5. Computational Fluid Flow and Heat Transfer, Muralidhar and T. Sundararajan, Narosa

ME4075 MACHINE TOOLS TECHNOLOGY Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Design gear box
CO2. Design different machine tools considering static and dynamic loads
CO3. Understand effect of vibrations on life of machine tools
CO4. Understand design considerations for Special features in Machine tools & NC machines.

Prerequisite: Manufacturing Processes and Design (ME-3015)

General classification of machine tools:
working and auxiliary motions, Hydraulic transmission and its elements Mechanical transmission and is elements,
General requirement of machine tools.

Kinematics of Machine Tools:
Stepped and stepless drive, basic consideration on the design of drives, Variable speed range in machine tools,
Graphical representation of speed and structure diagram, selection of optimum ray diagram, design of speed and feed gear boxes, Step less regulation of speed and feed rates

Machine Tool structure:
Design criteria, materials static and dynamic stiffness, basic design procedure, design of beds and columns, Model technique in design of machine tool structure

Guideways and powers Screws:
Classification of guideways, materials and lubrication. Design criteria and calculations for slideways, Design of guides under hydrostatic lubrication. Aerostatics slideways, Antifriction guideways combination guideways, Classifications of power screws, Design principle of powers screws, re-circulating powers screw assemblies, elimination of backlash.

Machine tool spindles and its bearings:
Materials of spindles, effect of machine tools, compliance on machining accuracy, design principles of spindles, antifriction and sliding bearings

Controlling system in machine tools:
Classifications, control systems for changing speeds and feeds, ergonomics consideration applied to design of control members, principle of automatic and adaptive control

Vibration in machine tools:
Forced vibration, self excited vibration, stick -slip vibration and its minimization, vibration isolation.

Numerical control of machine tool:
Fundamental concepts and its classifications, Components of NC machines and their description, elements of part programming.
Text book:


Reference Books:


ME4077 ADVANCED OPERATIONS RESEARCH Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1. Advance Operations Research is a discipline that deals with the application of advanced analytical methods to help make better decisions.

CO2. Understand and analyze managerial problems in industry so that they are able to use resources (capitals, materials, staffing, and machines) more effectively;

CO3. Knowledge of formulating mathematical models for quantitative analysis of managerial problems in industry;

CO4. Skills in the use of Operations Research approaches and computer tools in solving real problems in industry;

Prerequisite: Industrial Engineering & Operations Research (ME-3017)

Non-Linear Programming:
Unconstrained univariate optimization problems: Bisection method & Newton’s method; Unconstrained multivariate optimization: Gradient search method; Constrained optimization: Kuhn Tucker conditions, Quadratic and Separable Programming methods

Dynamic Programming:
Principle of Optimality, Concepts of state and stage, Solution of Discrete Problems through Backward Dynamic Programming, Multi-stage Dynamic programming problems Shortest path, minimum spanning tree, maximum flow and minimum cost flow problems;

Queuing Theory:
Markov Process - Description of state, Transition probability matrix, Birth and Death process, Markovian and Semi-Markovian Single-channel and Multiple-channel queues, Queuing Networks, Replacement Theory, Game Theory. Two person Zero-sum game, Saddle point, Mixed strategies, Use of dominance, Sub games method

Discrete-event Simulation:
Time-flow mechanisms, Random number and Random variate generation, Simulation of queuing, inventory and industrial problems Integer Programming: 0-1 and mixed integer programming problem formulation, Branch and Bound method, Cutting-plane method

Text Book:
1. Operation Research, Hira and Gupta, S. Chand

References Books:
1. Operation Research: An Introduction, Taha H A, PHI
2. Operation Research, Phillips, Rabindran and Solberg, John Wiley & Sons
3. Introduction to Operation Research, Hiller F S and Lieberman G J
4. Operation Research, S D Sharma
Course Outcome: At the end of the course, the students will be able to:

CO1. Understand the concept of additive manufacturing, its benefits and applications
CO2. Know the various liquid, powder and solid material based technologies in Rapid Prototyping and Rapid Tooling.
CO3. Design solid models and converting it to STL file format required for part generation.
CO4. Focus on the various errors in the RP parts
CO5. Apply reverse engineering for generating RP parts.

