

**COURSES OFFERED**

**IN A.Y. 2024-25**

**FOR**

**B.E. (ELECTRICAL ENGINEERING)**

**IN ALIGNMENT WITH GAPC 4.0**



**THAPAR INSTITUTE**  
OF ENGINEERING & TECHNOLOGY  
(Deemed to be University)

## COURSE OUTCOMES AND PROGRAM OUTCOMES

### Program Outcomes (POs) for UG Program

**PO1: Engineering Knowledge:** Apply knowledge of mathematics, natural science, computing, engineering fundamentals, and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

**PO2: Problem Analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

**PO3: Design/Development of Solutions:** Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet the identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society, and environment as required. (WK5)

**PO4: Conduct Investigations of Complex Problems:** Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modeling, analysis & interpretation of data to provide valid conclusions. (WK8)

**PO5: Engineering Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

**PO6: The Engineer and The World:** Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal frameworks, culture, and the environment. (WK1, WK5 and WK7)

**PO7: Ethics:** Apply ethical principles and commit to professional ethics, human values, diversity, and inclusion; and adhere to relevant national and international laws. (WK9)

**PO8: Individual and Collaborative Team Work:** Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams. (WK9)

**PO9: Communication:** Communicate effectively and inclusively within the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, considering cultural, language, and learning differences. (WK9)

**PO10: Project Management and Finance:** Apply knowledge and understanding of the engineering management principles and economic decision-making, and apply these to one's

own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments. (WK9)

**PO11: Life-Long Learning:** Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

### **Program Specific Outcomes (PSOs) for B.E. EE Program**

**PSO1:** To design, analyse, and implement electrical systems by applying principles of mathematics, science, and engineering for industrial and societal solutions

**PSO2:** To apply modern tools and techniques to address challenges in electrical engineering, while actively engaging in lifelong learning with consideration of safety standards and sustainability goals

## **KNOWLEDGE AND ATTITUDE PROFILE (WK)**

**WK1:** A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences.

**WK2:** Conceptually-based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.

**WK3:** A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline.

**WK4:** Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.

**WK5:** Knowledge, including efficient resource use, environmental impacts, whole-life cost, re-use of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area.

**WK6:** Knowledge of engineering practice (technology) in the practice areas in the engineering discipline.

**WK7:** Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development.

**WK8:** Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.

**WK9:** Ethics, inclusive behavior and conduct. Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc. with mutual understanding and respect, and of inclusive attitudes.

## COURS OFFERED IN AY 2024-25

### Rationale:

TIET has adopted the credit system in accordance with the latest National Board of Accreditation (NBA) guidelines, wherein one academic credit corresponds to 30 hours of student learning, including both direct faculty-led instruction and self-learning (student effort) hours.

Accordingly, the credit allocation for all courses in the B.E. Electrical Engineering programme has been computed based on the total student learning hours for a 15-week semester (excluding three weeks of examinations i.e. Mid semester & End semester Exams), taking into account both contact hours and self-learning hours. The semester-wise distribution of courses and their corresponding credits is presented in the following tables.

### SEMESTER-I

| S. No. | Course Code | Course Name                | CODE | L          | T         | P         | SL         | Cr          |
|--------|-------------|----------------------------|------|------------|-----------|-----------|------------|-------------|
| 1.     | UPH013      | PHYSICS                    | BSC  | 45         | 15        | 30        | 45         | 4.5         |
| 2.     | UES101      | ENGINEERING DRAWING        | ESC  | 30         | 60        | 0         | 30         | 4.0         |
| 3.     | UHU003      | PROFESSIONAL COMMUNICATION | HSS  | 30         | 0         | 30        | 30         | 3.0         |
| 4.     | UMA022      | CALCULUS FOR ENGINEERS     | BSC  | 45         | 15        | 0         | 45         | 3.5         |
| 5.     | UES102      | MANUFACTURING PROCESSES    | ESC  | 30         | 0         | 30        | 30         | 3.0         |
| 6.     | UTA032      | BOOT CAMP                  |      | 0          | 0         | 0         | 30         | 1.0         |
|        |             | <b>TOTAL</b>               |      | <b>180</b> | <b>90</b> | <b>90</b> | <b>180</b> | <b>18.0</b> |

### SEMESTER-II

| S. No. | Course Code | Course Name                               | CODE | L          | T         | P         | SL         | Cr          |
|--------|-------------|-------------------------------------------|------|------------|-----------|-----------|------------|-------------|
| 1.     | UCB009      | CHEMISTRY                                 | BSC  | 45         | 0         | 30        | 45         | 4.0         |
| 2.     | UES103      | PROGRAMMING FOR PROBLEM SOLVING           | ESC  | 45         | 0         | 30        | 45         | 4.0         |
| 3.     | UES013      | ELECTRICAL & ELECTRONICS ENGINEERING      | ESC  | 45         | 15        | 30        | 45         | 4.5         |
| 4.     | UEN008      | ENERGY AND ENVIRONMENT                    | HSS  | 30         | 0         | 0         | 30         | 2.0         |
| 5.     | UMA023      | DIFFERENTIAL EQUATIONS AND LINEAR ALGEBRA | BSC  | 45         | 15        | 0         | 45         | 3.5         |
|        |             | <b>TOTAL</b>                              |      | <b>210</b> | <b>30</b> | <b>90</b> | <b>210</b> | <b>18.0</b> |

### SEMESTER-III

| S. No. | Course Code | Course Name                                     | CODE | L          | T         | P          | SL         | Cr          |
|--------|-------------|-------------------------------------------------|------|------------|-----------|------------|------------|-------------|
| 1.     | UMA028      | MATHEMATICS FOR DATA SCIENCE                    | BSC  | 45         | 0         | 30         | 45         | 4.0         |
| 2.     | UEE307      | TRANSMISSION AND DISTRIBUTION OF ELECTRIC POWER | PCC  | 30         | 15        | 0          | 30         | 2.5         |
| 3.     | UES301      | ANALOG CIRCUITS                                 | ESC  | 30         | 0         | 30         | 30         | 3.0         |
| 4.     | UEE301      | DIRECT CURRENT MACHINES AND TRANSFORMERS        | PCC  | 45         | 15        | 30         | 45         | 4.5         |
| 5.     | UES302      | INTRODUCTION TO MEASUREMENT SYSTEMS             | ESC  | 30         | 0         | 30         | 30         | 3.0         |
| 6.     | UTA030      | ENGINEERING DESIGN PROJECT (BUGGY)              | PRJ  | 15         | 0         | 60         | 15         | 3.0         |
| 7.     | UTD003      | APTITUDE SKILLS BUILDING                        | HSS  | 30         | 0         | 0          | 30         | 2.0         |
|        |             | <b>TOTAL</b>                                    |      | <b>225</b> | <b>30</b> | <b>180</b> | <b>225</b> | <b>22.0</b> |

### SEMESTER-IV

| S. No. | Course Code | Course Name                                  | CODE** | L              | T         | P          | SL             | Cr          |
|--------|-------------|----------------------------------------------|--------|----------------|-----------|------------|----------------|-------------|
| 1.     | UEE401      | ALTERNATING CURRENT MACHINES                 | PCC    | 45             | 15        | 30         | 45             | 4.5         |
| 2.     | UTA018      | OBJECT ORIENTED PROGRAMMING                  | ESC    | 45             | 0         | 30         | 45             | 4.0         |
| 3.     | ULC303      | COMPUTER ARCHITECTURE AND ORGANIZATION       | PCC    | 45             | 0         | 0          | 45             | 3.0         |
| 4.     | UEE409      | NETWORK THEORY                               | PCC    | 45             | 15        | 30         | 45             | 4.5         |
| 5.     | UEI501      | CONTROL SYSTEMS                              | PCC    | 45             | 15        | 30         | 45             | 4.5         |
| 6.     | UMA035      | OPTIMIZATION TECHNIQUES                      | BSC    | 45             | 0         | 30         | 45             | 4.0         |
| 7.     | UHU050      | EVOLUTIONARY PSYCHOLOGY (1 SELF EFFORT HOUR) | HSS    | 15*            | 0         | 0          | 15*            | 1.0         |
|        |             | <b>TOTAL</b>                                 |        | <b>270+15*</b> | <b>45</b> | <b>150</b> | <b>270+15*</b> | <b>25.0</b> |

\*Alternate Week

**SEMESTER-V**

| S. No. | Course Code | Course Name                            | Code | L          | T         | P          | SL         | Cr.         |
|--------|-------------|----------------------------------------|------|------------|-----------|------------|------------|-------------|
| 1      | UEI501      | CONTROL SYSTEMS                        | CP   | 45         | 15        | 30         | 45         | 4.5         |
| 2      | UTA026      | MANUFACTURING PROCESSES                | CF   | 30         | 0         | 30         | 30         | 3.0         |
| 3      | UEE509      | POWER SYSTEM ANALYSIS                  | CP   | 45         | 15        | 30         | 45         | 4.5         |
| 4      | UEE510      | HIGH VOLTAGE ENGINEERING               | CP   | 45         | 0         | 30         | 45         | 4.0         |
| 5      | UEE504      | POWER ELECTRONICS                      | CP   | 45         | 15        | 30         | 45         | 4.5         |
| 6      |             | ELECTIVE-I                             | PE   | 30         | 0         | 30         | 30         | 3.0         |
| 7      | UCS541      | FOUNDATIONS OF ARTIFICIAL INTELLIGENCE | CF   | 45         | 0         | 30         | 45         | 4.0         |
|        |             | <b>TOTAL</b>                           |      | <b>285</b> | <b>45</b> | <b>210</b> | <b>285</b> | <b>27.5</b> |

**SEMESTER-VI**

| S. No. | Course Code | Course Name                       | Code | L          | T         | P          | SL         | Cr.         |
|--------|-------------|-----------------------------------|------|------------|-----------|------------|------------|-------------|
| 1      | UCS540      | DATA STRUCTURES AND ALGORITHMS    | CP   | 45         | 0         | 30         | 45         | 4.0         |
| 2      | UEE613      | INDUSTRIAL DRIVES AND AUTOMATION  | CP   | 45         | 15        | 30         | 45         | 4.5         |
| 3      | UEE610      | POWER SYSTEM PROTECTION           | CP   | 45         | 0         | 30         | 45         | 4.0         |
| 4      | ULC402      | FUNDAMENTALS OF SIGNAL PROCESSING | CP   | 45         | 0         | 30         | 45         | 4.0         |
| 5      | UEE612      | MACHINE LEARNING TECHNIQUES       | CP   | 45         | 0         | 30         | 45         | 4.0         |
| 6      |             | ELECTIVE-II                       | PE   | 30         | 0         | 30         | 30         | 3.0         |
| 7      | UEE795      | CAPSTONE PROJECT (START)          | PR   | 1*         | 0         | 2          |            | --          |
|        |             | <b>TOTAL</b>                      |      | <b>255</b> | <b>15</b> | <b>180</b> | <b>255</b> | <b>23.5</b> |

\*Alternate week

## SEMESTER-VII

| S. No. | Course Code | Course Name                | Code | L          | T        | P          | SL         | Cr.       |
|--------|-------------|----------------------------|------|------------|----------|------------|------------|-----------|
| 1      | UEE705      | SUSTAINABLE ENERGY SYSTEMS | CP   | 30         | 0        | 30         | 30         | 3.0       |
| 2      | UEE706      | IoT AND REAL TIME SYSTEMS  | CP   | 45         | 0        | 30         | 15         | 3.0       |
| 3      |             | ELECTIVE-III               | PE   | 30         | 0        | 30         | 30         | 3.0       |
| 4      |             | GENERIC ELECTIVE           | GE   | 30         | 0        | 0          | 30         | 2.0       |
| 5      | UEE795      | CAPSTONE PROJECT           | PR   | 0          | 0        | 30         | 210        | 8.0       |
|        |             | TOTAL                      |      | <b>135</b> | <b>0</b> | <b>120</b> | <b>315</b> | <b>19</b> |

## SEMESTER-VIII

| S. No. | Course Code | Course Name                     | Code | L         | T         | P         | SL         | Cr.         |
|--------|-------------|---------------------------------|------|-----------|-----------|-----------|------------|-------------|
| 1      | UEE894      | PROJECT SEMESTER                | PR   | 0         | 0         | 0         | 450        | <b>15.0</b> |
|        |             | OR                              |      |           |           |           |            |             |
| 1      | UEE632      | POWER GENERATION AND ECONOMICS  | CP   | 45        | 15        | 0         | 45         | 3.5         |
| 2      | UEE522      | ENERGY AUDITING AND MANAGEMEN T | CP   | 45        | 15        | 0         | 45         | 3.5         |
| 3      | UEE895      | DESIGN PROJECT                  | PR   | 0         | 0         | 30        | 210        | 8.0         |
|        |             | TOTAL                           |      | <b>90</b> | <b>30</b> | <b>30</b> | <b>300</b> | <b>15</b>   |
|        |             | OR                              |      |           |           |           |            |             |
| 1      | UEE896      | START- UP SEMESTER              | PR   | 0         | 0         | 0         | 450        | <b>15.0</b> |

## SEMESTER-I

| UPH013: Physics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |    |    |    |    |     |
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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | L  | T  | P  | SL | Cr  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 45 | 15 | 30 | 45 | 4.5 |
| <p><b>Course Objective:</b> To introduce the student to the basic physical laws of oscillators, acoustics of buildings, ultrasonics, electromagnetic waves, wave optics, lasers, and quantum mechanics and demonstrate their applications in technology. To introduce the student to measurement principles and their application to investigate physical phenomena</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |    |    |    |    |     |
| <p><b>Syllabus</b></p> <p><b>Oscillations and Waves:</b> Oscillatory motion and damping, Applications - Electromagnetic damping – eddy current; <b>Acoustics:</b> Reverberation time, absorption coefficient, Sabine's and Eyring's formulae (Qualitative idea), Applications - Designing of hall for speech, concert, and opera; <b>Ultrasonics:</b> Production and Detection of Ultrasonic waves, Applications - green energy, sound signaling, dispersion of fog, remote sensing, Car's airbag sensor.</p> <p><b>Electromagnetic Waves:</b> Scalar and vector fields; Gradient, divergence, and curl; Stokes' and Green's theorems; Concept of Displacement current; Maxwell's equations; Electromagnetic wave equations in free space and conducting media, Application - skin depth.</p> <p><b>Optics: Interference:</b> Parallel and wedge-shaped thin films, Newton rings, Applications as Non-reflecting coatings, Measurement of wavelength and refractive index. <b>Diffraction:</b> Single and Double slit diffraction, and Diffraction grating, Applications - Dispersive and Resolving Powers. <b>Polarization:</b> Production, detection, Applications – Anti-glare automobile headlights, Adjustable tint windows. <b>Lasers:</b> Basic concepts, Laser properties, Ruby, HeNe, and Semiconductor lasers, Applications – Optical communication and Optical alignment.</p> <p><b>Quantum Mechanics:</b> Wave function, Steady State Schrodinger wave equation, Expectation value, Infinite potential well, Tunneling effect (Qualitative idea), Application - Quantum computing.</p> |    |    |    |    |     |
| <p><b>Laboratory Work</b></p> <ol style="list-style-type: none"> <li>1. Determination of damping effect on oscillatory motion due to various media.</li> <li>2. Determination of velocity of ultrasonic waves in liquids by stationary wave method.</li> <li>3. Determination of wavelength of sodium light using Newton's rings method.</li> <li>4. Determination of dispersive power of sodium-D lines using diffraction grating.</li> <li>5. Determination of specific rotation of cane sugar solution.</li> <li>6. Study and proof of Malus' law in polarization.</li> <li>7. Determination of beam divergence and beam intensity of a given laser.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |    |    |    |    |     |

8. Determination of displacement and conducting currents through a dielectric.
9. Determination of Planck's constant.

#### Micro Project:

Students will be given physics-based projects/assignments using computer simulations, etc.

#### Course Outcomes (COs)

The students will be able to:

1. understand damped and simple harmonic motion, the role of reverberation in designing a hall and generation and detection of ultrasonic waves.
2. use Maxwell's equations to describe propagation of EM waves in a medium.
3. demonstrate interference, diffraction and polarization of light.
4. explain the working principle of Lasers.
5. use the concept of wave function to find probability of a particle confined in a box.
6. perform an experiment, collect data, tabulate and report them and interpret the results with error analysis.

#### Text Books

1. Beiser, A., Concept of Modern Physics, Tata McGraw Hill (2007) 6th ed.
2. Griffiths, D.J., Introduction to Electrodynamics, Prentice Hall of India (1999) 3rd ed.
3. Jenkins, F.A. and White, H.E., Fundamentals of Optics, McGraw Hill (2001) 4th ed.

#### Reference Books

1. Wehr, M.R, Richards, J.A., Adair, T.W., Physics of The Atom, Narosa Publishing House (1990) 4th ed.
2. Verma, N.K., Physics for Engineers, Prentice Hall of India (2014) 1st ed.
3. Pedrotti, Frank L., Pedrotti, Leno S., and Pedrotti, Leno M., Introduction to Optics, Pearson Prentice HallTM (2008) 3rd ed.

| CO MAPPING WITH PO and PSO |         |         |         |         |         |         |         |         |         |          |          |          |          |
|----------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|----------|----------|----------|----------|
| CO/P<br>O                  | PO<br>1 | PO<br>2 | PO<br>3 | PO<br>4 | PO<br>5 | PO<br>6 | PO<br>7 | PO<br>8 | PO<br>9 | PO1<br>0 | PO1<br>1 | PSO<br>1 | PSO<br>2 |
| CO1                        | 3       | -       | 2       | -       | -       | -       | -       | -       | -       | -        | -        | 2        | -        |
| CO2                        | 3       | -       | 2       | -       | -       | -       | -       | -       | -       | -        | -        | 2        | -        |
| CO3                        | 3       | -       | -       | -       | -       | -       | -       | -       | -       | -        | -        | 2        | -        |
| CO4                        | 3       | -       | -       | -       | -       | -       | -       | -       | -       | -        | -        | 2        | -        |
| CO5                        | 3       | -       | -       | -       | -       | -       | -       | -       | -       | -        | -        | 2        | -        |
| CO6                        | -       | 1       | -       | 1       | 3       | -       | -       | -       | -       | -        | -        | 1        | 3        |

| CO MAPPING WITH WK |     |     |     |     |     |     |     |     |     |
|--------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| CO/WK              | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |
| CO1                | ✓   | ✓   |     |     |     |     |     |     |     |
| CO2                | ✓   | ✓   |     |     |     |     |     |     |     |
| CO3                | ✓   | ✓   |     |     |     |     |     |     |     |
| CO4                | ✓   | ✓   |     |     |     |     |     |     |     |
| CO5                | ✓   | ✓   |     |     |     |     |     |     |     |
| CO6                | ✓   | ✓   | ✓   | ✓   |     | ✓   |     | ✓   |     |

#### Evaluation Scheme

| Sr. No. | Evaluation elements                                                                                                                                        | Weightage (%) |
|---------|------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| 1       | MST                                                                                                                                                        | 25-30         |
| 2       | EST                                                                                                                                                        | 40-45         |
| 3       | Sessional: (May include the following)<br>Assignment, Sessional (Includes Regular Lab assessment and Quizzes Project (Including report, presentation etc.) | 30            |

## UES101: Engineering Drawing

|    |    |   |    |     |
|----|----|---|----|-----|
| L  | T  | P | SL | Cr  |
| 30 | 60 | 0 | 30 | 4.0 |

**Course Objective:** This module is dedicated to graphics and includes two sections: 2D drafting and 3D modelling of solid objects. This course is aimed at making the student understand the concepts of projection systems, learn how to create projections of solid objects using first and third angle orthographic projection as well as isometric and auxiliary projection, concept of sectioning, to interpret the meaning and intent of toleranced dimensions and to create/edit drawings using drafting software. In addition, this course shall

give an insight on the basic 3D modelling concepts like extrude, revolve, sweep, construction of complex solids.

### Syllabus

#### ***Engineering Drawing Concepts***

1. Introduction to Engineering Drawing
2. Projection systems: First angle and third angle projection system
3. Orthographic Projection: Points, Lines, Solid objects
4. Isometric Projections
5. Auxiliary Projections
6. Development of surfaces
7. Section of solids
8. Limits, fits and tolerances

#### ***2D Drafting***

1. Management of screen menus commands
2. Creating basic drawing entities
3. Co-ordinate systems: Cartesian, polar and relative coordinates
4. Drawing limits, units of measurement and scale
5. Layering: organizing and maintaining the integrity of drawings
6. Design of prototype drawings as templates.
7. Editing/modifying drawing entities: selection of objects, object snap modes, editing commands,
8. Dimensioning: use of annotations, dimension types, properties and placement, adding text to drawing

#### ***3D Modelling***

1. Management of screen menus commands
2. Introduction to basic 3D modelling commands such as extrude, revolve, sweep etc.
3. Creation of 2D drawings from a 3D model

#### ***Micro Projects /Assignments:***

1. Completing the views - Identification and drawing of missing lines and views in the projection of objects

2. Projects related to orthographic and isometric projections Using wax blocks/soap bars/any soft material to develop three dimensional object from given orthographic projections
3. a. 3D modelling of complex machine components  
b. Development of production drawings of individual components from the model

### Course Outcomes (COs)

The students will be able to:

1. creatively comprehend the geometrical details of common engineering objects
2. draw dimensioned orthographic and isometric projections of simple engineering objects
3. interpret the meaning and intent of limits, fits and tolerances in the drawing
4. create/edit the engineering drawings for simple engineering objects using 2D drafting software
5. create/edit 3D models of engineering components using 3D modelling software

### Text Books

1. Jolhe, D.A., Engineering Drawing, Tata McGraw Hill, 2008
2. Davies, B. L., Yarwood, A., Engineering Drawing and Computer Graphics, Van Nostrand Reinhold (UK), 1986

### Reference Books

1. Gill, P.S., Geometrical Drawings, S.K. Kataria & Sons, Delhi (2008).
2. Gill, P.S., Machine Drawings, S.K. Kataria & Sons, Delhi (2013).
3. Mohan, K.R., Engineering Graphics, Dhanpat Rai Publishing Company (P) Ltd, Delhi (2002).
4. French, T. E., Vierck, C. J. and Foster, R. J., Fundamental of Engineering Drawing & Graphics Technology, McGraw Hill Book Company, New Delhi (1986).
5. Rowan, J. and Sidwell, E. H., Graphics for Engineers, Edward Arnold, London (1968).
6. Mastering AutoCAD 2021 and AutoCAD LT 2021, Brian C. Benton, George Omura, Sybex - John Wiley and Sons, Indiana (2021).

### CO MAPPING WITH PO and PSO

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PSO 1 | PSO 2 |
|-------|------|------|------|------|------|------|------|------|------|------|------|-------|-------|
| CO1   | 3    | 2    | -    | -    | -    | -    | -    | 3    | -    | -    | -    | -     | -     |
| CO2   | 3    | 2    | -    | -    | -    | -    | -    | 3    | -    | -    | -    | -     | -     |
| CO3   | 3    | 2    | -    | -    | -    | -    | -    | 1    | -    | -    | -    | -     | -     |
| CO4   | -    | 2    | -    | -    | 3    | -    | -    | -    | -    | -    | -    | -     | 2     |
| CO5   | -    | 2    | -    | -    | 3    | -    | -    | -    | -    | -    | -    | -     | 2     |

|     |   |   |   |   |   |   |   |   |   |   |   |   |   |
|-----|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO6 | - | 2 | - | - | 3 | - | - | - | - | - | - | - | 2 |
|-----|---|---|---|---|---|---|---|---|---|---|---|---|---|

#### CO MAPPING WITH WK

| CO/WK | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| CO1   |     |     | ✓   |     |     |     |     |     |     |
| CO2   |     |     | ✓   |     |     |     |     |     |     |
| CO3   |     |     | ✓   |     |     |     |     |     |     |
| CO4   |     |     |     |     |     | ✓   |     |     |     |
| CO5   |     |     |     |     |     | ✓   |     |     |     |
| CO6   |     |     |     |     |     | ✓   |     |     |     |

#### Evaluation Scheme

| Course Component                           | Weightage |
|--------------------------------------------|-----------|
| AutoCAD tutorials/SolidWorks/Project work* | 35        |
| MST (1.5 hours-CAD based)**                | 20        |
| EST (2 hours-CAD based)**                  | 45        |

***\*Students are required to bring their personal computers for the tutorial work.***

***\*Availability of institute server resources for sharing the software licences with the student community.***

***\*\*Institute computational resources in collaboration with other academic units / departments for conducting the mid semester and end semester test.***

| UHU003: Professional Communication                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |   |                                                                                                                                              |    |     |  |   |   |   |    |    |    |   |    |    |     |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|----------------------------------------------------------------------------------------------------------------------------------------------|----|-----|--|---|---|---|----|----|----|---|----|----|-----|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |   |                                                                                                                                              |    |     |  |   |   |   |    |    |    |   |    |    |     |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |   | <table><tr><td>L</td><td>T</td><td>P</td><td>SL</td><td>Cr</td></tr><tr><td>30</td><td>0</td><td>30</td><td>30</td><td>3.0</td></tr></table> |    |     |  | L | T | P | SL | Cr | 30 | 0 | 30 | 30 | 3.0 |
| L                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | T | P                                                                                                                                            | SL | Cr  |  |   |   |   |    |    |    |   |    |    |     |
| 30                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 0 | 30                                                                                                                                           | 30 | 3.0 |  |   |   |   |    |    |    |   |    |    |     |
| <p><b>Course Objective:</b> The course is designed to develop the interpersonal, written, and oral as well as the non- verbal communication skills of the students. The course begins by building up on the theoretical concepts and then practicing on the applicability of the various elements. Since the course has very high applicability content, the students are advised to practice in class as well as off class. A very high level of interaction is expected of the students in the class.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |   |                                                                                                                                              |    |     |  |   |   |   |    |    |    |   |    |    |     |
| <p><b>Syllabus</b></p> <p><b>Fundamentals of Communication:</b> Meaning, Types and Characteristics of communication, Applicability of Transactional Analysis and Johari Window for enhancing interpersonal communication skills. Seven Cs of Effective Communication, Barriers to Effective Communication.</p> <p><b>Effective Oral Communication:</b> Understanding Principles of Oral communication, Formal and Informal Oral Communication, Oral Communication and Behavioral Patterns, Advantages and Disadvantages of Oral Communication.</p> <p><b>Effective Listening:</b> Listening vs Hearing, Active Listening techniques, Barriers to Listening.</p> <p><b>Effective non-verbal communication:</b> Meaning and Importance of Non-Verbal Communication, Different Types of Non-verbal Communication, Interpretation of Non-verbal Cues.</p> <p><b>Effective written Communication:</b> Characteristics of Good Writing, Choice of Words, Sentence Construction, Paragraph development, Forms of writing.</p> <p><b>Business Communication:</b> Technical Report Writing, Designing Resumes and Cover Letters for effective job application, E-mail writing and e-mail etiquette.</p> <p><b>Organizational Communication:</b> Directional communication: Downward, Upward and Horizontal Communication, Grapevine.</p> <p><b>Reading:</b> The following texts (one from each of the two categories listed below) are required to be read by the students in the semester:</p> <p><b>Category 1:</b> Animal Farm by George Orwell, Lord of the Flies by William Golding, Life of Pi by Yann Martel</p> <p><b>Category 2:</b> The Namesake by Jhumpa Lahiri, The God of Small Things by Arundhati Roy, Q&amp;A by Vikas Swarup</p> |   |                                                                                                                                              |    |     |  |   |   |   |    |    |    |   |    |    |     |
| <p><b>Laboratory Work</b></p> <p>1. Needs-assessment of spoken and written communication with feedback.</p> <p>2. Training for Group Discussions through simulations and role plays.</p> <p>3. Technical report writing on survey-based projects.</p> <p>4. Project-based team presentations.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |                                                                                                                                              |    |     |  |   |   |   |    |    |    |   |    |    |     |
| <p><b>Course Outcomes (COs)</b></p> <p>The students will be able to:</p> <p>1. Apply communication concepts for effective interpersonal communication.</p> <p>2. Speak assertively and effectively.</p> <p>3. Interpret non-verbal cues in professional communication.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |   |                                                                                                                                              |    |     |  |   |   |   |    |    |    |   |    |    |     |

4. Write objectively, purposefully and effectively.
5. Design effective resumes and reports.

#### Text Books

1. Mukherjee H.S..Business Communication: Connecting at Work. Oxford University Press.(2013)
2. Lesikar R.V, and Flatley M.E., Basic Business Communication Skills for empowering the internet generation.(2006)
3. Raman, M.,and Singh ,P, Business Communication . Oxford. University Press (2008).

#### CO MAPPING WITH PO and PSO

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO1 0 | PO1 1 | PSO 1 | PSO 2 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|
| CO1   | -    | -    | -    | -    | -    | -    | -    | -    | 3    | -     | 3     | -     | 3     |
| CO2   | -    | -    | -    | -    | -    | -    | -    | -    | 3    | -     | 3     | -     | 3     |
| CO3   | -    | -    | -    | -    | -    | -    | -    | -    | 3    | -     | 3     | -     | 3     |
| CO4   | -    | -    | -    | -    | -    | -    | -    | -    | 2    | 3     | 3     | -     | 3     |
| CO5   | -    | -    | -    | -    | -    | -    | -    | -    | 2    | 3     | 3     | -     | 3     |

#### CO MAPPING WITH WK

| CO/WK | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| CO1   |     |     |     |     |     |     |     |     | ✓   |
| CO2   |     |     |     |     |     |     |     |     | ✓   |
| CO3   |     |     |     |     |     |     |     |     | ✓   |
| CO4   |     |     |     |     |     |     |     |     | ✓   |
| CO5   |     |     |     |     |     |     |     |     | ✓   |

#### Evaluation Scheme

| Sr. No. | Evaluation elements                                                                                                                                        | Weightage (%) |
|---------|------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| 1       | MST                                                                                                                                                        | 25-30         |
| 2       | EST                                                                                                                                                        | 40-45         |
| 3       | Sessional: (May include the following)<br>Assignment, Sessional (Includes Regular Lab assessment and Quizzes Project (Including report, presentation etc.) | 30            |

**UMA022: CALCULUS FOR ENGINEERS**

|    |    |   |    |     |
|----|----|---|----|-----|
| L  | T  | P | SL | Cr  |
| 45 | 15 | 0 | 45 | 3.5 |

**Course Objective:** To provide students with skills and knowledge in sequence and series, advanced calculus, calculus of several variables and complex analysis which would enable them to devise solutions for given situations they may encounter in their engineering profession.

**Syllabus**

**Sequences and Series:** Introduction to sequences and infinite series, Tests for convergence/divergence, Limit comparison test, Ratio test, Root test, Cauchy integral test, Alternating series, Absolute convergence, and conditional convergence.

**Series Expansions:** Power series, Taylor series, Convergence of Taylor series, Error estimates, Term by term differentiation and integration.

**Partial Differentiation:** Functions of several variables, Limits and continuity, Chain rule, Change of variables, Partial differentiation of implicit functions, Directional derivatives and its properties, Maxima and minima by using second order derivatives.

**Multiple Integrals:** Double integral (Cartesian), Change of order of integration in double integral, Polar coordinates, Graphing of polar curves, Change of variables (Cartesian to polar), Applications of double integrals to areas and volumes, Evaluation of triple integral (Cartesian).

**Complex analysis:** Introduction to complex numbers, Geometrical interpretation, Functions of complex variables, Examples of elementary functions like exponential, trigonometric and hyperbolic functions, Elementary calculus on the complex plane (limits, continuity, differentiability), Cauchy – Riemann equations, Analytic functions, Harmonic functions.

**Course Outcomes (COs)**

The students will be able to:

1. determine the convergence/divergence of infinite series, approximation of functions using power and Taylor's series expansion and error estimation.
2. examine functions of several variables, define and compute partial derivatives, directional derivatives, and their use in finding maxima and minima in some engineering problems.
3. evaluate multiple integrals in Cartesian and Polar coordinates, and their applications to engineering problems.
4. represent complex numbers in Cartesian and Polar forms and test the analyticity of complex functions by using Cauchy – Riemann equations.

**Text Books**

1. Thomas, G.B. and Finney, R.L., Calculus and Analytic Geometry, Pearson Education (2007), 9th ed.
2. Stewart James, Essential Calculus; Thomson Publishers (2007), 6th ed.
3. Kasana, H.S., Complex Variables: Theory and Applications, Prentice Hall India, 2005 (2nd edition).

**CO MAPPING WITH PO and PSO**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PSO 1 | PSO 2 |
|-------|------|------|------|------|------|------|------|------|------|------|------|-------|-------|
| CO1   | 2    | -    | -    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     |
| CO2   | 2    | 2    | -    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     |
| CO3   | 2    | 2    | 2    | 2    | -    | -    | -    | -    | -    | -    | -    | 2     | -     |
| CO4   | 3    | -    | -    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     |

**CO MAPPING WITH WK**

| CO/WK | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| CO1   |     | ✓   |     |     |     |     |     |     |     |
| CO2   |     | ✓   |     |     |     |     |     |     |     |
| CO3   |     | ✓   |     |     |     |     |     |     |     |
| CO4   |     | ✓   |     |     |     |     |     |     |     |

**Evaluation Scheme**

| Sr. No. | Evaluation elements                                                                                                                                        | Weightage (%) |
|---------|------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| 1       | MST                                                                                                                                                        | 25-30         |
| 2       | EST                                                                                                                                                        | 40-45         |
| 3       | Sessional: (May include the following)<br>Assignment, Sessional (Includes Regular Lab assessment and Quizzes Project (Including report, presentation etc.) | 30            |

## UES102: Manufacturing Processes

| L  | T | P  | SL | Cr  |
|----|---|----|----|-----|
| 30 | 0 | 30 | 30 | 3.0 |

**Course Objective:** This course introduces the basic concepts of manufacturing via machining, forming, casting and joining, enabling the students to develop a basic knowledge of the mechanics, operation and limitations of basic machining tools along with metrology and measurement of parts. The course also introduces the concept of smart manufacturing.

### Syllabus

**Machining Processes:** Principles of metal cutting, Cutting tools, Cutting tool materials and applications, Geometry of single point cutting tool, Introduction to computerized numerical control (CNC) machines, G and M code programming for simple turning and milling operations, introduction of canned cycles.

**Metal Casting:** Introduction & Principles of sand casting, Requisites of a sound casting, Permanent mold casting processes, casting defects

**Metal Forming:** Hot & cold metal working, Forging, Rolling, Sheet Metal operations.

**Joining Processes:** Method of joining, type of electric arc welding processes, Methods of shielding, Power source characteristics, Resistance welding, Soldering, Brazing.

**Smart Manufacturing:** IoT and ML in manufacturing, Introduction to Additive Manufacturing, Robotics and Automation in manufacturing.

### Laboratory Work

Relevant shop floor exercises involving practices in Sand casting, Machining, Welding, Sheet metal fabrication techniques, CNC turning and milling exercises, Experiments on basic engineering metrology and measurements to include measurements for circularity, ovality, linear dimensions, profiles, radius, angular measurements, measurement of threads, surface roughness.

Basic knowledge and derivations related to above measurements, uncertainties, statistical approaches to estimate uncertainties, Line fitting, static and dynamic characteristics of instruments will be discussed in laboratory classes.

**Assignments:** Assignments for this course will include the topics: Manufacturing of micro-chips used in IT and electronics industry and use of touch screens. Another assignment will be given to practice numerical exercises on topics listed in the syllabus. Case study related to smart manufacturing.

**Micro Project:** Fabrication of multi-operational jobs using the above processes as per requirement by teams consisting of 4 -6 members. Quality check should be using the equipment available in metrology lab.

**Course Outcomes (COs)**

The students will be able to:

1. identify & analyse various machining processes/operations for manufacturing of industrial components
2. apply the basic principle of bulk and sheet metal forming operations
3. apply the knowledge of metal casting for different requirements.
4. identify and analyse the requirements to for achieving a sound welded joint apply the concept of smart manufacturing

**Text Books**

1. Degarmo, E. P., Kohser, Ronald A. and Black, J. T., Materials and Processes in Manufacturing, Prentice Hall of India (2008) 8<sup>th</sup> ed.
2. Kalpakjian, S. and Schmid, S. R., Manufacturing Processes for Engineering Materials, Dorling Kingsley (2006) 4<sup>th</sup> ed.

**CO MAPPING WITH PO and PSO**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PSO 1 | PSO 2 |
|-------|------|------|------|------|------|------|------|------|------|------|------|-------|-------|
| CO1   | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | 2    | 2    | -     | -     |
| CO2   | 3    | 2    | -    | -    | -    | -    | 2    | -    | -    | 2    | 2    | 2     | -     |
| CO3   | 3    | 2    | -    | -    | -    | -    | 2    | -    | -    | 2    | 2    | 2     | -     |
| CO4   | 3    | 2    | -    | -    | -    | -    | 2    | -    | -    | 2    | 2    | 2     | -     |

**CO MAPPING WITH WK**

| CO/WK | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| CO1   |     | ✓   | ✓   |     |     |     |     | ✓   |     |
| CO2   |     | ✓   | ✓   |     |     |     |     | ✓   |     |
| CO3   |     | ✓   | ✓   |     |     |     |     | ✓   |     |
| CO4   |     | ✓   | ✓   |     |     |     |     | ✓   |     |

**Evaluation Scheme**

| Sr. No. | Evaluation elements                    | Weightage (%) |
|---------|----------------------------------------|---------------|
| 1       | MST                                    | 25-30         |
| 2       | EST                                    | 40-45         |
| 3       | Sessional: (May include the following) | 30            |

|  |  |                                                                                                                        |  |  |
|--|--|------------------------------------------------------------------------------------------------------------------------|--|--|
|  |  | Assignment, Sessional (Includes Regular Lab<br>assessment and Quizzes Project (Including report,<br>presentation etc.) |  |  |
|--|--|------------------------------------------------------------------------------------------------------------------------|--|--|

## SEMESTER-II

### UCB009: Chemistry

| L  | T | P  | SL | Cr  |
|----|---|----|----|-----|
| 45 | 0 | 30 | 45 | 4.0 |

**Course Objective:** The course aims at elucidating principles of applied chemistry in industrial systems, water treatment, engineering materials, computational and analytical techniques.

#### Syllabus

**Atomic and Molecular spectroscopy:** Introduction to spectroscopy, principles of atomic absorption, flame emission spectrophotometry and ICP-AES (Inductively Coupled Plasma- Atomic Emission Spectroscopy), Quantification by calibration method, Jablonski diagram, fluorescence and phosphorescence, Beer-Lambert's Law, principle and applications of UV-Vis and IR spectroscopy.