Prerequisite: NIL

Introduction:

Liquid and Solid Based Rapid Prototyping Systems:

Powder Based Rapid Prototyping Systems:

Data Processing for Rapid Prototyping:
Process planning for rapid prototyping, CAD model preparation, Data Requirements & geometric modeling techniques: Wire frame, surface and solid modeling data formats - Data interfacing, Tessellation of surfaces, STL file generation Defects in STL files and repairing algorithms, Part orientation and support generation, Support structure design, Model Slicing and contour data organization, direct and adaptive slicing, Tool path generation.

Issues of Prototype:
Accuracy issues in Rapid Prototyping, Strength of RP Parts, Surface roughness problem in Rapid Prototyping, Part deposition orientation and issues like accuracy, surface finish, build time, support structure, cost etc.

Rapid Tooling:
Classification: Soft tooling, Production tooling, Bridge tooling; direct and indirect, Fabrication processes, Applications, Rapid tooling techniques such as laminated metallic tooling, direct metal laser sintering, vacuum casting.

Reverse Engineering:
Introduction to reverse engineering, Integration of reverse engineering and rapid prototyping.

Text Book:

References Books:
MECHANICAL (AUTOMOBILE) ENGINEERING
Program Educational Objectives (PEOs):

The Program Educational Objectives (PEOs) of B.Tech Program in Mechanical (Automobile) Engineering are established and are listed as follows

PEO-1. To lead a successful career in industry or pursue higher studies or entrepreneurial endeavors.

PEO-2. To offer techno-commercially feasible and socially acceptable solutions to real life engineering problems.

PEO-3. To demonstrate effective communication skill, professional attitude and a desire to learn.

Program Outcomes (POs):

The Program Outcomes of UG in Mechanical (Automobile) Engineering are:

a. An ability to apply knowledge of mathematics, science, and engineering

b. An ability to design and conduct experiments, as well as to analyze and interpret data and report

c. An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability

d. An ability to function on multidisciplinary teams

e. An ability to identify, formulate, and solve engineering problems

f. An understanding of professional and ethical responsibility

g. An ability to communicate effectively

h. The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context

i. A recognition of the need for, and an ability to engage in life-long learning

j. A knowledge of contemporary issues

k. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice
AE4031 TRACTOR AND FARM EQUIPMENTS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1: Identify different component and part of tractor and power tiller.
CO2: Select Farm Equipments for land preparation.
CO3: Do trouble shooting of tractor power tiller.

Prerequisite: Internal Combustion Engines & Gas Turbines (ME-3003)

General Design of Tractors:
Classification of Tractors-Main components of Tractor-Safety Rules.

Control of the Tractor and Fundamentals of Engine Operation:
Tractor controls and the starting of the tractor engines-Basic notions and definition-Engine cycles-Operation of multicylinder engines-General engine design - Basic engine performance characteristics.

Engine Frame Work and Valve Mechanism of Tractor:
Cylinder and pistons-Connecting rods and crankshafts Engine balancing – Construction and operation of the valve mechanism-Valve mechanism components – Valve mechanism troubles.

Cooling system, Lubrication System and Fuel System of a Tractor:
Cooling system – Classification –Liquid cooling system – Components, Lubricating system servicing and troubles – Air cleaner and turbocharger – Fuel tanks and filters –Fuel pumps.

Farm Equipments:
Working attachment of tractors-Farm equipment – Classification – Auxiliary equipment – Trailers and body tipping mechanism.

Text Book:
1. Farm Tractor-Maintenance and Repair, Jain, McGraw-Hill Education.

Reference Books:

AE4032 NOISE, VIBRATION AND HARSHNESS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1: Model noise and vibration problems
CO2: Conduct measurement using instrumentation of automotive NVH
CO3: Identify the sources of noise and vibration
CO4: Measure sound intensity and human sensitivity and carryout statistical and frequency analysis.

Prerequisite: Machine Dynamics (ME-2002)

NVH in the Automotive Industry:
Sound and Vibration Theory:

Test Facilities and Instrumentation:
Laboratory simulation: rolling roads (dynamometers), road simulators, semi-anechoic rooms, wind tunnels, etc. Transducers, signal conditioning and recording systems. Binaural head recordings. Sound Intensity technique, Acoustic Holography, Statistical Energy Analysis.

Signal Processing:

NVH Control Strategies & Comfort:

Text Books:

Reference Books:

AE4033 COMBUSTION ENGINEERING Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1: Model mathematically the combustion processes.
CO2: Make performance calculation of engine.
CO3: Select Intake and Exhaust Systems for Engines.
CO4: Model Supercharging, Turbocharging and Scavenging in Engines.