**Electrochemistry:** Background of electrochemistry, Ionic mobility, Conductometric titrations, Modern Batteries: Pb-acid and Li ion battery, Corrosion and its protection.

**Water Treatment and Analysis:** Physiochemical parameters of water quality, External and internal methods of Softening of water: carbonate, phosphate, calgon and colloidal conditioning, Zeolite process, Ion exchange process, treatment of water for domestic use, Desalination of brackish water: Reverse osmosis & Electrodialysis.

**Fuels:** Classification of fuels, Calorific value, Cetane and Octane number, alternative fuels: biodiesel, Power alcohol, synthetic petrol, Fuel cells: H<sub>2</sub> production and storage, Water splitting, Rocket propellant.

**Chemistry of Polymers:** Classification of polymers, tacticity of polymers, molecular weight calculations, Polymers in daily life, conducting, inorganic and biodegradable polymers.

**Computers in Chemistry:** Introduction to SMILES (Simplified Molecular Input Line-Entry System): Methodology and encoding rules, SMILES notation-chemical structure interconversions and its applications.

#### Laboratory Work

Electrochemical measurements: Experiments involving use of pH meter, conductivity meter, potentiometer, Spectroscopic technique, Volumetric titrations: Determination of mixture of bases, hardness, alkalinity, chloride and iron content, Application of polymers and SMILES Language.

#### Course Outcomes (COs)

The students will be able to:

1. recognize principles and applications of atomic and molecular spectroscopy.
2. explain the concepts of conductometric titrations, modern batteries and corrosion.

3. apply and execute water quality parameter and treatment methods.
4. discuss the concept of alternative fuels, application of polymers and SMILES.
5. execute laboratory techniques like pH metry, potentiometry, spectrophotometry, conductometry and volumetry.

#### Text Books

1. Engineering Chemistry, S. Vairam and S. Ramesh, Wiley India 1st ed, 2014.
2. Engineering Chemistry, K. S. Maheswaramma, and M. Chugh. Pearson, 2016.

#### CO MAPPING WITH PO and PSO

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PSO 1 | PSO 2 |
|-------|------|------|------|------|------|------|------|------|------|------|------|-------|-------|
| CO1   | 3    | 2    | -    | -    | -    | 1    | -    | -    | -    | -    | -    | 2     | -     |
| CO2   | 3    | 2    | -    | -    | -    | 1    | -    | -    | -    | -    | -    | 2     | -     |
| CO3   | 3    | 2    | -    | -    | -    | 1    | -    | -    | -    | -    | -    | 2     | -     |
| CO4   | 3    | 2    | -    | -    | 3    | 1    | -    | -    | -    | -    | -    | 2     | -     |
| CO5   | 3    | 2    | -    | -    | 3    | 1    | -    | -    | -    | -    | -    | -     | 2     |

#### CO MAPPING WITH WK

| CO/WK | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| CO1   | ✓   |     |     |     |     |     |     |     |     |
| CO2   | ✓   |     |     |     | ✓   |     |     |     |     |
| CO3   | ✓   |     |     |     | ✓   |     |     |     |     |
| CO4   | ✓   |     |     |     | ✓   |     |     |     |     |
| CO5   | ✓   |     |     |     |     |     |     |     |     |

#### Evaluation Scheme

| Sr. No. | Evaluation elements                                                                                                                                        | Weightage (%) |
|---------|------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| 1       | MST                                                                                                                                                        | 25-30         |
| 2       | EST                                                                                                                                                        | 40-45         |
| 3       | Sessional: (May include the following)<br>Assignment, Sessional (Includes Regular Lab assessment and Quizzes Project (Including report, presentation etc.) | 30            |

| UES103: Programming for Problem Solving                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |  |  |    |   |    |     |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|--|----|---|----|-----|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |  |  | L  | T | P  | SL  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |  |  | 45 | 0 | 30 | 45  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |  |  |    |   |    | Cr  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |  |  |    |   |    | 4.0 |
| <p><b>Course Objectives:</b> This course is designed to solve and explore the problems using the art of computer programming with the help of C Language. Students will be able to apply these problem solving concepts in real life applications.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |  |  |    |   |    |     |
| <p><b>Syllabus</b></p> <p><b>Introduction to Computer Fundamentals-</b> Computer Memory Hierarchy, Types of Software Binary number system, Algorithm, Flowchart, Formulate simple algorithms for logical and arithmetic problems.</p> <p><b>Basics of C Programming:</b> Structure and Life cycle of a C Program, Data types, Identifiers, Variables, Keywords, Constants, input/output statements, Operators, Type conversion and type casting. Translate the algorithms to code snippets.</p> <p><b>Decision Making and Iterative Statements- Decision making-</b> if, if-else, Nested if-else, Multiple if, else if, switch, Ternary Operator, <b>Loops-</b> (while, do-while, for), Nesting of Loops, break, continue and goto. Implement the switch () to solve the basic functions of scientific calculator.</p> <p><b>Functions:</b> Function prototype, Definition and Call, Type of Functions, Scope of variables in (Block, Function, Program, File), Storage classes (Auto, Register, Static and Extern), Recursion (with the introduction of Stack), Implementation of recursion to solve the problem of Tower of Hanoi.</p> <p><b>Arrays and Strings-</b> One-dimensional array its operations (Traversal, Linear Search, Insertion, Deletion, Bubble Sort), Two-dimensional and its operations (Addition, Transpose and Multiplication), Passing of array into a function (row and entire array), Input and output of a string, string inbuilt functions, 2-D Character array.</p> <p><b>Pointers:</b> Introduction to Pointers, Pointer arithmetic, Passing arguments to a function using pointer (understanding of call by value and call by reference), Accessing arrays using pointers Dynamic memory allocation (malloc(), calloc(), realloc() and free()), Pointer and Functions.</p> <p><b>Structures and Union:</b> Structure declaration, Initialization of structures, Structure variables, Accessing structure elements using (.) operator, Array of structure variables, Passing structure variable to a function (individual and entire structure), Structure pointer, Comparison of Structure and Union.</p> <p><b>File Handling:</b> Introduction of Files (streams in C), using File (Declaring, Opening and Closing), Operations on File (Reading, Writing and appending), and Random Access of a file, command line argument.</p> |  |  |    |   |    |     |
| <p><b>Laboratory Work</b></p> <p>To implement programs for various kinds of real life applications in C Language.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |  |  |    |   |    |     |

**Course Outcomes (COs)**

On completion of this course, the students will be able to:

1. Comprehend and analyze the concepts of number system, memory, compilation and debugging of the programs in C language.
2. Analyze the control & iterative statements to solve the problems with C language source codes.
3. Design and create programs for problem solving involving arrays, strings and pointers.
4. Evaluate and analyze the programming concepts based on user define data types and filehandling using C language.

**Text Books**

1. C Programming Language, Brian W. Kernighan Dennis M. Ritchie, 2<sup>nd</sup> ed, 2012.
2. Programming in ANSI C, Balagurusamy G., 8<sup>th</sup> ed., 2019

**CO MAPPING WITH PO and PSO**

| CO/P<br>O | PO<br>1 | PO<br>2 | PO<br>3 | PO<br>4 | PO<br>5 | PO<br>6 | PO<br>7 | PO<br>8 | PO<br>9 | PO1<br>0 | PO1<br>1 | PSO<br>1 | PSO<br>2 |
|-----------|---------|---------|---------|---------|---------|---------|---------|---------|---------|----------|----------|----------|----------|
| CO1       | 3       | 2       | -       | -       | 3       | -       | -       | 3       | 2       | -        | 2        | 3        | 3        |
| CO2       | 3       | 2       | -       | -       | 3       | -       | -       | 3       | 2       | -        | 2        | 3        | 3        |
| CO3       | 3       | 2       | 3       | 3       | 2       | -       | -       | 3       | 2       | -        | 2        | 3        | 3        |
| CO4       | 3       | 2       | 2       | 2       | 2       | -       | -       | 3       | 2       | -        | 2        | 3        | 3        |

**CO MAPPING WITH WK**

| CO/WK | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| CO1   |     | ✓   | ✓   |     |     | ✓   |     |     |     |
| CO2   |     | ✓   | ✓   |     |     | ✓   |     |     |     |
| CO3   |     | ✓   | ✓   |     |     | ✓   |     |     |     |
| CO4   |     | ✓   | ✓   |     |     | ✓   |     |     |     |

**Evaluation Scheme**

| Sr. No. | Evaluation elements | Weightage (%) |
|---------|---------------------|---------------|
| 1       | MST                 | 25-30         |
| 2       | EST                 | 40-45         |

|   |                                                                                                                                                                  |    |
|---|------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| 3 | Sessional: (May include the following)<br>Assignment, Sessional (Includes Regular Lab<br>assessment and Quizzes Project (Including report,<br>presentation etc.) | 30 |
|---|------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|

**UES013: Electrical and Electronics Engineering**

|    |    |    |    |     |
|----|----|----|----|-----|
| L  | T  | P  | SL | Cr  |
| 45 | 15 | 30 | 45 | 4.5 |

**Course Objective:** To introduce the basic concepts of electrical and electronics engineering.

**Syllabus:**

**DC Circuits:** Introduction to circuit elements; rms and average values for different wave shapes, independent and dependent current and voltage sources; Kirchhoff's laws; mesh and node analysis; source transformations; network theorems: Superposition theorem, Thevenin's and Norton's theorem, Maximum power transfer theorem; star-delta transformation; steady state and transient response of R-L and R-C and R-L-C circuits.

**AC Circuits:** Concept of phasor, phasor representation of circuit elements; analysis of series and parallel AC circuits; concept of real, reactive and apparent powers; resonance in RLC series and parallel circuits; balanced three phase circuits: voltage, current and power relations for star and delta arrangement; analysis of balanced and unbalanced circuits; three phase power measurement using two-wattmeter and one-wattmeter methods.

**Magnetic circuits:** analogy between electric and magnetic circuits; series and parallel magnetic circuits; operating principles of electrical appliances: single-phase transformer and rotating machines; tests and performance of single-phase transformer.

**Digital Logic Design:** Digital signals, Number systems, Positive and negative representation of numbers, Signed-number representation, Binary arithmetic, Postulates and theorems of Boolean Algebra, Algebraic simplification, Sum of products and product of sums formulations (SOP and POS), Gate primitives, Logic Gates and Universal Gates, Minimization of logic functions, Karnaugh Maps, Logic implementation using Gates, Decoder, MUX, Flip-Flops, Asynchronous up/down counters.

**Electronic Devices:** p- n junction diode: V-I characteristics of diode, Operation of Bipolar Junction Transistor, CB and CE configuration, Transistor as a switch, Operation of SCR, DIAC and TRIAC.

**Operational Amplifier Circuits:** The ideal operational amplifier, the inverting, non-inverting amplifiers, Op-Amp Characteristics, Applications of Op-amp: summing amplifier, differentiator and integrator.

**Laboratory Work:** Kirchhoff's laws, network theorems, ac series and parallel circuit, three phase power measurement, magnetic circuit, tests on transformer, resonance in AC circuit, combinational circuits, flip flops, shift register and binary counters, asynchronous and synchronous up/down counters, BJT characteristics.

**Course Outcomes (COs)**

After completion of this course, the students will be able to:

1. Apply various networks laws and theorems to solve dc circuits
2. Compute different ac quantities with phasor representation
3. Comprehend the operation in magnetic circuits, single phase transformer and rotating machines
4. Recognize and apply the number systems and Boolean algebra.
5. Reduce and simplify Boolean expressions and implement them with logic gates.
6. Discuss and explain the working of diode, transistor and operational amplifier, their configurations and applications.

**Text Books**

1. Hughes, E., Smith, I.M., Hiley, J. and Brown, K., Electrical and Electronic Technology, Prentice Hall (2008) 10th ed.

2. Nagrath, I.J. and Kothari, D.P., Basic Electrical Engineering, Tata McGraw Hill (2002).
3. Boylestad, R.L. and Nashelsky, L., Electronic Devices & Circuit Theory, Pearson (2009).
4. Mano M. M. and Ciletti, M.D., Digital Design, Pearson, Prentice Hall, (2013).

#### Reference Books

1. Chakraborti, A., Basic Electrical Engineering, Tata McGraw-Hill (2008).
2. Del Toro, V., Electrical Engineering Fundamentals, Prentice-Hall of India Private Limited (2004).
3. David Bell, Electronics Devices and Circuits, Oxford Publications (2009).

#### CO MAPPING WITH PO and PSO

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PSO 1 | PSO 2 |
|-------|------|------|------|------|------|------|------|------|------|------|------|-------|-------|
| CO1   | 3    | 3    | 3    | 3    | -    | -    | -    | -    | -    | -    | -    | 3     | -     |
| CO2   | 3    | 3    | -    | -    | -    | -    | -    | -    | -    | -    | -    | 3     | -     |
| CO3   | 2    | 2    | 3    | 3    | -    | -    | -    | -    | -    | -    | -    | 3     | -     |
| CO4   | 3    | -    | -    | 2    | 2    | -    | -    | -    | -    | -    | -    | 3     | 1     |
| CO5   | 3    | -    | -    | 2    | 3    | -    | -    | -    | -    | -    | -    | 3     | 1     |
| CO6   | 3    | -    | -    | 2    | 3    | -    | -    | -    | -    | -    | -    | 3     | 2     |

#### CO MAPPING WITH WK

| CO/WK | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| CO1   |     | ✓   | ✓   | ✓   |     |     |     |     |     |
| CO2   |     | ✓   | ✓   | ✓   |     |     |     |     |     |
| CO3   |     | ✓   | ✓   | ✓   |     |     |     |     |     |
| CO4   |     | ✓   | ✓   | ✓   |     | ✓   |     |     |     |
| CO5   |     | ✓   | ✓   | ✓   |     | ✓   |     |     |     |
| CO6   |     | ✓   | ✓   | ✓   |     | ✓   |     |     |     |

#### Evaluation Scheme

| Sr. No. | Evaluation elements | Weightage (%) |
|---------|---------------------|---------------|
| 1       | MST                 | 25-30         |
| 2       | EST                 | 40-45         |

|  |   |                                                                                                                                                                  |    |  |
|--|---|------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|--|
|  | 3 | Sessional: (May include the following)<br>Assignment, Sessional (Includes Regular Lab<br>assessment and Quizzes Project (Including report,<br>presentation etc.) | 30 |  |
|--|---|------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|--|

| UEN008: Energy and Environment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |   |   |    |     |  |   |   |   |    |    |    |   |   |    |     |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---|----|-----|--|---|---|---|----|----|----|---|---|----|-----|
| <table><tr><td>L</td><td>T</td><td>P</td><td>SL</td><td>Cr</td></tr><tr><td>30</td><td>0</td><td>0</td><td>30</td><td>2.0</td></tr></table>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |   |   |    |     |  | L | T | P | SL | Cr | 30 | 0 | 0 | 30 | 2.0 |
| L                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | T | P | SL | Cr  |  |   |   |   |    |    |    |   |   |    |     |
| 30                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 0 | 0 | 30 | 2.0 |  |   |   |   |    |    |    |   |   |    |     |
| <p><b>Course Objective:</b> The exposure to this course would facilitate the students in understanding the terms, definitions and scope of environmental and energy issues pertaining to current global scenario; understanding the need of sustainability in addressing the current environmental &amp; energy challenges.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |   |   |    |     |  |   |   |   |    |    |    |   |   |    |     |
| <p><b>Syllabus</b></p> <p><b>Introduction:</b> Concept of sustainability and sustainable use of natural resources, Climate Change &amp; its related aspects.</p> <p><b>Air Pollution:</b> Origin, Sources and effects of air pollution; Primary and secondary meteorological parameters; wind roses; Atmospheric stability; Source reduction and Air Pollution Control Devices for particulates and gaseous pollutants in stationary sources.</p> <p><b>Water Pollution:</b> Origin, Sources of water pollution, Category of water pollutants, Physicochemical characteristics, Components of wastewater treatment systems.</p> <p><b>Solid waste management:</b> Introduction to solid waste management, Sources, characteristics of municipal solid waste, Solid waste management methods: Incineration, composting, landfilling.</p> <p><b>Energy Resources:</b> Classification of Energy Resources; Non-conventional energy resources- Biomass energy, Thermo-chemical conversion and biochemical conversion route; Solar energy-active and passive solar energy absorption systems; Type of collectors; Thermal and photo conversion applications.</p> |   |   |    |     |  |   |   |   |    |    |    |   |   |    |     |
| <p><b>Course Outcomes (COs)</b><br/>The students will be able to:</p> <ol style="list-style-type: none"><li>1. comprehend the interdisciplinary context of environmental issues with reference to sustainability</li><li>2. assess the impact of anthropogenic activities on the various elements of environment and apply suitable techniques to mitigate their impact.</li><li>3. demonstrate the application of technology in real time assessment and control of pollutants.</li><li>4. correlate environmental concerns with the conventional energy sources associated and assess the uses and limitations of non-conventional energy technologies</li></ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |   |   |    |     |  |   |   |   |    |    |    |   |   |    |     |
| <p><b>Text Books</b></p> <ol style="list-style-type: none"><li>1. Moaveni, S., Energy, Environment and Sustainability, Cengage (2018)</li><li>2. Rajagopalan, R., Environmental Studies, Oxford University Press (2018)</li><li>3. O’Callagan, P.W., Energy Management, McGraw Hill Book Co. Ltd. (1993).</li></ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |   |    |     |  |   |   |   |    |    |    |   |   |    |     |

| CO MAPPING WITH PO and PSO |     |     |     |     |     |     |     |     |     |      |      |      |      |
|----------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|
| CO/PO                      | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1                        | -   | -   | -   | -   | -   | 1   | 1   | -   | -   | -    | 1    | -    | 1    |
| CO2                        | -   | -   | -   | -   | -   | 1   | 1   | -   | -   | -    | 1    | -    | 1    |
| CO3                        | -   | -   | -   | -   | -   | 1   | 1   | -   | -   | -    | 1    | -    | 1    |
| CO4                        | -   | -   | -   | -   | -   | 1   | 1   | -   | -   | -    | 1    | -    | 1    |

  

| CO MAPPING WITH WK |     |     |     |     |     |     |     |     |     |  |
|--------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|--|
| CO/WK              | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |  |
| CO1                |     |     |     |     | ✓   |     | ✓   |     | ✓   |  |
| CO2                |     |     |     |     | ✓   |     | ✓   |     | ✓   |  |
| CO3                |     |     |     |     | ✓   |     | ✓   |     | ✓   |  |
| CO4                |     |     |     |     | ✓   |     | ✓   |     | ✓   |  |

  

| Evaluation Scheme |                                                                                                                                                            |               |
|-------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| Sr. No.           | Evaluation elements                                                                                                                                        | Weightage (%) |
| 1                 | MST                                                                                                                                                        | 25-30         |
| 2                 | EST                                                                                                                                                        | 40-45         |
| 3                 | Sessional: (May include the following)<br>Assignment, Sessional (Includes Regular Lab assessment and Quizzes Project (Including report, presentation etc.) | 30            |

| UMA023: DIFFERENTIAL EQUATIONS AND LINEAR ALGEBRA                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |    |   |    |                                                                                                                                              |   |   |   |    |    |    |    |   |    |     |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|---|----|----------------------------------------------------------------------------------------------------------------------------------------------|---|---|---|----|----|----|----|---|----|-----|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |    |   |    | <table><tr><td>L</td><td>T</td><td>P</td><td>SL</td><td>Cr</td></tr><tr><td>45</td><td>15</td><td>0</td><td>45</td><td>3.5</td></tr></table> | L | T | P | SL | Cr | 45 | 15 | 0 | 45 | 3.5 |
| L                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | T  | P | SL | Cr                                                                                                                                           |   |   |   |    |    |    |    |   |    |     |
| 45                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 15 | 0 | 45 | 3.5                                                                                                                                          |   |   |   |    |    |    |    |   |    |     |
| <b>Course Objective:</b> To introduce students the theory and concepts of differential equations, linear algebra, Laplace transformations and Fourier series which will equip them with adequate knowledge of mathematics to formulate and solve problems analytically.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |    |   |    |                                                                                                                                              |   |   |   |    |    |    |    |   |    |     |
| <b>Syllabus</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |    |   |    |                                                                                                                                              |   |   |   |    |    |    |    |   |    |     |
| <b>Ordinary Differential Equations:</b> Review of first order differential equations, Exact differential equations, Second and higher order differential equations, Solution techniques using one known solution, Cauchy - Euler equation, Method of undetermined coefficients, Variation of parameters method, Engineering applications of differential equations.                                                                                                                                                                                                                                                                                                                                                                                                                                                         |    |   |    |                                                                                                                                              |   |   |   |    |    |    |    |   |    |     |
| <b>Laplace Transform:</b> Definition and existence of Laplace transforms and its inverse, Properties of the Laplace transforms, Unit step function, Impulse function, Applications to solve initial and boundary value problems.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |    |   |    |                                                                                                                                              |   |   |   |    |    |    |    |   |    |     |
| <b>Fourier Series:</b> Introduction, Fourier series on arbitrary intervals, Half range expansions, Applications of Fourier series to solve wave equation and heat equation.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |    |   |    |                                                                                                                                              |   |   |   |    |    |    |    |   |    |     |
| <b>Linear Algebra:</b> Row reduced echelon form, Solution of system of linear equations, Matrix inversion, Linear spaces, Subspaces, Basis and dimension, Linear transformation and its matrix representation, Eigen-values, Eigen-vectors and Diagonalisation, Inner product spaces and Gram-Schmidt orthogonalisation process.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |    |   |    |                                                                                                                                              |   |   |   |    |    |    |    |   |    |     |
| <b>Course Outcomes (COs)</b><br>The students will be able to:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |    |   |    |                                                                                                                                              |   |   |   |    |    |    |    |   |    |     |
| <div>1. solve the differential equations of first and 2nd order and basic application problems described by these equations.</div> <div>2. find the Laplace transformations and inverse Laplace transformations for various functions. Using the concept of Laplace transform students will be able to solve the initial value and boundary value problems.</div> <div>3. find the Fourier series expansions of periodic functions and subsequently will be able to solve heat and wave equations.</div> <div>4. solve systems of linear equations by using elementary row operations.</div> <div>5. identify the vector spaces/subspaces and to compute their bases/orthonormal bases. Further, students will be able to express linear transformation in terms of matrix and find the eigenvalues and eigenvectors.</div> |    |   |    |                                                                                                                                              |   |   |   |    |    |    |    |   |    |     |
| <b>Text Books</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |    |   |    |                                                                                                                                              |   |   |   |    |    |    |    |   |    |     |
| <div>1. Simmons, G.F., Differential Equations (With Applications and Historical Notes), Tata McGraw Hill (2009).</div> <div>2. Krishnamurthy, V.K., Mainra, V.P. and Arora, J.L., An introduction to Linear Algebra, Affiliated East West Press (1976).</div>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |    |   |    |                                                                                                                                              |   |   |   |    |    |    |    |   |    |     |

| CO MAPPING WITH PO and PSO |      |      |      |      |      |      |      |      |      |      |      |       |       |
|----------------------------|------|------|------|------|------|------|------|------|------|------|------|-------|-------|
| CO/PO                      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PSO 1 | PSO 2 |
| CO1                        | 3    | -    | -    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     |
| CO2                        | 3    | -    | -    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     |
| CO3                        | 3    | -    | -    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     |
| CO4                        | 3    | -    | -    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     |
| CO5                        | 3    | -    | -    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     |

| CO MAPPING WITH WK |     |     |     |     |     |     |     |     |     |  |
|--------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|--|
| CO/WK              | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |  |
| CO1                |     | ✓   |     |     |     |     |     |     |     |  |
| CO2                |     | ✓   |     |     |     |     |     |     |     |  |
| CO3                |     | ✓   |     |     |     |     |     |     |     |  |
| CO4                |     | ✓   |     |     |     |     |     |     |     |  |
| CO5                |     | ✓   |     |     |     |     |     |     |     |  |

#### Evaluation Scheme

| Sr. No. | Evaluation elements                                                                                                                                        | Weightage (%) |
|---------|------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| 1       | MST                                                                                                                                                        | 25-30         |
| 2       | EST                                                                                                                                                        | 40-45         |
| 3       | Sessional: (May include the following)<br>Assignment, Sessional (Includes Regular Lab assessment and Quizzes Project (Including report, presentation etc.) | 30            |

## Semester III

| UMA028: Mathematics for Data Science                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |    |   |    |    |     |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|---|----|----|-----|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | L  | T | P  | SL | Cr  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 45 | 0 | 30 | 45 | 4.0 |
| <p><b>Course Objective:</b> To introduce the student to the concept of Probability and Statistics that plays a vital role in computing and computational intelligence. Knowledge of these topics is critical to decision making and to the analysis of data. Using concepts of probability and statistics, individuals are able to predict the likelihood of an event occurring, organize and evaluate data.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |    |   |    |    |     |
| <p><b>Syllabus:</b></p> <p><b>Mathematical Foundations of Data Sciences:</b> Matrices, Vectors, Vector Spaces, Matrix Decomposition, Singular Value Decomposition, Eigenvalues and vectors, Sets and classes, Limit of a sequence of sets, rings, sigma-rings, sigma fields, monotone classes.</p> <p><b>Probability:</b> Classical, relative frequency and axiomatic definitions of probability, addition rule and conditional probability, multiplication rule, total probability, Bayes' Theorem and independence, Random variable, some common discrete and continuous distributions (Binomial, Poisson, Negative binomial, Geometric, Rectangular, Exponential, Normal, Gamma).</p> <p><b>Bi-variate Probability Distribution:</b> Probability distribution of functions of a random variable, Joint and marginal distributions, Conditional distributions.</p> <p><b>Correlation and Regression:</b> Covariance, Karl-Pearson and rank Correlation coefficients; linear regression between two variables.</p> <p><b>Estimation:</b> Theory of Estimation, Properties of an estimator: Unbiasedness, consistency, Method of maximum likelihood, the method of moments, confidence intervals for parameters in one sample and two sample problems of normal populations, confidence intervals for proportions.</p> <p><b>Hypothesis:</b> Introduction to Sampling Distribution (standard normal, chi-square, T &amp; F distributions), Critical regions, Neyman-Pearson lemma (without proofs).</p> <p><b>Parametric &amp; Non-parametric tests:</b> Tests for Goodness of fit: Based on Chi-square Test, one sample and paired sample tests; Sign Test, Signed-rank Test, Kolmogorov Smirnov Test.</p> <p><b>Data Processing:</b> Regression, Dimensionality Reduction, Linear Discriminant Analysis Principal Component Analysis.</p> <p><b>Laboratory Work:</b> Lab work based on the programming in MATLAB/ Python /SPSS/R language of various statistical techniques.</p> |    |   |    |    |     |
| <p><b>Course Outcomes (COs)</b></p> <p>After completion of this course, the students will be able to:</p> <ol style="list-style-type: none"> <li>1. Compute probabilities of composite events along with an understanding of random variables and distribution functions.</li> <li>2. Understand the convergence of sequence in probabilities</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |    |   |    |    |     |

3. Analyse the correlated data and fit the linear regression models
4. Make statistical inferences using principles of hypothesis tests.

#### Text Books

1. Meyer P. L., Introduction to Probability and Statistical Applications, Oxford & IBH, (2007).
2. Hogg, R. V. and Craig, A.T., Introduction to Mathematical Statistics, Prentice Hall of India, (2004).
3. Ross, S.M., A First Course in Probability, 9th edition, Pearson (2012).
4. Peng, D., R., R Programming for Data Science, Lulu.com (2012).

#### Reference Books

1. Walpole, R. E., Myers, R. H., Myers, S. L. and Ye, K.,. Probability and statistics for engineers and scientists, Pearson, (2010).
2. Hestie Trevor, Tibshirani R., Friedman J., the elements of statistical learning, SpringerVerlag New York Inc., 2nd Ed., (2001).

#### CO MAPPING WITH PO and PSO

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PSO 1 | PSO 2 |
|-------|------|------|------|------|------|------|------|------|------|------|------|-------|-------|
| CO1   | 2    | 2    | -    | -    | -    | -    | -    | -    | -    | -    | -    | 3     | -     |
| CO2   | 2    | 2    | -    | -    | -    | -    | -    | -    | -    | -    | -    | 3     | -     |
| CO3   | 2    | 2    | -    | 3    | -    | -    | -    | -    | -    | -    | -    | 3     | -     |
| CO4   | 2    | 2    | -    | 3    | -    | -    | -    | -    | -    | -    | -    | 3     | -     |

#### CO MAPPING WITH WK

| CO/WK | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| CO1   |     | ✓   | ✓   |     |     |     |     |     |     |
| CO2   |     | ✓   | ✓   |     |     |     |     |     |     |
| CO3   |     | ✓   | ✓   |     |     |     |     | ✓   |     |
| CO4   |     | ✓   | ✓   |     |     |     |     | ✓   |     |

#### Evaluation Scheme

| Sr. No. | Evaluation elements                    | Weightage (%) |
|---------|----------------------------------------|---------------|
| 1       | MST                                    | 25-30         |
| 2       | EST                                    | 40-45         |
| 3       | Sessional: (May include the following) | 30            |

|  |  |                                                                                                                  |  |
|--|--|------------------------------------------------------------------------------------------------------------------|--|
|  |  | Assignment, Sessional (Includes Regular Lab assessment and Quizzes Project (Including report, presentation etc.) |  |
|--|--|------------------------------------------------------------------------------------------------------------------|--|

**UEE307: Transmission and Distribution of Electric Power**

|    |    |   |    |     |
|----|----|---|----|-----|
| L  | T  | P | SL | Cr  |
| 30 | 15 | 0 | 30 | 2.5 |

**Course Objective:** To introduce the concepts of transmission lines, line insulators, cables. To get familiarize with distribution, EHV and HVDC transmission system.

**Syllabus:**

**Introduction:** Structure of power systems–Indian perspective, Interconnections and their advantages, per unit system.

**Transmission Line Parameters:** Choice of voltage and frequency, computation of Resistance, Inductance and capacitance for different conductors, single phase and three phase transmission lines, effect of ground on capacitance, transposition and double circuit lines, Electrostatic and Electromagnetic interference with communication lines.

**Insulators:** Insulator types, String efficiency, Improvement of String Efficiency through insulation grading and usage of guard ring, Insulator Failure, Arcing horns, Armoured rods and Bushing.

**Transmission Line Performance:** Characteristics and performance of power transmission lines: Short, Medium, Long lines,  $\pi$  and T models, Generalized constants, Power flow, Regulation, Power circle diagrams, Series and shunt compensation

**Corona :** Corona visual and disruptive, Critical voltage, Phenomenon of Corona, Corona loss, Factors affecting Corona, Ferranti Effect

**Insulated Cables:** Constructional features, electric field intensity, dielectric strength, Grading of cables, Cable laying procedures, Fault location Methods, High voltage cables, Thermal characteristics, Ratings of Cables, Introduction to XLPE cables.

**Mechanical design of overhead transmission lines:** Tension and sag calculations, Effect of ice, wind and temperature, Sag template, Stringing charts, Vibrations and vibration damper.

**Distribution Systems:** Power supply systems and their comparison, Classification of distribution system, Primary and secondary distribution, Ring main and radial systems, Systematic design of distribution systems.

**EHV transmission and HVDC transmission:** Need of EHV transmission system, types of DC links, advantages of DC transmission, EHV and HVDC systems in India and trends. Standards: Indian Electricity Rules.

**Course Outcomes (COs)**

After completion of this course, the students will be able to:

1. Analyse the transmission line models and evaluate its performance parameters
2. Design the transmission lines under various working conditions
3. Select the configurations of different line insulators and evaluate their performance
4. Supervise the laying of cables and fault detection in cables
5. Design the distribution system network.

**Text Books**

1. Chakrabarti, A., Soni, M.L., Gupta, P.V. and Bhatnagar, U.S., A Text Book on Power System Engineering, Dhanpat Rai (2008).
2. Wadhwa, C.L., Electrical Power Systems, New Age International (P) Limited, Publishers (2008).

## Reference Books

1. Gupta, B.R., Power System Analysis and Design, S. Chand(2009).
2. Nagrath, I.J. and Kothari, D.P., Power System Engineering, Tata McGraw-Hill (2007).
3. Pabla, A.S., Electric Power Distribution, McGraw-Hill (2008).
4. Stevenson, W.D., Power System Analysis, McGraw-Hill (2007).

### CO MAPPING WITH PO and PSO

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PSO 1 | PSO 2 |
|-------|------|------|------|------|------|------|------|------|------|------|------|-------|-------|
| CO1   | 3    | 3    | -    | 3    | -    | -    | -    | -    | -    | -    | -    | 2     | -     |
| CO2   | 3    | 3    | 3    | 3    | -    | -    | -    | -    | -    | -    | -    | 2     | -     |
| CO3   | 3    | 3    | -    | -    | -    | -    | -    | -    | -    | -    | -    | 1     | -     |
| CO4   | 3    | 3    | -    | -    | -    | -    | -    | -    | -    | -    | -    | 1     | -     |
| CO5   | 3    | 3    | 3    | 3    | -    | -    | -    | -    | -    | -    | -    | 3     | -     |

### CO MAPPING WITH WK

| CO/WK | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| CO1   |     | ✓   | ✓   | ✓   |     |     |     | ✓   |     |
| CO2   |     | ✓   | ✓   | ✓   | ✓   |     |     |     |     |
| CO3   |     | ✓   | ✓   | ✓   | ✓   |     |     |     |     |
| CO4   |     | ✓   | ✓   | ✓   | ✓   |     |     |     |     |
| CO5   |     | ✓   | ✓   | ✓   | ✓   |     |     |     |     |

## Evaluation Scheme

| Sr. No. | Evaluation elements                                                                                                                                        | Weightage (%) |
|---------|------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| 1       | MST                                                                                                                                                        | 25-30         |
| 2       | EST                                                                                                                                                        | 40-45         |
| 3       | Sessional: (May include the following)<br>Assignment, Sessional (Includes Regular Lab assessment and Quizzes Project (Including report, presentation etc.) | 30            |
|         |                                                                                                                                                            |               |

| UES301: ANALOG CIRCUITS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |    |   |    |    |     |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|---|----|----|-----|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | L  | T | P  | SL | Cr  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 30 | 0 | 30 | 30 | 3.0 |
| <b>Course Objective:</b> To analyse working of BJT and MOSFET, understand multi-stage and power amplifications, working of operational amplifiers, active filters and oscillators.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |    |   |    |    |     |
| <b>Syllabus:</b><br><br><b>Biasing and Thermal Stabilization:</b> Transistor biasing and load line analysis, structure, working and applications of MOSFET, output and transfer characteristics, Thermal Runaway, Thermal Stability, biasing schemes,<br><br><b>Amplifiers:</b> low and high frequency analysis of single stage amplifiers, h-parameter models, variation of parameters, short-circuit current gain, gain-bandwidth product frequency compensation, current mirrors, multistage amplifiers<br><br><b>Differential and operational amplifiers:</b> Basic operations, negative and positive feedback, distortion and frequency response of an amplifier, applications of amplifiers for multi-stage and power amplifications, CMOS Operational Amplifier: Structure, Analysis and Design, Frequency Response and Compensation Techniques. Switched Capacitor Circuits: Principles of operation, Filter and non-filter applications.<br><br><b>Active filters and Oscillators:</b> Design of Butterworth filters using op amp, condition for sustained oscillation, R-C phase shift, Hartley, Colpitts, Crystal and Wien Bridge Oscillators, Negative Resistance oscillator; Multi-vibrators (Astable, Mono-stable, Bi-Stable). |    |   |    |    |     |
| <b>Laboratory Work:</b> RC coupled amplifier in CE mode, application of bistable, astable and monostable multivibrators, Hartley and Colpitts oscillator.<br><b>Minor Project:</b> Automatic intensity control of street lights, auto night lamp with high power LED, water level alarm, panic alarm, dc motor control using L298N motor driver module and Arduino.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |    |   |    |    |     |
| <b>Course Outcomes (COs)</b><br>After completion of the course, the students will be able to: <ol style="list-style-type: none"> <li>1. Design different types of transistor biasing circuits</li> <li>2. Analyse the applications of amplifiers for multi-stage and power amplifications</li> <li>3. Design Butterworth active filters and oscillator circuits</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |    |   |    |    |     |
| <b>Text Books</b> <ol style="list-style-type: none"> <li>1. Boylestad R. L., Electronic Devices and Circuit Theory, Pearson Education(2007).</li> <li>2. Millman, J. and Halkias, C.C., Integrated Electronics, Tata McGraw Hill(2006).</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |    |   |    |    |     |
| <b>Reference Books</b> <ol style="list-style-type: none"> <li>1. Neamen, Donald A., Electronic Circuit Analysis and Design, McGraw Hill(2006).</li> <li>2. Sedra A. S. and Smith K. C., Microelectronic Circuits, Oxford University Press(2006).</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |    |   |    |    |     |

| CO MAPPING WITH PO and PSO |      |      |      |      |      |      |      |      |      |      |      |       |       |
|----------------------------|------|------|------|------|------|------|------|------|------|------|------|-------|-------|
| CO/PO                      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PSO 1 | PSO 2 |
| CO1                        | 3    | 3    | 3    | -    | 2    | -    | -    | -    | -    | -    | -    | 3     | 1     |
| CO2                        | 3    | 3    | -    | 2    | -    | -    | -    | -    | -    | -    | -    | 3     | -     |
| CO3                        | 3    | 3    | 3    | -    | 2    | -    | -    | -    | -    | -    | -    | 3     | 2     |

| CO MAPPING WITH WK |     |     |     |     |     |     |     |     |     |  |
|--------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|--|
| CO/WK              | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |  |
| CO1                |     | ✓   | ✓   | ✓   | ✓   | ✓   |     |     |     |  |
| CO2                |     | ✓   | ✓   | ✓   |     |     |     | 3   |     |  |
| CO3                |     | ✓   | ✓   | ✓   | ✓   | ✓   |     |     |     |  |

#### Evaluation Scheme

| Sr. No. | Evaluation elements                                                                                                                                        | Weightage (%) |
|---------|------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| 1       | MST                                                                                                                                                        | 25-30         |
| 2       | EST                                                                                                                                                        | 40-45         |
| 3       | Sessional: (May include the following)<br>Assignment, Sessional (Includes Regular Lab assessment and Quizzes Project (Including report, presentation etc.) | 30            |

**UEE301: Direct Current Machines and Transformers**

|    |    |    |    |     |
|----|----|----|----|-----|
| L  | T  | P  | SL | Cr  |
| 45 | 15 | 30 | 45 | 4.5 |

**Course Objective:** To introduce the fundamental concepts of dc machines and transformers.

**Syllabus:**

**General Concepts of Rotating Electrical Machines:** Electromagnetic torque, Reluctance torque, Constructional features of rotating electrical machines, Classifications of rotating electrical machines, Construction of DC machines.