Prerequisites : Internal Combustion Engines & Gas Turbines (ME-3003) & Engineering Thermodynamics (ME-2001).

Thermodynamics of Combustion:
Premixed and diffusion combustion process in IC engines and gas turbines. First and Second Law of Thermodynamics applied to combustion- combustion Stoichiometry chemical equilibrium, spray formation and droplet combustion.

Chemical Kinetics of Combustion:

Flames :
Laminar premixed – flame speed correlations- quenching, flammability, and ignition, flame stabilization, laminar diffusion flames, turbulent premixed flames-Damkohler number.
**Burning of Fuels:**
Spray formation & droplet behavior, gas turbine spray combustion, direct injection engine combustion, detonation of liquid – gaseous mixture, combustion of solid fuels,

**Text Book:**

**Reference Books:**

**AE4034 AUTOMOTIVE SAFETY AND LIGHTING**

**Course Outcome:** At the end of the course, the students will be able to:

CO1: Design an automobile for the safety and comfort  
CO2: Select best safety attachments and ergonomics  
CO3: Conduct test as per safety standard  
CO4: Select most suitable automotive lighting systems

**Prerequisites : Basic Electronics (EC-1001) & Basic Electrical Engineering (EE-1003)**

**Automotive Safety:**
Active and passive safety, Driver assistance systems in automobiles, Definitions and terminology, Balance of stiffness and toughness characteristics and energy absorption characteristics of vehicle structures, Design of crash crumple zones, Modeling and simulation studies, Optimization of vehicle structures for crash worthiness, Types of impacts, and Impact with rebound, movable barrier tests, Analysis and simulation of vehicle in barrier impacts, Roll over crash tests, Behavior of specific body structures in crash testing, Photographic analysis of impact tests, Regulatory requirements for crash testing.

**Ergonomics and Human response to Impact:**
Importance of Ergonomics in Automotive safety, Locations of controls, Anthropomerty, Human impact tolerance, Determination of Injury thresholds, Severity Index, Study of comparative tolerance, Application of Trauma for analysis of crash injuries. Injury criteria’s and relation with crash and modeling and simulation studies in dummy.

**Vehicle safety systems:**
Survival space requirements, Restraints systems used automobiles, Types of safety belts, Head restraints, Air bags used in automobiles, Use of energy absorbing systems in automobiles, Impact protection from steering controls, Design of seats for safety, types of seats used in automobiles. Importance of Bumpers in automobiles, Damageability criteria in bumper designs. Introduction to the types of safety glass and their requirements and rearward field of vision in automobiles, Types of rear view mirrors and their assessment. Warning devices, indicators, hinges, latches, wipers, horns, etc.

**Fundamentals of light, vision and colour:**
Light Measurements, Testing equipment, calibration and photometric practice:
Basics of standards and detectors, spectral measurements and Colorimetry, illuminant meters and luminance meters, colorimeters. Fundamentals of equipment used for light measurement in Automotive field; Gonio-Photometer, Reflecto-meter, Colorimeter, Integrating sphere, types, application, coordinates system. Types of sensors and working principle, construction, characteristics etc. used in different equipment. National and international Regulations, test requirements and testing procedure.

New Technology in Automotive lighting:
Technology progress in automotive lighting, Gas Discharges lamps, LED, adoptive front lighting system, Daylight running lamps.

Text Book:

Reference Books:

AE4035 TWO AND THREE WHEELERS Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1: Select best components of two and three wheeled vehicles given application.
CO2: Design and develop a two wheeler.
CO3: Do trouble shooting of two wheeler and three wheeler.

Prerequisites: Internal Cumbustion Engines & Gas Turbines (ME-3003) & Machine Dynamics(ME-2002)

Power Unit:

Chassis and Sub-Systems:

Brake and Wheels:

Two wheeler dynamics:
Stability of two wheelers on straight and curved path.

Two Wheelers:
Three Wheelers:

Text Book:
1. Two Wheelers, K. K. Ramlingam, SCITECH

Reference Books:

AE4036 AUTOMOTIVE CHASSIS, SUSPENSION AND TRANSMISSION SYSTEM Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1: Select most suitable Tyres, Drive train, Steering System, Brakes and Suspension System for given
CO2: Design chassis, transmission system and Suspension System.
CO3: Identify and solve problems related to Tyres, Steering System, Brakes, and Suspension and transmission system.