**DC Generators:** Classification of DC generator, Armature reaction, Compensating windings, Commutation, Methods of improving commutation, Characteristic of DC generators, Voltage buildup of shunt generators, Voltage regulation, Parallel operation of DC generators, Condition for maximum efficiency, Applications of DC generators.

**DC Motors:** Characteristic of DC motors, Speed control of DC motors, Ward–Leonard control (Voltage control), Three-point starter, four-point starter, DC shunt motor starter design, Electric breakings of DC shunt and series motors, Condition for maximum mechanical power.

**Testing of DC machines:** Brake test, Swinburne's test, Hopkinson's test or back to back test, Retardation test or Running test, Field's test, Applications of DC motors.

**Single Phase Transformers:** Introduction, Basic principle, Types of transformer, Construction, Equivalent circuit, Open circuit and short circuit, Separation of core losses, Per unit representation, Voltage regulation of a transformer, Losses in a transformer, Efficiency of a transformer, Condition for maximum efficiency, All day efficiency, Polarity test of a single-phase transformer, Sumpner's test, Parallel operation, Auto transformer.

**Three-Phase Transformer:** Advantages of three phase transformer, Principle of operation, Construction, Three-phase transformer connections, Open delta or V–V connection, Scott connection or T–T connection, Three-phase to two-phase conversion, Three-phase to six-phase conversion, Three-winding transformer, Parallel operation of transformers.

**Special Purpose Transformers:** Instrument transformers (CT and PT), Earthing transformer, Pulse transformer, High frequency transformer, Converter transformer.

**Laboratory Work:** DC Machines: Characteristics of generators and motors, Speed control, Efficiency, DC generators in parallel. Transformers: Open and short circuit tests, Parallel operation, Harmonics in no-load current, Three-phase connections, 3-phase to 2-phase and 6-phase conversions.

**Course Outcomes (COs)**

After completion of this course, the students will be able to:

1. Analyse the performance characteristics of DC motors and DC generators
2. Use different methods for starting and speed control of DC motors
3. Analyse the performance of transformers under various operating conditions
4. Use and analyse special purpose transformer (s) for measurement and protection
5. Elucidate the advantages of parallel operation of generators/transformers.

**Text Books**

1. Bimbhra, P.S., Electrical Machinery, Khanna Publishers(2008).
2. Mukherjee, P.K. and Chakravorty, S., Electrical Machines, DhanpatRai(2004).
3. Nagrath, I.J. and Kothari, D.P., Electric Machines, Tata McGraw Hill(2004).

**Reference Books**

1. Bimbhra, P.S., Generalized Theory of Electrical Machines, Khanna Publishers (2007).
2. Fitzgerald, A.E., Kingsley, C. Jr. and Umans, Stephen, Electric Machinery, McGraw Hill (2002).

**CO MAPPING WITH PO and PSO**

| CO/P<br>O | PO<br>1 | PO<br>2 | PO<br>3 | PO<br>4 | PO<br>5 | PO<br>6 | PO<br>7 | PO<br>8 | PO<br>9 | PO1<br>0 | PO1<br>1 | PSO<br>1 | PSO<br>2 |
|-----------|---------|---------|---------|---------|---------|---------|---------|---------|---------|----------|----------|----------|----------|
| CO1       | 3       | 3       | -       | 3       | -       | -       | -       | -       | -       | -        | -        | -        | -        |
| CO2       | 3       | 3       | -       | -       | -       | -       | -       | -       | -       | -        | -        | 2        | 1        |
| CO3       | 3       | 3       | -       | 3       | -       | -       | -       | -       | -       | -        | -        | 2        | 1        |
| CO4       | 3       | 3       | -       | 3       | -       | -       | -       | -       | -       | -        | -        | 2        | 1        |
| CO5       | 3       | 3       | -       | -       | -       | -       | -       | -       | -       | -        | -        | 1        | 1        |

**CO MAPPING WITH WK**

| CO/WK | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| CO1   |     | ✓   | ✓   | ✓   |     |     |     | ✓   |     |
| CO2   |     | ✓   | ✓   | ✓   |     |     |     |     |     |
| CO3   |     | ✓   | ✓   | ✓   |     |     |     | ✓   |     |
| CO4   |     | ✓   | ✓   | ✓   |     |     |     | ✓   |     |
| CO5   |     | ✓   | ✓   | ✓   |     |     |     |     |     |

**Evaluation Scheme**

| Sr. No. | Evaluation elements                                                                                                                                        | Weightage (%) |
|---------|------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| 1       | MST                                                                                                                                                        | 25-30         |
| 2       | EST                                                                                                                                                        | 40-45         |
| 3       | Sessional: (May include the following)<br>Assignment, Sessional (Includes Regular Lab assessment and Quizzes Project (Including report, presentation etc.) | 30            |

**UES302: Introduction to Measurement Systems**

|    |   |    |    |     |
|----|---|----|----|-----|
| L  | T | P  | SL | Cr  |
| 30 | 0 | 30 | 30 | 3.0 |

**Course Objective:** To introduce the classification of standards, to get familiar with principle, operation and comparison of electromechanical indicating instruments. To get familiarize with power and energy measurement systems, working and applications of various type of bridges and transducer.

**Syllabus:**

**Introduction:** Types of measurements, Instrument classification, Elements of an instrument, Input-output configuration of measuring instruments, Methods of correction for interfering and modifying inputs, Calibration, Static and Dynamic characteristics, measurement errors and error analysis, Classification of standards, Time and frequency standards, Electrical standards.

**Electromechanical Indicating Instruments:** PMMC galvanometer, Ohmmeter, Electrodynamometer, Moving iron meter, Rectifier and thermo-instruments, Comparison of various types of indicating instruments.

**Power and Energy Measurement:** Electrodynamometer type of wattmeter and power factor meter, Single-phase induction and Electronic energy meters. Amplitude and phase comparator, Phasor extraction and Introduction to PMU and its Applications.

**Bridges for Measurement:** Kelvin double bridge, AC bridges: Maxwell's bridge, Hay's bridge, Schering bridge, Wien's bridge, Low and High resistance measurement.

**Electronic Instruments:** Electronic multi-meter, Quantization error, Digital frequency meter, Q meter, Spectrum Analyzer, Digital Storage Oscilloscopes.

**Sensors and Transducers:** Basic principle and applications of Resistive, Inductive, Capacitive and, Piezoelectric sensors, Synchros and Resolvers, Fiber optic sensors, Hall-Effect, Photo transducer, Photovoltaic, Digital transducers, Tacho-generators, shaft parameters measurement in rotating shafts.

**Laboratory Work:** To measure sensitivity of Wheat Stone Bridge, Comparison of various types of indicating instruments, Single phase induction type energy meter, AC bridge measurement, Familiarization with storage type digital oscilloscopes.

**Course Outcomes (COs)**

After completion of the course, the students will be able to:

1. Select various types of instruments for measurement of variables.
2. Select and use various types of sensors in different conditions.
3. Select and use various types of bridge circuits with different sensors.
4. Demonstrate the working of electronic instruments, working of sensors and transducers

**Text Books**

1. Golding, E.W., and Widdis, F.C., Electrical Measurements and Measuring Instruments, Pitman (2003).
2. Sawhney, A.K., A Course in Electrical and Electronic Measurements and Instrumentation, Dhanpat Rai and Co. (P) Ltd.(2007).
3. Nakra, B. C. and Chaudhry, K. K., Instrumentation Measurement and Analysis, Tata McGraw-Hill (2003).

**Reference Books**

1. Murthy, D.V.S., Transducers and Instrumentation, Prentice–Hall of India Private Limited(2003).
2. Doebelin, E.O., Measurement systems, Applications and Design, McGraw–Hill(1982).

**CO MAPPING WITH PO and PSO**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PSO 1 | PSO 2 |
|-------|------|------|------|------|------|------|------|------|------|------|------|-------|-------|
| CO1   | 3    | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     |
| CO2   | 3    | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     |
| CO3   | 3    | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     |
| CO4   | 3    | 3    | -    | -    | -    | -    | -    | -    | -    | -    | -    | 1     | -     |

**CO MAPPING WITH WK**

| CO/WK | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| CO1   |     | ✓   | ✓   | ✓   | ✓   |     |     |     |     |
| CO2   |     | ✓   | ✓   | ✓   | ✓   |     |     |     |     |
| CO3   |     | ✓   | ✓   | ✓   | ✓   |     |     |     |     |
| CO4   |     | ✓   | ✓   | ✓   |     |     |     |     |     |

**Evaluation Scheme**

| Sr. No. | Evaluation elements                                                                                                                                        | Weightage (%) |
|---------|------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| 1       | MST                                                                                                                                                        | 25-30         |
| 2       | EST                                                                                                                                                        | 40-45         |
| 3       | Sessional: (May include the following)<br>Assignment, Sessional (Includes Regular Lab assessment and Quizzes Project (Including report, presentation etc.) | 30            |

### UTA030: Engineering Design Project (Buggy)

| L  | T | P  | SL | Cr  |
|----|---|----|----|-----|
| 15 | 0 | 60 | 15 | 3.0 |

**Course Objective:** The project will introduce students to the challenge of electronic systems design & integration. The project is an example of 'hardware and software co-design' and the scale of the task is such that it will require teamwork as a co-ordinated effort.

#### Syllabus:

##### Hardware overview of Arduino:

- ❖ Introduction to Arduino Board: Technical specifications, accessories and applications.
- ❖ Introduction to Eagle (PCB layout tool) software.

##### Sensors and selection criterion:

- ❖ Concepts of sensors, their technical specifications, selection criterion, working principle and applications such as IR sensors, ultrasonic sensors.

##### Active and passive components:

- ❖ Familiarization with hardware components, input and output devices, their technical specifications, selection criterion, working principle and applications such as-
  - Active and passive components: Transistor (MOSFET), diode (LED), LCD, potentiometer, capacitors, DC motor, Breadboard, general PCB etc.
  - Instruments: CRO, multimeter, Logic probe, solder iron, desolder iron
  - Serial communication: Concept of RS232 communication, Xbee
- ❖ Introduction of ATtiny microcontroller based PWM circuit programming.

##### Programming of Arduino:

- ❖ Introduction to Arduino: Setting up the programming environment and basic introduction to the Arduinomicro-controller
- ❖ Programming Concepts: Understanding and Using Variables, If-Else Statement, Comparison Operators and Conditions, For Loop Iteration, Arrays, Switch Case Statement and Using a Keyboard for Data Collection, While Statement, Using Buttons, Reading Analog and Digital Pins, Serial Port Communication, Introduction programming of different type of sensors and communication modules, DC Motors controlling.

##### Basics of C#:

- ❖ Introduction: MS.NET Framework Introduction, Visual Studio Overview and Installation
- ❖ Programming Basics: Console Programming, Variables and Expressions, Arithmetic Operators, Relational Operators, Logical Operators, Bitwise Operators, Assignment Operators, Expressions, Control Structures, Characters, Strings, String Input, serial port communication: Read and write data using serial port.
- ❖ Software code optimization, software version control.

##### Laboratory Work:

Schematic circuit drawing and PCB layout design on CAD tools, implementing hardware module of IR sensor, Transmitter and Receiver circuit on PCB.

**Bronze Challenge:** Single buggy around track twice in Clockwise direction, under full supervisory control. Able to detect an obstacle. Parks safely. Able to communicate state of the track and buggy at each gantry stop to the console.

**Silver Challenge:** Two buggies, both one loop around, track in opposite directions under full supervisory, control. Able to detect an obstacle. Both park safely. Able to communicate state of the track and buggy at each gantry stop with console.

**Gold Challenge:** Same as silver but user must be able to enter the number of loops around the track beforehand to make the code generalized.

### Course Outcomes (COs)

After completion of this course, the students will be able to:

1. Recognize issues to be addressed in a combined hardware and software system design
2. Draw the schematic diagram of an electronic circuit and design its PCB layout using CAD Tools
3. Apply hands-on experience in electronic circuit implementation and its testing
4. Demonstrate programming skills by integrating coding, optimization and debugging for different challenges
5. Develop group working, including task sub-division and integration of individual contributions from the team.

### Text Books

1. Michael McRoberts, Beginning Arduino, Technology in Action Publications, 2<sup>nd</sup> Edition.
2. Alan G. Smith, Introduction to Arduino: A piece of cake, Create Space Independent Publishing Platform (2011).

### Reference Books

1. John Boxall, Arduino Workshop - a Hands-On Introduction with 65 Projects, No Starch Press; 1<sup>st</sup> edition (2013).

### CO MAPPING WITH PO and PSO

| CO/P<br>O | PO<br>1 | PO<br>2 | PO<br>3 | PO<br>4 | PO<br>5 | PO<br>6 | PO<br>7 | PO<br>8 | PO<br>9 | PO1<br>0 | PO1<br>1 | PSO<br>1 | PSO<br>2 |
|-----------|---------|---------|---------|---------|---------|---------|---------|---------|---------|----------|----------|----------|----------|
| CO1       | 1       | 1       | -       | -       | 3       | -       | -       | -       | -       | -        | -        | 2        | 3        |
| CO2       | 2       | 2       | -       | -       | 3       | -       | -       | -       | -       | -        | -        | 2        | 3        |
| CO3       | 3       | 3       | -       | -       | 3       | -       | -       | -       | -       | -        | -        | 2        | 3        |
| CO4       | 1       | 1       | -       | -       | 3       | -       | -       | -       | -       | -        | -        | 2        | 3        |
| CO5       | -       | -       | -       | -       | -       | -       | 3       | 3       | -       | 3        | 2        | 2        | 3        |

| CO MAPPING WITH WK |     |     |     |     |     |     |     |     |     |
|--------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| CO/WK              | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |
| CO1                |     | ✓   |     |     |     | ✓   |     |     |     |
| CO2                |     | ✓   | ✓   |     |     | ✓   |     |     |     |
| CO3                |     | ✓   | ✓   | ✓   |     | ✓   |     |     |     |
| CO4                |     | ✓   |     |     |     | ✓   |     |     |     |
| CO5                |     |     |     |     |     |     |     |     | ✓   |

**UTD 003: APTITUDE SKILLS BUILDING**

| L  | T | P | SL | Cr  |
|----|---|---|----|-----|
| 30 | 0 | 0 | 30 | 2.0 |

**Course Objective:**

- The course aims to equip students with a comprehensive understanding of quantitative, verbal, and logical reasoning concepts, enhancing their ability to solve numerical problems, interpret written information, and evaluate arguments effectively. It provides exposure to various aptitude test formats, and time-management strategies, and offers practice opportunities with personalized feedback to build confidence and prepare students for aptitude tests, increasing their job market competitiveness and career advancement opportunities.
- Verbal Ability & Reading Comprehension:** Introduction to Reading Comprehension: Strategies for approaching different types of passages, identifying main ideas, and understanding structure, Advanced reading techniques, dealing with inferences, tone, and author's purpose, Introduction to Verbal Ability: Grammar Fundamentals, sentence structure, common errors, Sentence Correction and Completion, Review and Test-Taking Strategies: Consolidate knowledge from all areas, focusing on test-taking strategies, time management, and practice tests.
- Quantitative & Logical Reasoning:** Introduction to Quantitative Ability - Arithmetic Basics: arithmetic concepts (numbers, operations, percentages, ratios, averages), Advanced Arithmetic & Introduction to Algebra: more complex arithmetic (interest, partnerships, mixtures, ratios, variation) and basics of algebra (equations, inequalities, speed, time and distance), Algebra Continued & Introduction to Modern Math: quadratic equations, sequences and introduce concepts of modern math set theory, probability, permutations, combinations, and more complex probability problems, Introduction to Data Interpretation: Basics of data interpretation, understanding and interpreting bar charts and pie charts, Data Interpretation - Line Charts and Tables, interpreting trends, and comparing data, practice session with mixed problems from quantitative ability and data interpretation, Introduction to Logical Reasoning: Number Series and Sequences, Family Relationships and Directions.

**Course Outcomes (Cos)**

**CO 1:** Ability to identify and provide solutions for complex problems and apply the basics of mathematics

**CO 2:** Able to analyze and interpret data from various sources to identify trends and make data-driven comparisons.

**CO 3:** Able to evaluate logical reasoning scenarios to identify patterns, solve sequences, and make accurate inferences.

**CO 4:** Able to improve communication skills, including correcting errors, refining structure, and enhancing verbal proficiency.

**CO 5:** Able to analyze various types of information to identify key points, infer meaning, and understand underlying tones and purposes.

**Text Books**

- Aggarwal, R.S., *Quantitative Aptitude for Competitive Examinations*; S Chand (2017)
- Agarwal, A., *An expert guide to problem-solving: with practical examples*; CreateSpace Independent Publishing Platform (2016)

|                                                                                                              |      |      |      |      |      |      |      |      |      |      |      |       |       |
|--------------------------------------------------------------------------------------------------------------|------|------|------|------|------|------|------|------|------|------|------|-------|-------|
| 3. Other supplemental materials: Instructor prepared material disseminated through social media tools & apps |      |      |      |      |      |      |      |      |      |      |      |       |       |
| 4. M. Tyra, Magical Book on Quicker Maths, Fifth Edition, BSC Publishing Co Pvt Ltd, 2018                    |      |      |      |      |      |      |      |      |      |      |      |       |       |
| 5. K Kundan, Advanced Verbal Reasoning, Tyrasons Publications, 2021                                          |      |      |      |      |      |      |      |      |      |      |      |       |       |
| 6. Wren and Martin, English Grammar Book, S. Chand Publication, 2024                                         |      |      |      |      |      |      |      |      |      |      |      |       |       |
| CO MAPPING WITH PO and PSO                                                                                   |      |      |      |      |      |      |      |      |      |      |      |       |       |
| CO/PO                                                                                                        | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PSO 1 | PSO 2 |
| CO1                                                                                                          | 2    | 2    | 2    | 2    | -    | -    | -    | -    | -    | -    | -    | 3     | 1     |
| CO2                                                                                                          | 2    | 2    | 2    | 2    | -    | -    | -    | -    | -    | -    | -    | 2     | -     |
| CO3                                                                                                          | -    | 2    | -    | 2    | -    | -    | -    | -    | -    | -    | -    | 2     | -     |
| CO4                                                                                                          | -    | -    | -    | -    | -    | -    | -    | -    | 3    | -    | 3    | 1     | 3     |
| CO5                                                                                                          | -    | -    | -    | -    | -    | -    | -    | -    | 3    | 3    | 3    | 1     | 3     |

|                    |     |     |     |     |     |     |     |     |     |  |
|--------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|--|
| CO MAPPING WITH WK |     |     |     |     |     |     |     |     |     |  |
| CO/WK              | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |  |
| CO1                |     | ✓   | ✓   | ✓   | ✓   |     |     |     |     |  |
| CO2                |     | ✓   | ✓   | ✓   |     |     |     | ✓   | ✓   |  |
| CO3                |     | ✓   | ✓   | ✓   |     |     |     | ✓   |     |  |
| CO4                |     |     |     |     |     |     |     | ✓   | ✓   |  |
| CO5                |     | ✓   | ✓   | ✓   |     |     |     | ✓   |     |  |

|                   |                     |               |
|-------------------|---------------------|---------------|
| Evaluation Scheme |                     |               |
| Sr. No.           | Evaluation elements | Weightage (%) |
| 1                 | EST                 | 50            |
| 2                 | Sessional           | 40            |
| 3                 | Assignment          | 10            |

## Semester IV

### UEE401: Alternating Current Machines

| L  | T  | P  | SL | Cr  |
|----|----|----|----|-----|
| 45 | 15 | 30 | 45 | 4.5 |

**Course Objective:** To introduce the concept of single phase and three phase AC machines, their construction and performance parameters.

#### Syllabus:

**Three-Phase Induction Motors:** Construction, working principle, Slip and its effect on rotor parameters: rotor frequency, Torque-slip characteristics, Power flow diagram, Efficiency, Synchronous watt, Measurement of slip, Equivalent circuit, No-load test, Blocked rotor test, Circle diagram, Starting methods, Speed control methods, Crawling, Cogging, Deep cage and Double cage rotors, Applications, self-excited and grid connected Induction generator.

**Fractional kW Motors and Special Machines:** Classification, Production of rotating field, Double revolving field theory, Equivalent circuit, Determination of equivalent circuit parameters, Split phase induction motor, Capacitor motor, Permanent split capacitor motor; Shaded pole motor, Universal motor, Stepper motor.

**Synchronous Generators/Alternators:** Introduction, Comparison with DC generator, Advantages of rotating field over rotating armature, Constructional features, Excitation systems, Armature windings, EMF equation, Winding factor, Harmonics, Armature resistance, Armature reaction: Unity power factor, Zero lagging and Zero leading power factor, Armature reaction reactance, Equivalent circuit of an alternator, Voltage equation, Phasor diagram of a loaded alternator for various types of loads, Voltage regulation and methods of estimation of voltage regulation, Load characteristic of alternators, power equation, Two reaction theory and Torque angle characteristic of a salient pole alternator, Maximum reactive power for a salient pole alternator, Losses and efficiency, Determination of  $X_d$  and  $X_q$ , Parallel operation of alternators, Synchronising procedures, Synchronising power and Torque coefficient, Damper Windings, Hunting.

**Synchronous Motors:** Voltage equation, Phasor diagram, Operation at constant load with variable excitation, Power equations, salient pole Synchronous motor, Starting of synchronous motors, Applications, Synchronous condensers.

**Laboratory Work:** Reactances of cylindrical and salient-pole synchronous machines, Voltage regulation, Operating characteristics, Synchronizing, Parallel operation and load division, determination of sub-transient, transient and steady state reactances and various time constants, Determination of positive, negative and zero sequence reactances, Synchronous motor starting, Efficiency. Three phase induction motors: starting methods, Equivalent circuit parameters, Load test, Polarity test, Single phasing, Efficiency, Schrage motor, Single-phase induction motors: Equivalent circuit parameters.

#### Course Outcomes (COs)

After the completion of the course, the students will be able to:

1. Comprehend the operation, test and performance and speed control of three-phase induction motor
2. Analyse the performance of fractional kW motors
3. Comprehend the performance, test and control of synchronous machines.

4. Elucidate the advantages of alternators connected in parallel.

#### Text Books

1. Bimbhra, P.S., Electrical Machinery, Khanna Publishers (2008).
2. Mukherjee, P.K. and Chakravorty, S., Electrical Machines, Dhanpat Rai and Co. (P) Ltd. (2004).
3. Nagrath, I.J. and Kothari, D.P., Electric Machines, Tata McGraw Hill (2004).
4. Sawhney, A. K., and Chakrabarti, A. Course in electrical machine design. Dhanpat Rai (2006).

#### Reference Books

1. Bimbhra, P.S., Electrical Machinery, Khanna Publishers (2008).
2. Mukherjee, P.K. and Chakravorty, S., Electrical Machines, Dhanpat Rai and Co. (P) Ltd. (2004).
3. Nagrath, I.J. and Kothari, D.P., Electric Machines, Tata McGraw Hill (2004).

#### CO MAPPING WITH PO and PSO

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|
| CO1   | 3   | 3   | -   | -   | -   | -   | -   | -   | -   | -    | -    | 3    | 1    |
| CO2   | 3   | 3   | -   | 3   | -   | -   | -   | -   | -   | -    | -    | 2    | 1    |
| CO3   | 3   | 3   | -   | -   | -   | -   | -   | -   | -   | -    | -    | 2    | 1    |
| CO4   | 3   | 3   | -   | -   | -   | -   | -   | -   | -   | -    | -    | 2    | 1    |

#### CO MAPPING WITH WK

| CO/WK | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| CO1   |     | ✓   | ✓   | ✓   |     |     |     |     |     |
| CO2   |     | ✓   | ✓   | ✓   |     |     |     | ✓   |     |
| CO3   |     | ✓   | ✓   | ✓   |     |     |     |     |     |
| CO4   |     | ✓   | ✓   | ✓   |     |     |     |     |     |

#### Evaluation Scheme

| Sr. No. | Evaluation elements                                                                                                                                        | Weightage (%) |
|---------|------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| 1       | MST                                                                                                                                                        | 25-30         |
| 2       | EST                                                                                                                                                        | 40-45         |
| 3       | Sessional: (May include the following)<br>Assignment, Sessional (Includes Regular Lab assessment and Quizzes Project (Including report, presentation etc.) | 30            |

**UTA018: Object Oriented Programming**

| L  | T | P  | SL | Cr  |
|----|---|----|----|-----|
| 45 | 0 | 30 | 45 | 4.0 |

**Course Objective:** To become familiar with object oriented programming concepts and be able to apply these concepts in solving diverse range of applications.

**Syllabus:**

**Objects and Classes:** Structure in C and C++, Class specification, Objects, Namespaces, Overview of pillars of OOPS (Data Encapsulation, Data Abstraction, Inheritance, Polymorphism), Inline functions, Passing objects as arguments, Returning object from a function, Array of objects, Static keyword with data member, member function and object, Friend function, and Friend classes, Pointer to objects, this pointer, Dynamic Initialization, Dynamic memory allocation.

**Constructor and Destructor:** Constructors and its types, Constructor Overloading, Constructors in array of objects, Constructors with default arguments, Dynamic Constructor, Destructor, 'const' keyword with data member, member function and object.

**Inheritance:** Introduction to Inheritance, Forms of Inheritance (Single, Multiple, Multilevel, Hierarchical and Hybrid) with various modes (Public, Private and Protected), Inheritance with Constructor and Destructor, Benefits and Limitations of Inheritance.

**Polymorphism:** Classification of Polymorphism (Compile-time and Run-time), Compile Time-Function Overloading, Operator Overloading (Unary operator and Binary operator with member function and friend function), Data Conversion (Basic to user-defined, user-defined to basic, one user-defined to another user-defined). Run-time- Pointers to derived class object, Overriding member function, Virtual functions, pure virtual functions, Abstract class.

**Exception Handling, Templates and Standard Template Library:** Exception handling mechanism, Usage of template, Function templates, Overloading of Function templates, Class templates, Introduction to Standard Template Library and its components. Algorithms, Containers (Array, Vector, Stack, List and Queue) and Iterators.

**Laboratory Work:** To implement object oriented constructs using C++programming language

**Course Outcomes (COs)**

After completion of this course, the students will be able to:

1. To recall the knowledge of structure and its variables to comprehend the concept of classes, objects, constructors and destructors for implementing the object oriented paradigms.
2. To apply and analyze the inheritance on real life case studies via coding competences.
3. To design and develop code snippets for polymorphism to proclaim coding potential; and management of run-time exceptions.
4. To assess and interpret the knowledge of templates to appraise the standard template libraries.

**Text Books**

1. C++:The Complete Reference , Schildt H., Tata McGraw Hill, 4th ed, 2003
2. C++Primer, Lippman B.S., Lajoie J., and MooE.B., , Addison-Wesley Professional, 5th ed, 2013

**Reference Books**

1. Object-Oriented Programming in C++, Lafore R., Pearson Education, 4th ed, 2002
2. Object Oriented Programming with C++, E Balagurusamy, 8<sup>th</sup> ed, 2017
3. The C++programming language, Stroustrup B., Pearson Education India, 4th ed, 2013

**CO MAPPING WITH PO and PSO**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PSO 1 | PSO 2 |
|-------|------|------|------|------|------|------|------|------|------|------|------|-------|-------|
| CO1   | 1    | 1    | -    | -    | 3    | -    | -    | -    | -    | -    | -    | 3     | -     |
| CO2   | 1    | 1    | -    | -    | 3    | -    | -    | -    | -    | -    | -    | 2     | -     |
| CO3   | 1    | 1    | -    | -    | 3    | -    | -    | -    | -    | -    | -    | 3     | -     |
| CO4   | 1    | 1    | -    | -    | 3    | -    | -    | -    | -    | -    | -    | -     | 3     |

**CO MAPPING WITH WK**

| CO/WK | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| CO1   |     | ✓   |     |     |     | ✓   |     |     |     |
| CO2   |     | ✓   |     |     |     | ✓   |     |     |     |
| CO3   |     | ✓   |     |     |     | ✓   |     |     |     |
| CO4   |     | ✓   |     |     |     | ✓   |     |     |     |
| CO5   |     | ✓   |     |     |     | ✓   |     |     |     |

**Evaluation Scheme**

| Sr. No. | Evaluation elements                                                                                                                                        | Weightage (%) |
|---------|------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| 1       | MST                                                                                                                                                        | 25-30         |
| 2       | EST                                                                                                                                                        | 40-45         |
| 3       | Sessional: (May include the following)<br>Assignment, Sessional (Includes Regular Lab assessment and Quizzes Project (Including report, presentation etc.) | 30            |

**ULC303: Computer Architecture and Organization**

| L  | T | P | SL | Cr  |
|----|---|---|----|-----|
| 45 | 0 | 0 | 45 | 3.0 |

**Course Objective:** Focus is on the architecture and organization of the basic computer modules viz. controls unit, central processing unit, input-output organization and memory unit.

**Syllabus:**

**Basics of Computer Architecture:** Number system and code conversion, Logic gates, Flip flops, Registers, Counters, Multiplexer, De-multiplexer, Decoder, Encoder etc.

**Register Transfer and Micro operations:** Register transfer Language, Register transfer, Bus & memory transfer, Arithmetic micro operations, Logic micro operations, Shift micro operations, Design of ALU.

**Basic Computer Organization:** Instruction codes, Computer instructions, Timing & control, Instruction Cycles, Memory, register, and input-output reference instructions, Interrupts, Complete computer description & design of basic computer.

**Central Processing Unit:** General register organization, Stack organization, Instruction format, Addressing modes, Data transfer & manipulation, Program control, RISC, CISC. Pipelining and hazards.

**Computer Arithmetic:** Addition & Subtraction, Multiplication Algorithms, Division algorithms. Memory Unit: Memory hierarchy, Processor vs. memory speed, High-speed memories, Main Memory, Cache memory and mapping schemes, Associative memory, Interleaving, Virtual memory, Memory management techniques.

**Multiprocessors:** Characteristics of multiprocessors, Interconnection structures, Interprocessor arbitration, Inter-processor communication & synchronization. Peripheral devices, I/O interface Data transfer schemes, Program control, Synchronous and asynchronous data transfer, Interrupt, DMA transfer, I/O processor.

**Course Learning Outcomes (CLO)**

After completion of the course, the students will be able to:

1. Illustrate various elementary concepts of computer architecture including, syntax of register transfer language, micro operations, instruction cycle, and control unit.
2. Describe the design of basic computer with instruction formats & addressing modes
3. Explore various memory management techniques and algorithms for performing addition, subtraction and division etc.
4. Interpret the concepts of pipelining, multiprocessors, and inter processor communication.

**Text Books**

1. Mano, Morris M., Computer System Architectue, Prentice Hall (1992).
2. Hayes, J.P., Computer Architecture and Organization, McGraw Hill (1998).

**Reference Books**

1. Hennessy, J.L., Patterson, D.A, and Goldberg, D., Computer Architecture A Quantitative Approach, Pearson Education Asia (2006).
2. Leigh, W.E. and Ali, D.L., System Architecture: software and hardware concepts, South Wester Publishing Co. (2000).

| <b>CO MAPPING WITH PO and PSO</b> |      |      |      |      |      |      |      |      |      |      |      |       |       |
|-----------------------------------|------|------|------|------|------|------|------|------|------|------|------|-------|-------|
| CO/PO                             | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PSO 1 | PSO 2 |
| CO1                               | 1    | 1    | -    | -    | 2    | -    | -    | -    | -    | -    | -    | 2     | -     |
| CO2                               | 1    | 1    | -    | -    | 2    | -    | -    | -    | -    | -    | -    | 2     | -     |
| CO3                               | 1    | 1    | -    | -    | 2    | -    | -    | -    | -    | -    | -    | 2     | -     |
| CO4                               | 1    | 1    | -    | -    | 2    | -    | -    | -    | -    | -    | -    | 2     | -     |

| <b>CO MAPPING WITH WK</b> |     |     |     |     |     |     |     |     |     |  |
|---------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|--|
| CO/WK                     | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |  |
| CO1                       |     | ✓   |     |     |     | ✓   |     |     |     |  |
| CO2                       |     | ✓   |     |     |     | ✓   |     |     |     |  |
| CO3                       |     | ✓   |     |     |     | ✓   |     |     |     |  |
| CO4                       |     | ✓   |     |     |     | ✓   |     |     |     |  |

#### Evaluation Scheme

| S. No. | Evaluation Elements                                                | Weightage (%) |
|--------|--------------------------------------------------------------------|---------------|
| 1.     | MST & EST                                                          | 70            |
| 2.     | Sessional (Assignments/Projects/Tutorials/Quizzes/Lab Evaluations) | 30            |

## UEE409: Network Theory

|    |    |    |    |     |
|----|----|----|----|-----|
| L  | T  | P  | SL | Cr  |
| 45 | 15 | 30 | 45 | 4.5 |

**Course Objective:** To make the students understand the concepts of graph theory, two port networks, filter and attenuators.

### Syllabus:

**Graph Theory:** Graph, Tree and link branches, Network matrices and their relations, Choice of linearly independent network variables, Topological equations for loop current and for nodal voltage, Duality.

**Network Theorems:** Source transformation, Superposition theorem, Thevenin's theorem, Norton's theorem, Millman's theorem, Reciprocity theorem and Maximum power transfer theorem as applied to ac circuits, Compensation theorem, Tellegen's theorem and their applications.

**Two Port Networks:** Two port network description in terms of open circuits impedance, Short circuit admittance, Hybrid and inverse hybrid, ABCD and inverse ABCD parameters, Inter-connection of two port network, Indefinite admittance matrix and its applications.

**Network Functions:** Concepts of complex frequency, Transform impedance, Networks function of one port and two port network, concepts of poles and zeros, property of driving point and transfer function.

**Passive Network Synthesis:** Introduction, Positive Real Functions: Definition, Necessary and sufficient conditions for a function to be positive real, Synthesis vs. analysis, Elements of circuit synthesis, Foster and Cauer forms of LC Networks, Synthesis of RC and RL networks.

**Filters and Attenuators:** Classification of Filters, Analysis of a prototype low pass, high pass, band pass, band stop and m-derived filters, Attenuation, Types of attenuators: symmetrical and asymmetrical.

**Active Filters:** Introduction to Active filters, first and second order low pass Butterworth filter, First and second order high pass Butterworth filter, Band pass filter.

**Laboratory Work:** Verification of Network Theorems, Determination of Z, Y, hybrid and ABCD parameters of two port network, Inter-connection of two port networks, Implementation of different types of filter and attenuator configurations.

### Course Outcomes (COs)

After completion of the course, the students will be able to:

1. Apply various laws and theorems to solve electric networks
2. Analyse the behaviour of two port networks
3. Apply graph theory concept to solve electrical networks
4. Realise one-port network parameters
5. Design different filter and attenuator configurations.

### Text Books

1. Hayt, W., Engineering Circuit Analysis, Tata McGraw-Hill (2006).
2. Hussain, A., Networks and Systems, CBS Publications (2004).

3. Valkenberg, Van, Network Analysis, Prentice–Hall of India Private Limited(2007).
4. Gayakwad, A. Op-Amps and Linear Integrated Circuits, Prentice–Hall of India(2006).

#### Reference Books

1. Chakrabarti,A., Circuit Theory, Dhanpat Rai and Co. (P) Ltd.(2006).
2. Roy Chowdhury, D. Network and Systems, New Age International (P) Limited (2007).
3. Suresh Kumar, K.S. Electrical circuits and Networks, Pearson Education,(2009).

#### CO MAPPING WITH PO and PSO

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PSO 1 | PSO 2 |
|-------|------|------|------|------|------|------|------|------|------|------|------|-------|-------|
| CO1   | 3    | 3    | -    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     |
| CO2   | 3    | 3    | -    | 3    | -    | -    | -    | -    | -    | -    | -    | 2     | -     |
| CO3   | 3    | 3    | -    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | -     |
| CO4   | 3    | 3    | -    | -    | -    | -    | -    | -    | -    | -    | -    | 1     | -     |
| CO5   | 3    | 3    | 3    | 3    | -    | -    | -    | -    | -    | -    | -    | 3     | -     |

#### CO MAPPING WITH WK

| CO/WK | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| CO1   |     | ✓   | ✓   | ✓   |     |     |     |     |     |
| CO2   |     | ✓   | ✓   | ✓   |     |     |     | ✓   |     |
| CO3   |     | ✓   | ✓   | ✓   |     |     |     |     |     |
| CO4   |     | ✓   | ✓   | ✓   |     |     |     |     |     |
| CO5   |     | ✓   | ✓   | ✓   | ✓   |     |     | ✓   |     |

#### Evaluation Scheme

| Sr. No. | Evaluation elements                                                                                                                                        | Weightage (%) |
|---------|------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| 1       | MST                                                                                                                                                        | 25-30         |
| 2       | EST                                                                                                                                                        | 40-45         |
| 3       | Sessional: (May include the following)<br>Assignment, Sessional (Includes Regular Lab assessment and Quizzes Project (Including report, presentation etc.) | 30            |

|  |                                |    |    |    |     |
|--|--------------------------------|----|----|----|-----|
|  | <b>UEI501: Control Systems</b> |    |    |    |     |
|  | L                              | T  | P  | SL | Cr  |
|  | 45                             | 15 | 30 | 45 | 4.5 |

**Course Objective:** To understand concepts of the mathematical modelling, feedback control and stability analysis in Time and Frequency domains. The concept of time response and frequency response of the system will be studied.

**Syllabus:**  
**Basic Concepts:** Historical review, Definitions, Classification, Relative merits and demerits of open and Closed loop systems, Linear and non-linear systems, Transfer function, , Block diagrams and signal flow graphs.

**Components:** D.C. and A.C. Servomotors, D.C. and A.C. Tach generators, Potentiometers and optical encoders, Synchro and stepper motors

**Analysis:** Steady-state errors and error constants, Concepts and applications of P, PD, PI and PID types of control. Stability: Definition, Routh-Hurwitz criterion, Root locus techniques, Nyquist criterion, Bode plots, Relative stability, Gain margin and phase margins.

**Compensation:** Lead, Lag and lag-lead compensators, Design of compensating networks for specified control system performance.

**State Space Analysis:** Concepts of state, State variables and state models, State space equations, Transfer function, Transfer model, State space representation of dynamic systems, State transition matrix, Decomposition of transfer function, Controllability and observability.

**Laboratory Work:** Linear system simulator, Compensation design, D.C. position control and speed control, Synchro characteristics, Servo demonstration, Stepper motor, Potentiometer error detector, Rate control system, Series control system, Temperature control system.