Prerequisite : Machine Dynamics(ME-2002)

Introduction:

Transmission:
Layout of power transmission system, requirement of transmission system Clutch Need of clutch. Types of clutches, principle, construction, torque capacity, clutch operating system. Performance curve.

Gear Box:
Requirement of gearbox, different types of gear box viz sliding, constant mesh and synchromesh gear box. Construction details of gear boxes. Gear ratios of vehicle Gear box operation principle.

Hydro dynamic drive:
Fluid coupling, Principle and operation Torque capacity Performance characteristic. Torque converter Construction, principle of operation, Torque capacity multistage torque converter Performance behaviour.

Automatic transmission:
Construction and operating principle, 4 forward and reverse & 3 forward and reverse. Over drive unit and its operation.

Electrical drive:
Construction and operation Electric drive Ward Leonard control system, construction and operation, advantages and disadvantages.

Front axle and Steering System:
Drive Line:

Rear Axles:

Suspension System:
Need of suspension system, types of suspension, suspension springs, constructional details and characteristics of leaf, coil and torsion bar springs. Independent suspension, Rubber suspension, Pneumatic suspension, Shock absorbers.

Braking System:

Text Book:
1. Automobile Engineering Vol-I, Kripal Singh, Standard Publisher Distributor.

Reference Books:

AE4037 VEHICLE MAINTENANCE Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1: Keep record of vehicle operation and maintenance, service schedules.
CO2: Follow best vehicle maintenance procedures.
CO3: Acquire skills in handling situations where the vehicle is likely to fail.
CO4: Repairing and overhauling procedure.
CO5: Enabling students to operate and manage maintenance workshops.
CO6: Inspect and diagnose the problems occurring in the various components of the vehicle.

Prerequisites: Automotive Chassis, Suspension and Transmission System (AE-4036) & Automotive electrical Systems and electronics (AE-4045)

Maintenance records and Schedules:

Maintenance, Repair and Overhauling of engine:
Maintenance, Repair and Overhauling of Chassis, Drive Line components:
- Clutch - Mechanical, Automatic types
- Gear box - Mechanical, Automatic types
- Final reduction
- Propeller shaft
- Front and rear suspension systems - Rigid and independent types
- Brakes systems - Hydraulic, Servo, Air
- Air bleeding
- Steering system - Wheel alignment - Tyres

Maintenance, Repair and Servicing of Electrical System:
- Battery - Testing methods
- Starter motor
- Charging system - DC Generator, AC Alternator, Regulator
- Ignition systems - Coil ignition, Transistor assisted ignition, Capacitor discharge ignition
- Eletric Horn, Wiper, Flasher, Electric fuel pump, Gauges
- Lighting system - Head lights focussing
- Wiring system

Maintenance, Repair and Servicing of Cooling System:
- Cooling system - types, water pump, radiator, thermostat valve
- Anti corrosion and anti freezing solutions

Lubrication system, Fuel system and Body:
- Lubricating system - Oil analysis, oil topping up, oil change, oil filters, oil relief valve
- Fuel system - Petrol, diesel fuel feed system components
- Body repair tools, minor body panel beating, tinkering, and soldering, polishing, painting
- Door locks mechanism
- Window glass actuating mechanism

Text Book:

Reference Books:

AE4038 AUTOMOTIVE MATERIALS AND PROCESSES Cr-3

Course Outcome:
At the end of the course, the students will be able to:

CO1: Apply of modern metallic and non metallic materials in automobile
CO3: Select recent material and manufacturing process for automobile components.

Prerequisites: Material Science and Engineering (ME-2007)

High strength steels:
- Bake hardening (BH) grades
- Isotropic steels
- Interstitial free (IF) grade steels
- Rephosphorized steels
- High strength micro alloy steels
- Dual phase steels
- TRIP steels
- Boron steels
- Multiphase steels
- AHSS grades – Austenitic SS, L-IP, TWIP; Hydroforming process.

Natural fiber composites:
- Why natural fiber composites? Natural fiber classification – Bast fibers, Leaf fibers, Sead fibers, Fruit fibers, Wood fibers
- Fiber properties; TS & TP composites with NFs and their properties; Automotive applications.

Smart Materials:
- What are Smart Materials? Functional properties that lead to their consideration; Piezoelectric materials, Electroactive materials, Shape memory alloys (SMA), Optical fibers, Nano-composites
- What are MEMS? Uses as sensors, actuators and signaling devices in vehicles.

Nano-composites:
- Definition, Types, Mechanisms, Structure=property relationship, Basic classes – TP, TS, Elastomers and blends;
- Forms – Fibers, Foams, Film, Membranes and Paints; Geometric forms – Nanospheres (clay), Nanotubes (Single
&multi wall) & Nano fibers, and Nanoplatelets; Importance of interface between matrix and nanophase; Functionalization; Production of Nano-composites – Melt processes, Solution processes, In-situ processes and other processes; Structural characterization of Nano-composites – X-ray Diffraction, Electron microscope (SEM, TEM), Scanning probe microscopy (SPM, AFM), Spectroscopic methods (EDS, FTIR); Mechanical behaviors, Thermal response, Fire retardancy, Chemical resistance and Electrical-Magnetic-Optical properties of ploymer nano-composites; Applications and future trends – Automobiles, Coatings, Adhesives, Fire retardants, Micro-electronic packages, Optical integrated circuits, Sensors, Membranes, etc.

Text book:

Reference Books:

Course Outcome: At the end of the course, the students will be able to:

CO1: Identify the applications of PLC are to automobile assembly line.
CO2: Design PLC programs to solve industrial control problems.
CO3: Identify processes to be best done by robotics application to reduce cost and increase productivity.
CO4: Design and apply pneumatics and hydraulic circuit using computer for automated factory.


Fundamental of Manufacturing and automation:
Types of production, functions in manufacturing, production concepts and mathematical models, automation strategies.

PLC (Programmable Logic controller):
Over view and architecture, PLC programming, Application examples.

Pneumatics and Hydraulics:
Pneumatic components: Properties of air compressors-filter, regulators, Unit- Air control Valves, Quick Exhaust valves, Pneumatic actuators- Fluid Power, Circuit design, speed control circuits. Hydraulic system- sources of hydraulic power, Fluid power actuators, Pumping theory, Direction control valves, pressure control valves, Types of hydraulic cylinders.

Robotics and Robot applications:

Computer Networks for manufacturing:
Hierarchy of computers in manufacturing, local area networking, manufacturing automation protocol.

The Future automated Factory:
Trends in manufacturing, The future automated factory.

Text Books:
AE4042     AUTOMOTIVE INSTRUMENTATION SYSTEMS       Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1: Select appropriate microcomputer.
CO2: Use different sensors and actuators for various automotive systems.
CO3: Adopt the electronic engine management systems.
CO4: Adopt the electronic vehicle management and special instrumentation systems.

Prerequisites: Basic Electronics (EC-1001) & Internal Combustion Engines & Gas Turbines (ME-3003)

Introduction to microcomputer:
Microcomputer: Buses, memory, timing, CPU registers; Microprocessor architecture: Initialization, operation codes, program counter, branch and jump instructions, subroutine. Analog to digital converters and Digital to analog converters, sampling, polling and interrupts, digital filters, lookup table.

Sensors and actuators:
Speed sensors, Pressure sensors: Manifold Absolute Pressure sensor, knock sensor, Temperature sensors: Coolant and Exhaust gas temperature, Exhaust Oxygen level sensor, Position sensors: Throttle position sensor, accelerator pedal position sensor and crankshaft position sensor, Air mass flow sensor. Solenoids, stepper motors and relays.

Electronic engine management system:
Electronic engine control: Input, output and control strategies, electronic fuel control system, fuel control modes: open loop and closed loop control at various modes, EGR control, Electronic ignition systems – Spark advance correction schemes, fuel injection timing control.

Electronic vehicle management system:
Cruise control system, Antilock braking system, electronic suspension system, electronic steering control, traction control system, Transmission control, Safety: Airbags, collision avoiding system, low tire pressure warning system.

Other instrumentation systems:
Input and output signal conversion, multiplexing, fuel quantity measurement, coolant temperature and oil pressure measurement, display devices- LED, LCD, VFD and CRT, Onboard diagnostics (OBD), OBD-II, off board diagnostics, telematics, GPS navigation, the GPS system structure.

Text Book:

Reference Books:
Course Outcome: At the end of the course, the students will be able to:

CO1: Apply principles of optimization to real life problems.
CO2: Model and use design of experiments to save time and money during testing of vehicles.
CO3: Solve multivariable problems using optimization technique.

Prerequisites : Numerical Methods(MA-2004) & Industrial Engineering & Operations Research (ME-3017)

Analysis of Variance and its meaning:
One-way classification- two-way classification. Basic principles of design of experiments (replication, randomization and local control)- CRD- RBD- LSD.