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>Course Outcomes (COs)</b></p> <p>After completion of the course, the students will be able to:</p> <ol style="list-style-type: none"> <li>1. Develop the transfer function of the physical systems</li> <li>2. Analyze the response of the Closed and open loop systems</li> <li>3. Analyze the stability of the Closed and open loop systems</li> <li>4. Design the various kinds of compensator</li> <li>5. Develop and analyze state space models</li> </ol> |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

### Text Books

1. Gopal, M., *Digital Control System*, Wiley Eastern (1986).
2. Nagrath, I.J. and Gopal, M., *Control System Engineering*, New Age International (P) Limited, Publishers (2003).
3. Ogata, K., *Modern Control Engineering*, Prentice–Hall of India Private Limited (2001).

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|     |   |   |   |   |   |   |   |   |   |   |   |   |   |
|-----|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO4 | 3 | 3 | 3 | 3 | 2 | - | - | - | - | - | - | 3 | 1 |
| CO5 | 3 | 3 | - | 3 | - | - | - | - | - | - | - | 3 | - |

| CO MAPPING WITH WK |     |     |     |     |     |     |     |     |     |
|--------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| CO/WK              | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |
| CO1                |     | ✓   | ✓   | ✓   |     |     |     |     |     |
| CO2                |     | ✓   | ✓   | ✓   |     |     |     | ✓   |     |
| CO3                |     | ✓   | ✓   | ✓   |     |     |     | ✓   |     |
| CO4                |     | ✓   | ✓   | ✓   | ✓   | ✓   |     | ✓   |     |
| CO5                |     | ✓   | ✓   | ✓   |     |     |     | ✓   |     |

#### Evaluation Scheme

| S. No. | Evaluation Elements                                                | Weightage (%) |
|--------|--------------------------------------------------------------------|---------------|
| 1.     | MST & EST                                                          | 70            |
| 2.     | Sessional (Assignments/Projects/Tutorials/Quizzes/Lab Evaluations) | 30            |

### UMA035: Optimization Techniques

| L  | T | P  | SL | Cr  |
|----|---|----|----|-----|
| 45 | 0 | 30 | 45 | 4.0 |

**Course Objective:** The main objective of the course is to formulate mathematical models and to understand solution methods for real life optimal decision problems. The emphasis will be on basic study of linear and non-linear programming problems, Integer programming problem, Transportation problem, Two person zero sum games with economic applications and project management techniques using CPM.

#### Syllabus:

**Scope of Operations Research:** Introduction to linear and non-linear programming formulation of different models.

**Linear Programming:** Geometry of linear programming, Graphical method, Linear programming (LP) in standard form, Solution of LP by simplex method, Exceptional cases in LP, Duality theory, Dual simplex method, Sensitivity analysis.

**Integer Programming:** Branch and bound technique, Gomory's Cutting plane method. Network Models: Construction of networks, Network computations, Free Floats, Critical path method (CPM), optimal scheduling (crashing). Initial basic feasible solutions of balanced and unbalanced transportation problems, optimal solutions, assignment problem.

**Multiobjective Programming:** Introduction to multiobjective programming, efficient solution, efficient frontier.

**Nonlinear Programming:** Unconstrained Optimization: unimodal functions, Fibonacci search method, Steepest Descent method, Conjugate Gradient method

**Constrained Optimization:** Concept of convexity and concavity, Maxima and minima of functions of n-variables, Lagrange multipliers, Karush-Kuhn-Tucker conditions for constrained optimization.

**Laboratory Work:** Lab experiments will be set in consonance with materials covered in the theory using Matlab.

#### Course Outcomes (COs)

After completion of the course, the students will be able to:

1. formulate the linear and nonlinear programming problems
2. solve linear programming problems using Simplex method and its variants
3. construct and optimize various network models
4. construct and classify multiobjective linear programming problems
5. solve nonlinear programming problems.

#### Text Books

1. Chandra, S., Jayadeva, Mehra, A., Numerical Optimization and Applications, Narosa Publishing House, (2013)
2. Taha H.A., Operations Research-An Introduction, PHI (2007).

#### Reference Books

1. Pant J. C., Introduction to optimization: Operations Research, Jain Brothers (2004)

2. BazaarraMokhtar S., Jarvis John J. and Shirali Hanif D., Linear Programming and Network flows, John Wiley and Sons(1990)
3. Swarup, K., Gupta, P. K., Mammohan, Operations Research, Sultan Chand & Sons, (2010).
4. H.S. Kasana and K.D. Kumar, Introductory Operations Research, Springer publication,(2004)
5. Ravindran, D. T. Phillips and James J.Solberg: Operations Research- Principles and Practice, John Wiley & Sons, Second edn.(2005).

**CO MAPPING WITH PO and PSO**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PSO 1 | PSO 2 |
|-------|------|------|------|------|------|------|------|------|------|------|------|-------|-------|
| CO1   | 2    | 2    | -    | -    | 2    | -    | -    | -    | -    | -    | -    | 2     | -     |
| CO2   | 2    | 2    | -    | -    | 2    | -    | -    | -    | -    | -    | -    | 3     | -     |
| CO3   | 2    | 2    | -    | -    | 2    | -    | -    | -    | -    | -    | -    | 3     | -     |
| CO4   | 2    | 2    | -    | -    | 2    | -    | -    | -    | -    | -    | -    | 2     | -     |
| CO5   | 2    | 2    | -    | -    | 2    | -    | -    | -    | -    | -    | -    | 2     | -     |

**CO MAPPING WITH WK**

| CO/WK | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| CO1   | ✓   | ✓   |     |     |     | ✓   |     |     |     |
| CO2   | ✓   | ✓   |     |     |     | ✓   |     |     |     |
| CO3   | ✓   | ✓   |     |     |     | ✓   |     |     |     |
| CO4   | ✓   | ✓   |     |     |     | ✓   |     |     |     |
| CO5   | ✓   | ✓   |     |     |     | ✓   |     |     |     |

**Evaluation Scheme**

| Sr. No. | Evaluation elements                    | Weightage (%) |
|---------|----------------------------------------|---------------|
| 1       | MST                                    | 25-30         |
| 2       | EST                                    | 40-45         |
| 3       | Sessional: (May include the following) | 30            |

|  |  |                                                                                                                  |  |
|--|--|------------------------------------------------------------------------------------------------------------------|--|
|  |  | Assignment, Sessional (Includes Regular Lab assessment and Quizzes Project (Including report, presentation etc.) |  |
|--|--|------------------------------------------------------------------------------------------------------------------|--|

## SEMESTER-V

| UEI501: Control Systems                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |    |    |    |    |     |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|----|----|----|-----|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | L  | T  | P  | SL | Cr  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 45 | 15 | 30 | 45 | 4.5 |
| <b>Course Objective:</b> To understand concepts of the mathematical modelling, feedback control and stability analysis in Time and Frequency domains. The concept of time response and frequency response of the system will be studied.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |    |    |    |    |     |
| <b>Syllabus:</b><br><b>Basic Concepts:</b> Historical review, Definitions, Classification, Relative merits and demerits of open and Closed loop systems, Linear and non-linear systems, Transfer function, , Block diagrams and signal flow graphs.<br><br><b>Components:</b> D.C. and A.C. Servomotors, D.C. and A.C. Tach generators, Potentiometers and optical encoders, Synchro and stepper motors<br><br><b>Analysis:</b> Steady-state errors and error constants, Concepts and applications of P, PD, PI and PID types of control.<br><br><b>Stability:</b> Definition, Routh-Hurwitz criterion, Root locus techniques, Nyquist criterion, Bode plots, Relative stability, Gain margin and phase margins.<br><br><b>Compensation:</b> Lead, Lag and lag-lead compensators, Design of compensating networks for specified control system performance.<br><br><b>State Space Analysis:</b> Concepts of state, State variables and state models, State space equations, Transfer function, Transfer model, State space representation of dynamic systems, State transition matrix, Decomposition of transfer function, Controllability and observability. |    |    |    |    |     |
| <b>Laboratory Work:</b> Linear system simulator, Compensation design, D.C. position control and speed control, Synchro characteristics, Servo demonstration, Stepper motor, Potentiometer error detector, Rate control system, Series control system, Temperature control system.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |    |    |    |    |     |
| <b>Course Outcomes (COs)</b><br>After completion of the course, the students will be able to: <ol style="list-style-type: none"> <li>1. Develop the transfer function of the physical systems</li> <li>2. Analyze the response of the Closed and open loop systems</li> <li>3. Analyze the stability of the Closed and open loop systems</li> <li>4. Design the various kinds of compensator</li> <li>5. Develop and analyze state space models</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |    |    |    |    |     |
| <b>Text Books</b> <ol style="list-style-type: none"> <li>1. Gopal, M., <i>Digital Control System</i>, Wiley Eastern (1986).</li> <li>2. Nagrath, I.J. and Gopal, M., <i>Control System Engineering</i>, New Age International (P) Limited, Publishers (2003).</li> <li>3. Ogata, K., <i>Modern Control Engineering</i>, Prentice–Hall of India Private Limited (2001).</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |    |    |    |    |     |

| CO MAPPING WITH PO and PSO |     |     |     |     |     |     |     |     |     |      |      |      |      |
|----------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|
| CO/PO                      | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1                        | 3   | 3   | -   | -   | -   | -   | -   | -   | -   | -    | -    | 3    | -    |
| CO2                        | 3   | 3   | -   | 3   | -   | -   | -   | -   | -   | -    | -    | 3    | -    |
| CO3                        | 3   | 3   | -   | 3   | -   | -   | -   | -   | -   | -    | -    | 3    | -    |
| CO4                        | 3   | 3   | 3   | 3   | 2   | -   | -   | -   | -   | -    | -    | 3    | 1    |
| CO5                        | 3   | 3   | -   | 3   | -   | -   | -   | -   | -   | -    | -    | 3    | -    |

  

| CO MAPPING WITH WK |     |     |     |     |     |     |     |     |     |  |
|--------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|--|
| CO/WK              | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |  |
| CO1                |     | ✓   | ✓   | ✓   |     |     |     |     |     |  |
| CO2                |     | ✓   | ✓   | ✓   |     |     |     | ✓   |     |  |
| CO3                |     | ✓   | ✓   | ✓   |     |     |     | ✓   |     |  |
| CO4                |     | ✓   | ✓   | ✓   | ✓   | ✓   |     | ✓   |     |  |
| CO5                |     | ✓   | ✓   | ✓   |     |     |     | ✓   |     |  |

  

| Evaluation Scheme |                                                                    |               |
|-------------------|--------------------------------------------------------------------|---------------|
| S. No.            | Evaluation Elements                                                | Weightage (%) |
| 1.                | MST & EST                                                          | 70            |
| 2.                | Sessional (Assignments/Projects/Tutorials/Quizzes/Lab Evaluations) | 30            |

## UTA026: MANUFACTURING PROCESSES

| L  | T | P  | SL | Cr  |
|----|---|----|----|-----|
| 30 | 0 | 30 | 30 | 3.0 |

**Course Objectives:** This course introduces the basic concepts of manufacturing via machining, forming, joining, casting and assembly, enabling the students to develop a basic knowledge of the mechanics, operation and limitations of basic machining tools. The course also introduces the concept of metrology and measurement of parts.

**Machining Processes:** Principles of metal cutting, Cutting tools, Cutting tool materials and applications, Geometry of single point cutting tool, Introduction to multi-point machining processes – milling, drilling and grinding, Tool Life, Introduction to computerized numerical control (CNC) machines, G and M code programming for simple turning and milling operations, introduction of canned cycles.

**Metal Casting:** Principles of metal casting, Introduction to sand casting, Requisites of a sound casting, Permanent mold casting processes.

**Metal Forming:** Forging, Rolling, Drawing, Extrusion, Sheet Metal operations.

**Joining Processes:** Electric arc, Resistance welding, Soldering, Brazing.

### Laboratory Work:

Relevant shop floor exercises involving practices in Sand casting, Machining, Welding, Sheet metal fabrication techniques, CNC turning and milling exercises, Experiments on basic engineering metrology and measurements to include measurements for circularity, ovality, linear dimensions, profiles, radius, angular measurements, measurement of threads, surface roughness.

Basic knowledge and derivations related to above measurements, uncertainties, statistical approaches to estimate uncertainties, Line fitting, static and dynamic characteristics of instruments will be discussed in laboratory classes.

**Assignments:** Assignments for this course will include the topics: Manufacturing of micro-chips used in IT and electronics industry and use of touch screens. Another assignment will be given to practice numerical exercises on topics listed in the syllabus.

**Micro Project:** Fabrication of multi-operational jobs using the above processes as per requirement by teams consisting of 4-6 members. The use of CNC machines must be part of micro project. Quality check should be using the equipment available in metrology lab.

### Course Outcomes (COs):

After the completion of this module, students will be able to:

1. develop simple CNC code, and use it to produce components while working in groups.
2. analyse various machining processes and calculate relevant quantities such as velocities, forces.
3. recognise cutting tool wear and identify possible causes and solutions.
4. understand the basic principle of bulk and sheet metal forming operations for analysis of forces.
5. analyse various shearing operations for tooling design.
6. apply the knowledge of metal casting for different requirements.

**Text books:**

1. Degarmo, E. P., Kohser, Ronald A. and Black, J. T., *Materials and Processes in Manufacturing*, Prentice Hall of India (2008) 8th ed.
2. Kalpakjian, S. and Schmid, S. R., *Manufacturing Processes for Engineering Materials*, Dorling Kingsley (2006) 4th ed.

**Reference Books:**

1. Martin, S.I., Chapman, W.A.J., *Workshop Technology*, Vol. I & II, Viva Books (2006) 4th ed.
2. Zimmer, E.W. and Groover, M.P., *CAD/CAM - Computer Aided Designing and Manufacturing*, Dorling Kingsley (2008).
3. Pandey, P.C. and Shan, H. S., *Modern Machining Processes*, Tata McGraw Hill (2008).
4. Mishra, P. K., *Non-Conventional Machining*, Narosa Publications (2006).
5. Campbell, J.S., *Principles of Manufacturing, Materials and Processes*, Tata McGraw Hill Company (1999).
6. Lindberg, Roy A., *Processes and Materials of Manufacture*, Prentice Hall of India (2008) 4th ed.

**CO MAPPING WITH PO and PSO**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|-------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| CO1   | 3    | 2    | -    | -    | -    | -    | -    | 3    | -    | -     | 2     | 2     | 2     | -     |
| CO2   | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | 2     | 2     | -     | -     |
| CO3   | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | 2     | -     | -     | -     |
| CO4   | 3    | 2    | -    | -    | -    | -    | -    | 2    | -    | -     | 2     | 2     | 2     | -     |
| CO5   | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -     | 2     | 2     | -     | -     |
| CO6   | 3    | 2    | -    | -    | -    | -    | -    | 2    | -    | -     | 2     | 2     | 2     | -     |

**CO MAPPING WITH WK**

| CO/WK | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| CO1   |     |     | ✓   | ✓   |     | ✓   |     |     |     |
| CO2   |     | ✓   | ✓   | ✓   |     | ✓   |     | ✓   |     |
| CO3   |     | ✓   | ✓   | ✓   |     | ✓   |     |     |     |
| CO4   |     | ✓   | ✓   | ✓   |     |     |     |     |     |

|     |  |   |   |   |  |   |  |   |  |
|-----|--|---|---|---|--|---|--|---|--|
| CO5 |  | ✓ | ✓ | ✓ |  |   |  | ✓ |  |
| CO6 |  | ✓ | ✓ | ✓ |  | ✓ |  |   |  |

**Evaluation Scheme:**

| Sr. No. | Evaluation elements                                                                                                                                               | Weightage (%) |
|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|
| 1       | MST                                                                                                                                                               | 25            |
| 2       | EST                                                                                                                                                               | 40            |
| 3       | Sessional: (May include the following)<br>Assignment, Sessionals (Includes Regular Lab<br>assessment and Quizzes Project (Including<br>report, presentation etc.) | 35            |

## UEE509: POWER SYSTEM ANALYSIS

| L  | T  | P  | SL | Cr  |
|----|----|----|----|-----|
| 45 | 15 | 30 | 45 | 4.5 |

**Course objective:** To explain concepts of power flow analysis, rotor angle and voltage, economic operation, load-frequency control and power system security.

**Load Flow Analysis:** Power flow equations, load flow solution using Gauss Seidal and Newton Raphson methods, decoupled and fast decoupled methods, comparison of load flow methods.

**Power System Stability:** Concepts of types of stability limits, steady state stability analysis, transient stability analysis, Swing equation and its solution by point-by-point method, Equal area criterion, critical clearing angle and improvement of transient stability.

**Economic Operation:** Characteristics of thermal and hydro units, Incremental fuel rate and their approximation, Minimum and maximum power generation limits; Economic dispatch with and without transmission line losses, Unit Commitment, Hydrothermal scheduling problems, Hydro-scheduling, solution methods.

**Power System Security:** Factors affecting security, Contingency analysis, Network sensitivity, correcting the generation dispatch by using sensitivity method.

**Voltage Stability:** Basic concepts, Voltage collapse, P-V and Q-V curves, Impact of load, Static and dynamic analysis of voltage stability, Prevention of voltage collapse.

**Laboratory work:** Simulate power flow solutions using NR method, stability studies using point by point integration method, economic load dispatch with and without losses and draw PV curve for single-machine infinite bus system, realize ALFC and AVR control and bias control on Simulink.

### Course Outcomes (COs):

After the completion of the course the students will be able to:

1. Analyse power flow of balanced power system.
2. Analyse the stability of single machine-infinite bus system.
3. Decide the scheduling of thermal units and hydro-thermal units for overall economy.
4. Design and apply control for frequency and voltage of power system represented by multi-area.
5. Carryout voltage stability and contingency analysis.

### Text Books:

1. Chakraborti, A., Soni, M.L., Gupta, P.V. and Bhatnagar, U.S., *A Text Book on Power System Engineering*, Dhanpat Rai and Co. (P) Ltd.(2008).
2. Nagrath, I.J. and Kothari, D.P., *Power System Engineering*, Tata McGraw-Hill(2007).
3. Stevenson, W.D., *Power System Analysis*, McGraw Hill(2007).

### Reference Books:

1. Kothari, D.P., Dhillon, J.S., *Power System Optimization*, PHI Learning(2010).
2. Allen J. Wood, Bruce F. Wollenberg and Gerald B. Sheble, *Power Generation, Operation and Control*, Wiley-Interscience(2013).
3. Kimbark, E. W., *Power System Stability, Volumes-I*, IEEE Press(1995).
4. Jizhong Z., *Optimization of power system operation*, Edition Wiley(1996).