Factorial experiments and their need:
Factorial Experimental Designs with out confounding (Theory and Problem only, no derivation expected).

Taguchi Approach:
Parameter Design, Robust Design

Optimal problem formulation:
Boundary phase method – Fibonacci search method

Golden section search method:
Powell’s conjugate direction method – Conjugate gradient method – Variable-metric method.

Kuhn-Trucker conditions:

Genetic algorithms (GAs):
working principle – difference between GAs and the traditional methods – GAs for constrained optimization – Simulated annealing – Global optimization: using steepest descent method and GA.

Quantitative Techniques:
Assignment, Transportation problem, Network analysis (CPM/PERT), Job sequencing, LPP (graphical & simplex), Artificial variables, dual problems, Integer programming problems .

Text Books:

Reference Books:
   Operations research, S.D. Sharma, Kedar nath Publications
Course Outcome: At the end of the course, the students will be able to:

- CO1: Apply concept of mechanical vibrating system.
- CO2: Predict and model suspension and tyre related vibrations.
- CO3: Simulate and analyze vibrations from vehicles.
- CO4: Analyze the stability and handling characteristics of vehicle at different operating conditions.
- CO5: Analyze and select suitable tires for a vehicle.

Prerequisite: Machine Dynamics (ME-2002)

Introduction:
Fundamental of vibration, Mechanical vibrating systems. Modelling and Simulation - Model of an automobile, Single, two, multi degrees of freedom systems, Free, forced and damped vibrations. Magnification factor - Transmissibility

Multi-degree of freedom systems:

Suspension and Tyres:

Vehicle Handling:
Oversteer, under steer, steady state cornering. Effect of braking, driving torques on steering. Effect of camber, transient effects in cornering.

Stability of Vehicles:
Directional stability of vehicles. Load distribution. Calculation of Tractive effort and reactions for different drives - Stability of a vehicle on a slope, on a curve and a banked road.

Text Book:

Reference Books:
Prerequisites: Basic Electrical Engineering (EE-1003) & Basic Electronics (EC-1001)

Starting System:
Condition at starting, Behavior of starter during starting, and its characteristics. Principle & construction of starter motor, working of different starter drive units, care and maintenance of starter motor. Starter Switches. Three point starter-basic construction and working principle.

Lighting System & Accessories:
Insulated & earth return systems, Positive & negative earth systems, Details of head light & side light, Headlight dazzling & preventive methods, Electrical fuel-pump, Speedometer, Fuel, oil & temperature gauges, Horn, Wiper system, Trafficator.

Automotive Electronics:
Current trends in modern automobiles Open and close loop systems- Components for electronic engine management, Electronic management of chassis system, Vehicle motion control.

Transducer:
Introduction, Mechanical spring devices, Pressure sensing primary devices, Basic requirements of transducer, Classification of transducer, Resistive transducer, Capacitive Transducer, Strain gauges, Thermistors, Thermocouples, R.V.D.T., Magnetoresistors, Magnetostrictive Transducers, Photoelectric transducer, Digital displacement transducer.

Sensors and Actuators:
Hall Effect, hot wire, thermistor, piezo electric, piezoresistive, based sensors. Introduction, basic sensor arrangement, types of sensors, oxygen concentration sensor, lambda sensor, crankshaft angular position sensor, cam position sensor, Mass air flow (MAF) rate, Manifold absolute pressure (MAP), Throttle plate angular position, engine oil pressure sensor, vehicle speed sensor, stepper motors, relays, detonation sensor, emission sensors.

Electronic Fuel Injection and Ignition Systems:
Introduction, feedback carburetor systems. Throttle body injection and multi port or point fuel injection, fuel injection systems, Injection system controls. Advantages of electronic ignition systems: Types of solid-state ignition systems and their principle of operation, Contact less electronic ignition system, and electronic spark timing control.

Digital Engine Control System:
Open loop and closed loop control systems-Engine cranking and warm up control-Acceleration enrichment-Deceleration leaning and idle speed control. Distributorless ignition-Integrated engine control systems, Exhaust emission control engineering.

Electronic Dashboard Instruments:
Onboard diagnosis system, security and warning system.

Text Books:
2. Electronics Engine Controls, Steve V. Hatch, CENGAGE Learning

Reference Books:
Course Outcome: At the end of the course, the students will be able to:

CO1: Select best promotional and advertisement strategy for new product.
CO2: Prepare questioner and conduct market survey and interpret the results.
CO3: Do market forecasting.

Prerequisites: Nil

Marketing Concepts:
Approaches to Marketing – Core concepts of marketing - Marketing Process – Functions of Marketing.

Marketing Environment:
The changing marketing environment – Analyzing needs and trends in Macro Environment and Micro Environment.

Market Segmentation:
Bases for market segmentation of consumer goods, industrial goods and services – Market Targeting and positioning strategies.

New Product Decision Process:

Marketing Mix:

Physical Distribution:
Importance and role of distribution in marketing – Introduction to the various channels of distribution – Promotion Tools – Sales Promotion, Advertising, Personal Selling, Direct Marketing and Online Marketing as promotion tools.

Pricing:

Market Evaluation and Controls:
Types, processes, obstacles to marketing control – Marketing Audit – Marketing Ethics.

Text Book:

Reference Books:
1. Marketing - Stanton, Michael Etzel, Walker (Tata)
2. Marketing Management - V.S. Ramaswamy and S. Namakumari
3. Marketing Special Indian Edition - Dhruv Grewal, Michael Levy
Course Outcome: At the end of the course, the students will be able to:

CO1: Select most suitable jigs and fixture for automotive application.
CO2: Design and prepare Jigs and fixtures for given components.

Prerequisites : Manufacturing Processes and Design (ME-3015)

Introduction: Definitions of Jigs and Fixtures, Principles of Jigs and Fixtures design, preliminary analysis and planning of Jigs and fixture parts and their materials, Basic steps in the design of jigs and fixtures and Advantages of Jigs & Fixtures.

Location and Clamping:
Degrees of freedom-3-2-1 location principle, Radial location and diamond pin location, Principle of pin location, Location from pin surfaces, location from a profile, location from a cylinder, Circular location, Jamming and remedies. Location Adjustable locators, redundant locators, fool proofing; Adjustable supports and centralizes Strap clamps, cam clamps , screw clamping, latch clamps, wedge clamps, pivoted clamps, eccentric operator clamp, power clamps, quick acting clamps, equalizers.

Loading and unloading problems:
Loading, Entering, locating and clamping, symmetric consideration. Unloading, Bur clearance, ejectors, receivers, chip problems, relief and projection, shields and seals.

Cutter Guidance:
Various types of setting blocks, Press fit bushes, Renewable bushes, Slip bushes, Threaded bushes, Special bushes, Drills with attached bushing for small holes.

Design of Jigs and Fixtures:
Three construction principles, Built-up type, casting and weldment. Practicing the various types of jigs, practicing the various types of milling fixtures, broaching fixtures, function of broaching fixtures-internal and external broaching fixtures.

Text Book:

References Books:

Course Outcome : At the end of the course, the students will be able to:

CO1: Distinguish between the terms PDM and PLM
CO2: Understand and implement basic components and functionality of a PDM system.
CO3: Use a PDM system to support and control a product realization process.
CO4: Given project, choose, configure, and adjust a PDM system to effectively support, follow up and control the project.
Prerequisite: Environmental Science (CH-1005)

Introduction:
Definition of total life cycle (TLC)-Concept of TLC-Life cycle impacts-Integrating life cycle technologies-Products and processes within TLC-TLC methodology-TLC assessment data to complex products-Results Improvement for product, Life Cycle Costing (LCC).

Vehicle End Life:
Design for end of old vehicle management –Problems of old vehicles in emerging markets-recovery and economic feasibility of materials such as Plastics, rubber aluminum, steel, etc.

Tradeoffs:
Applying life cycle thinking to define tradeoffs along the supply, manufacture-use and end of life chain-Effect on the customer- Expectation of the customer-Evaluate product cost on fuel consumption, emissions, durability, environment and health.

Sustainability:
What is sustainability-Use of renewable resources-View to design horizon. Harmonization of Environmental Goals: TLC for emerging vs. developed markets-Rules and regulations to guide designers-International common practices for end of life products.

Total quality environment (TQE):
Environmental management system (EMS), product evaluation standards, requirements of ISO 14001, environmental policy, elements of environmental planning: environmental aspects, legal and other requirements, objectives and targets, and environmental management programme.

Text Book:

Course Outcome: At the end of the course, the students will be able to:

CO1: Apply different types of Alternative fuels in Automobiles.
CO2: Test Performance of Alternative Fuels used in Automobiles.
CO3: Model of pollutant formation in engines.
CO4: Select treatment and control Techniques.