5. Elgerd, O. *Electric Energy Systems Theory*, McGraw Hill Education Private Limited(2001).

**CO MAPPING WITH PO and PSO**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PSO 1 | PSO 2 |
|-------|------|------|------|------|------|------|------|------|------|------|------|-------|-------|
| CO1   | 3    | 3    | -    | 3    | -    | -    | -    | -    | -    | -    | 1    | 3     | 2     |
| CO2   | 3    | 3    | -    | 3    | -    | -    | -    | -    | -    | -    | 1    | 3     | 2     |
| CO3   | 3    | 3    | 3    | -    | -    | 2    | -    | -    | -    | -    | 1    | 3     | 2     |
| CO4   | 3    | 3    | -    | 3    | -    | -    | -    | -    | -    | -    | 1    | 3     | 2     |
| CO5   | 3    | 3    | -    | -    | -    | -    | -    | -    | -    | -    | 1    | 3     | 2     |

**CO MAPPING WITH WK**

| CO/WK | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| CO1   |     | ✓   | ✓   | ✓   |     |     |     | ✓   |     |
| CO2   |     | ✓   | ✓   | ✓   |     |     |     | ✓   |     |
| CO3   |     | ✓   | ✓   | ✓   | ✓   |     |     |     |     |
| CO4   |     | ✓   | ✓   | ✓   |     |     |     | ✓   |     |
| CO5   |     | ✓   | ✓   | ✓   |     |     |     |     |     |

**Evaluation Scheme:**

| S. No. | Evaluation Elements                                                | Weightage (%) |
|--------|--------------------------------------------------------------------|---------------|
| 1.     | MST                                                                | 25            |
| 2.     | EST                                                                | 45            |
| 3.     | Sessional (Assignments/Projects/Tutorials/Quizzes/Lab Evaluations) | 30            |

## UEE510: HIGH VOLTAGE ENGINEERING

| L  | T | P  | SL | Cr  |
|----|---|----|----|-----|
| 45 | 0 | 30 | 45 | 4.0 |

**Course Objective:** To introduce the concepts of breakdown of gaseous, solid, and liquid insulations including generation and measurement of high voltage DC, AC and HV Impulse.

**Introduction:** Basic concept of high voltage engineering, need for higher voltages in power systems, classification of levels of voltage, concept of electrical insulation or dielectric materials, importance of high voltage measurement and testing, safety measures for high voltage systems.

**Effects of Electric Field and Electric Stress:** Concept of uniform and non-uniform electric field, electric stress control in dielectrics, electric strength of dielectric, types of breakdowns, estimation of electric field intensity.

**Breakdown in Gaseous Insulations:** Elementary ideas on ionization by electron collision, Townsend mechanism, Townsend's first and second ionization coefficients, Paschen's law, breakdown in non-uniform fields and corona discharges, vacuum breakdown mechanisms, application of gaseous insulations.

**Breakdown in Liquid Insulations:** Breakdown in liquids, fundamentals of insulating oils, conduction and breakdown in pure and commercial liquids, properties of liquid insulation-transformer oil, testing of insulating oils/fluids, effect of moisture on dielectric properties of liquid insulation, alternative liquid insulations, applications.

**Breakdown in Solid Insulations:** Fundamentals of solid insulating materials intrinsic, electromechanical and thermal breakdown, breakdown in simple and composite dielectrics, types of insulating materials, temperature classification, factor affecting dielectric strength, applications of solid insulations, design of insulations for rotating machines, transformers, transmission lines, switch gear, etc.

**Generation of High Voltages and Currents:** Generation of HVDC, half and full wave rectifier circuits, voltage doubler and cascaded circuits, electrostatic machines, Generation of HVAC, cascade transformers, resonant transformer, generation of high frequency ac high voltage, high voltage impulse, circuits for impulse waves, characteristics parameters of impulse voltages, single stage impulse generator circuits, multistage impulse generation circuits, generation of impulse current.

**Measurement of High Voltages:** Principles, classification and applications of potential dividers, generating voltmeters, Measurement of HVDC, HVAC and HV impulse, electrostatic voltmeters, peak voltage measurement with sphere gaps, ammeter in series with high voltage resistors and voltage divider, capacitive voltage transformer (CVT), potential transformer, peak reading voltmeter for ac voltage, impulse voltage.

**Overvoltage Phenomenon and Insulation Coordination:** Causes of overvoltages in power system: lightning, switching surges, travelling waves, lattice diagram, insulation coordination

in high voltage systems, surge arresters, BIL, equipment insulation level and insulation coordination of sub-stations

**Non-Destructive Tests:** Measurement of dc resistivity, dielectric constant and loss factor, measurement of dielectric properties by Schering bridge, partial discharge measurement, partial discharge detection in power cables.

**High Voltage Testing:** Testing of power system component such as insulators, circuit breakers, cables and transformers, testing of surge arresters, radio interference measurement.

**Laboratory work:** BDV measurement for liquid and solid insulation, Generation of HVDC, HVAC and Impulse, Voltage measurement by sphere gap and Chubb and Fortesque methods, Insulation resistance measurement, experimental setup for standard lightning wave, peak voltage measurement by sphere gap, capacitance and dissipation factor measurement, partial discharge measurements, flashover voltage measurement for string insulator.

#### Course Outcomes (COs):

After the completion of the course the students will be able to:

1. Analyze the breakdown mechanism of solids, liquids and gases.
2. Calculate the circuit parameters involved in generation of high voltages.
3. Measure direct, alternating and impulse high voltage signals.
4. Analyze application of insulation coordination for high voltage power system.
5. Perform non-destructive tests and high voltage tests on electrical apparatus.

#### Text Books:

1. Khalifa, M., *High Voltage Engineering: Theory and Practice*, Marcel Dekker Inc. (2000).
2. Naidu, M.S. and Kamaraju, V., *High Voltage Engineering*, 6th Ed, McGraw Hill (2020).
3. Arora Ravindra and Rajpurohit Bharat Singh, *Fundamentals of High-Voltage Engineering*, 1st Ed, Wiley, 2019
4. Wadhwa, C.L., *High Voltage Engineering*, 3rd Ed, New Age International (P) Limited Publishers, 2020.

#### Reference Books:

1. Kuffel, E., Zaengl, W.S., Kuffel, J. *High Voltage Engineering Fundamentals*, Butterworth-Heinemann, 2000
2. Huge M. Ryan, Editor; *High-Voltage Engineering and Testing*, 3<sup>rd</sup> Edition, Institution of Engineering and Technology, 2013.

| CO MAPPING WITH PO and PSO |         |         |         |         |         |         |         |         |         |          |          |          |          |
|----------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|----------|----------|----------|----------|
| CO/P<br>O                  | PO<br>1 | PO<br>2 | PO<br>3 | PO<br>4 | PO<br>5 | PO<br>6 | PO<br>7 | PO<br>8 | PO<br>9 | PO1<br>0 | PO1<br>1 | PSO<br>1 | PSO<br>2 |
| CO1                        | 2       | 2       | -       | -       | -       | 1       | -       | -       | -       | -        | -        | 2        | 1        |

|     |   |   |   |   |   |   |   |   |   |   |   |   |   |
|-----|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO2 | 3 | 3 | - | - | - | - | - | - | - | - | - | 2 | 1 |
| CO3 | 1 | 1 | - | - | - | - | - | - | - | - | - | 2 | 1 |
| CO4 | 3 | 3 | - | 3 | - | - | - | - | - | - | - | 2 | 1 |
| CO5 | 2 | 2 | - | - | 2 | - | - | - | - | - | - | 2 | 1 |

| CO MAPPING WITH WK |     |     |     |     |     |     |     |     |     |  |
|--------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|--|
| CO/WK              | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |  |
| CO1                | ✓   | ✓   |     |     |     |     |     |     |     |  |
| CO2                |     | ✓   | ✓   | ✓   |     |     |     |     |     |  |
| CO3                |     | ✓   |     |     |     |     |     |     |     |  |
| CO4                |     | ✓   | ✓   | ✓   |     |     |     | ✓   |     |  |
| CO5                |     |     | ✓   | ✓   |     | ✓   |     |     |     |  |

**Evaluation Scheme:**

| S. No. | Evaluation Elements                                                | Weightage (%) |
|--------|--------------------------------------------------------------------|---------------|
| 1      | MST                                                                | 25            |
| 2      | EST                                                                | 45            |
| 3      | Sessional (Assignments/Projects/Tutorials/Quizzes/Lab Evaluations) | 30            |

## UEE504: POWER ELECTRONICS

| L  | T  | P  | SL | Cr  |
|----|----|----|----|-----|
| 45 | 15 | 30 | 45 | 4.5 |

**Course objective:** To review the operational aspects of power electronic devices and principle of conversion and control of AC and DC voltages for high power applications.

**Introduction:** Introduction to Thyristors and its family, static and dynamic characteristics, turn-on and turn-off methods and firing circuits, Ratings and protection of SCRs, series and parallel operation.

**Phase Controlled Converters:** Principle of phase control, Single phase and three phase converter circuits with different types of loads, continuous and discontinuous conduction, effect of source inductance, Dual converters and their operation.

**DC Choppers:** Principle of chopper operation, control strategies, types of choppers, step up and step down choppers, steady state time domain analysis with R, L, and E type loads, voltage, current and load commutated choppers.

**Inverters:** Single phase voltage source bridge inverters and their steady state analysis, modified McMurray half bridge inverter, series inverters, three phase bridge inverters with  $180^\circ$  and  $120^\circ$  modes. Single-phase PWM inverters, current source inverters, CSI with R load (qualitative approach).

**AC Voltage Controllers:** Types of single-phase voltage controllers, single-phase voltage controller with R and RL type of loads.

**Cycloconverters:** Principles of operation, single phase to single phase step up and step down cycloconverters, three phase to single phase cycloconverters, output voltage equation for acycloconverter.

**Laboratory work:** SCR V-I characteristics, Gate firing circuit, DC -DC chopper, Semi converter and Full converter with R, RL and RLE type of loads, DC shunt motor speed control, Single phase AC voltage controller with R load, Inverters, Simulation of power electronics converters.

### Course Outcomes (COs):

After the completion of the course the students will be able to:

1. Select the power devices as per the usage for energy conversion and control.
2. Design of firing and commutation circuits for different converter configurations.
3. Analyse various converter configuration / topology with different types of load.
4. Identify converter configurations for various power applications.
5. Exhibit the usage of power converters for harmonic mitigation, voltage and frequency control.

### Text Books:

1. Dubey, G.K., Doradla, S.R., Joshi, A. and Sinha, R.M.K., *Thyristorised Power Controllers*, New Age International (P) Limited, Publishers(2004).
2. Rashid, M., *Power Electronics*, Prentice Hall of India(2006).
3. Bimbhra, P.S., *Power Electronics*, Khanna Publishers(2012).

### Reference Books:

1. Mohan, N., Underland, T. and Robbins, W. P., *Power Electronics: Converter Applications and Design*, John Wiley (2007)<sup>3rd ed.</sup>
2. Bose, B.K., *Handbook of Power Electronics*, IEEE Publications

| CO MAPPING WITH PO and PSO |      |      |      |      |      |      |      |      |      |      |      |       |       |
|----------------------------|------|------|------|------|------|------|------|------|------|------|------|-------|-------|
| CO/PO                      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PSO 1 | PSO 2 |
| CO1                        | 3    | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | 2     |
| CO2                        | 3    | 3    | 2    | 3    | -    | -    | -    | -    | -    | -    | -    | 2     | 2     |
| CO3                        | 3    | 3    | -    | 1    | -    | -    | -    | -    | -    | -    | -    | 2     | 1     |
| CO4                        | 3    | 3    | 3    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | 3     |
| CO5                        | 3    | 3    | -    | -    | -    | -    | -    | -    | -    | -    | -    | 2     | 2     |

| CO MAPPING WITH WK |     |     |     |     |     |     |     |     |     |
|--------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| CO/WK              | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |
| CO1                |     | ✓   | ✓   | ✓   | ✓   |     |     |     |     |
| CO2                |     | ✓   | ✓   | ✓   | ✓   | ✓   |     | ✓   |     |
| CO3                |     | ✓   | ✓   | ✓   |     |     |     | ✓   |     |
| CO4                |     | ✓   | ✓   | ✓   | ✓   |     |     |     |     |
| CO5                |     | ✓   | ✓   | ✓   |     |     |     |     |     |

**Evaluation Scheme:**

| S. No. | Evaluation Elements                                       | Weightage (%) |
|--------|-----------------------------------------------------------|---------------|
| 1.     | MST                                                       | 25            |
| 2.     | EST                                                       | 45            |
| 3.     | Sessional (Assignments/Tutorials/Quizzes/Lab Evaluations) | 30            |

**UEE525: DATA ANALYTICAL METHODS (Elective-I)**

| L  | T | P  | SL | Cr  |
|----|---|----|----|-----|
| 30 | 0 | 30 | 30 | 3.0 |

**Course Objective:** Data Analytics is the science of analysing data to convert information to useful knowledge. This knowledge could help the students understand our world better, and in many contexts enable us to make better decisions. This course seeks to present the students with a wide range of data analytic techniques and is structured around the broad contours of the different types of data analytics, namely, descriptive, inferential, predictive, and prescriptive analytics.

**Introduction:** Data definitions and Analysis techniques, Elements, Variables, and Data categorization, Levels of Measurement, Data management and indexing.

**Data Cleaning:** Organizing, merging and managing the data, Obtain usable data from the web, APIs, and databases, Understand common data storage systems.

**Statistical Interference:** Review of probability, random variables, expectations, Measures of central tendency, Measures of location of dispersions, Statistical hypothesis generation and testing, Correlation analysis, Maximum likelihood test, confidence intervals.

**Exploratory Data Analytics:** Regression analysis, Classification techniques, Clustering, Multivariable regression, Investigate analysis of residuals and variability, Understand ANOVA and ANCOVA model cases.

**Data Visualization:** Dimension reduction, graphical displays of very high dimensional data, Understand analytic graphics and Visualization.

**Advancement in Data Analytics:** Big data storage, bog data warehouse, big data on cloud, Scalable and parallel computing concept, advanced graphing systems such as the Lattice system.

**Laboratory Work:** Fundamentals of Python and associated Libraries NumPy, Pandas, Matplotlib; Implement central tendency measures, Analysis of Variance - one-way and two-way ANOVA, Hypothesis testing; Implement linear regression, K-means clustering, Binary classification; Visualization of data; different plots including density plots, box-plot, heat map, area plot.

**Course Outcomes (COs):**

After the completion of the course the students will be able to:

1. Analyze data by utilizing clustering and classification algorithms
2. Analyze big data and create statistical models
3. Explore advanced level of understanding of the usage of big data in real world
4. Comprehend the concepts of advancement in big data analytics.

**Text Books:**

1. Anand Rajaraman and Jeffrey David Ullman, "Mining of Massive Datasets", Cambridge University Press, 2012.
2. David Loshin, "Big Data Analytics: From Strategic Planning to Enterprise

Integration with Tools, Techniques, NoSQL, and Graph”, Morgan Kaufmann/El sevier Publishers, 2013.

| CO MAPPING WITH PO and PSO |     |     |     |     |     |     |     |     |     |      |      |      |      |
|----------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|
| CO/PO                      | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1                        | 2   | 2   | -   | 3   | 2   | -   | -   | -   | -   | -    | -    | 3    | -    |
| CO2                        | 2   | 2   | -   | 3   | 2   | -   | -   | -   | -   | -    | -    | 3    | -    |
| CO3                        | 2   | 2   | -   | 3   | 2   | -   | -   | -   | -   | -    | -    | 3    | -    |
| CO4                        | 2   | 2   | -   | 3   | 2   | -   | -   | -   | -   | -    | -    | 3    | -    |

| CO MAPPING WITH WK |     |     |     |     |     |     |     |     |     |  |
|--------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|--|
| CO/WK              | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |  |
| CO1                |     | ✓   | ✓   |     |     | ✓   |     | ✓   |     |  |
| CO2                |     | ✓   | ✓   |     |     | ✓   |     | ✓   |     |  |
| CO3                |     | ✓   | ✓   |     |     | ✓   |     | ✓   |     |  |
| CO4                |     | ✓   | ✓   |     |     | ✓   |     | ✓   |     |  |

**Evaluation Scheme:**

| Sr. No. | Evaluation Elements                                | Weightage (%) |
|---------|----------------------------------------------------|---------------|
| 1.      | MST                                                | 30            |
| 2.      | EST                                                | 45            |
| 3.      | Sessional (Assignments/Projects/Tutorials/Quizzes) | 25            |

## UEE526: EMBEDDED SYSTEM DESIGN (Elective-I)

| L  | T | P  | SL | Cr  |
|----|---|----|----|-----|
| 30 | 0 | 30 | 30 | 3.0 |

**Introduction:** Introduction to Embedded System and its Architecture and system Model, Introduction to the ARM Processor architecture, Embedded Hardware Building Block.

**Microprocessor Architecture:** Core Architecture, Reset, Power architecture, Low power modes, Clock Functions, Memory organization and system, addressing modes, instruction set, Input & Output port, Data Conversion, RAM & ROM Allocation, Timer programming, Exception Processing–Watch dog, Soft Resets and Interrupts, Communications-SPI, RS232, I2C, CAN and ADC.

**Embedded Programming:** C-language programming basics, declarations and expressions, arrays, qualifiers and reading numbers, decision and control statements.

**Development tools and Programming:** Hardware and Software development tools, Project IDE, Compiler, Assembler and Debugger, JTAG and Hardware Debuggers, Interfacing with LCD, Real Time Clock and Temperature Sensors with I2C and SPI bus.

**Real-time Operating Systems in Embedded system:** Basic concepts of Real-time Operating Systems (RTOS) and its types, Task, process & threads, interrupt routines in RTOS, Multiprocessing and Multitasking, Preemptive and non-preemptive scheduling, Concurrency, Reentrancy, Intertask communication, Implementation of RTOS with some case studies.

**Laboratory Work:** Programming of micro controller with Integrated development environment(IDE), Use of JTAG and Hardware Debuggers, Input Devices and Output Devices with their Programming, programming for Interrupts, Clock Functions, LCD interfacing, Interfacing Keypad and Switch Debouncing, ADC, DAC, Real Time Clock, Temperature Sensors with I2C and SPI bus. Interfacing to Motor, LCDs, Transducer, RS-232 Interface and their examples.

### Course Outcomes (COs):

After the completion of the course the students will be able to:

1. Acquire a basic knowledge about programming and system control to perform a specific task.
2. Acquire knowledge about devices and buses employed in embedded networking
3. Develop programming skills in embedded systems for various applications.
4. Acquire knowledge about the basic concepts of circuit emulators.
5. Acquire knowledge about the life cycle of embedded design and its testing.

### Text Books:

1. Barrett, S.F. and Pack, J.D., *Embedded Systems*, Pearson Education (2008).
2. Haung, H.W., *The HCS12 / 9S12: An Introduction to Software and Hardware Interfacing*, Delmar Learning(2007).

### Reference Books:

1. Fredrick, M.C., *Assembly and C programming for HCS12*

*Microcontrollers, Oxford University Press(2005).*

2. *Ray, A.K., Advance Microprocessors and Peripherals – Architecture, Programming and Interfacing, Tata McGraw Hill(2007)*

#### CO MAPPING WITH PO and PSO

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PSO 1 | PSO 2 |
|-------|------|------|------|------|------|------|------|------|------|------|------|-------|-------|
| CO1   | 2    | 2    | -    | -    | 3    | -    | -    | -    | -    | -    | -    | 2     | 2     |
| CO2   | 2    | 2    | -    | -    | 3    | -    | -    | -    | -    | -    | -    | 2     | 2     |
| CO3   | 2    | 2    | -    | -    | 3    | -    | -    | -    | -    | -    | -    | 2     | 2     |
| CO4   | 2    | 2    | -    | -    | 3    | -    | -    | -    | -    | -    | -    | 2     | 2     |
| CO5   | 2    | 2    | -    | -    | 3    | -    | -    | -    | -    | -    | -    | 2     | 2     |

#### CO MAPPING WITH WK

| CO/WK | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| CO1   |     | ✓   |     | ✓   |     | ✓   |     |     |     |
| CO2   |     | ✓   |     | ✓   |     | ✓   |     |     |     |
| CO3   |