Prerequisites: Environmental Science (CH-1005) &Internal Combustion Engines & Gas Turbines(ME-3003)

Introduction:
General Scenario on automotive Pollution, Pollutants-sources-formation-effects-transient operational effects on pollution.

Engine Combustion and Pollutant Formation:
HC, CO, NOx, Particulate Matters, Aldehyde emissions, Effect of operating variables on emission formation.

Emission Control Efforts:
Supply of fuel – establishment of national test centers, construction of road networks.

Alternate Fuels:
**Emission Standards:**

**Control Techniques for SI and CI:**
Design changes, optimization of operating factors, Control of Crankcase emission, Evaporative emission, Exhaust emission - exhaust gas recirculation, air injector PCV system, thermal reactors, catalytic converters.

**Test Procedure & Instrumentation for Emission Measurement:**
Test procedures- Measurements of invisible emissions - ORSAT apparatus, NDIR analyzer, Flame ionization detectors, Chemiluminescent analyzer, Gas analyzer, Measurements of visible emissions – Comparison methods & Obsolete methods - Smoke meters, Emission standards.

**Text book:**
1. Automotive Engineering Fuels and Emissions (Classroom & Shop Manual), Ollembeak, CENGAGE Learning

**Reference Books:**

**AE4063 TOTAL QUALITY MANAGEMENT IN AUTOMOBILES Cr-3**

**Course Outcome:** At the end of the course, the students will be able to:

CO1: Implement TQM in different processes.
CO2: Select best quality practices for given organization.
CO3: Do quality audit and follow international standard.

**Prerequisite :** Engineering Metrology and Measurements (ME-2014)

**Introduction to Quality:**
Defining Quality, Quality as a Management Framework, Quality and Competitive Advantage, Quality cost, Quality losses, link between Quality and productivity.

**Tools for Quality Control:**
Basic tools of quality (the stem and leaf plot, histogram, box plot etc.), ISO 9000:2000, Six Sigma, Total quality management, introduction to total quality management, the evolution of total quality, Statistical methods for Quality control and improvement.

**Statistical Process Control:**

**Sampling Plan:**
Design of single sampling plan. Double, multiple and sequential sampling plans, O.C. curve, AOQ, AOQL.

**Reliability:**
Reliability analysis and predictions, Bath-Tub Curve, Exponential and Weibull distribution in modelling reliability, System reliability.
Experimental Design:
Experimental designs and factorial experiments: Concepts of randomization, Blocking and Confounding Single factor randomized design, ANOVA, 2 factor experiments Taguchi philosophy; Loss function; Signal to noise ratio, Orthogonal arrays for parameter and tolerance design.

Process Capability:
Process capability analysis using histogram, use and interpretation of Cp, normality and process capability ratio, process capability analysis using designed experiment.

Text Book:

Reference Books:

AE4065 ENGINE TRIBOLOGY Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1: Select triobological elements based on design considerations.
CO2: Realize the importance of proper choice of triobological elements
CO3: Apply the knowledge of wear and lubricants for different applications

Prerequisite : Machine Dynamics (ME-2002)

Surface, Friction and Wear:

Lubrication Theory:

Rolling Element Bearings:

Tribo Measurement and Instrumentation:
Engine Tribology:

Text Book:

Reference Books:
1. Friction And Wear Of Materials, Ernest Rabinowie z, Inter science Publishers, 1995
4. Friction And Lubrication Of Solids, Bowden, F.P. & Tabor, D., Oxford University Press 1986

AE4067 OFF-ROAD VEHICLES Cr-3

Course Outcome: At the end of the course, the students will be able to:

CO1: Select off road vehicles for different constructional and land preparation activities.
CO2: Do trouble shooting of off road vehicles.

Prerequisites: Machine Dynamics (ME-2002) & Internal Combustion Engines & Gas Turbines (ME-3003)

Introduction:
Classification of off road vehicles and their application Excavator: Different types of Shovel and Dragline, their construction, operating principles, operating cycles. Production capacity and cost of production.

Transport Equipment:
Various types of Dumpers, Main system, components and Carrying capacity of Dumper.

Road making and maintenance Machines:
Different types of Dozer, Grader, and their construction. Operating principles, Production capacity and application mechanism.

Other equipment:
Scraper and front end loader, their construction and operation.

Maintenance:
Maintenance aspect of Off Road vehicles.

Text Book:

Reference Books: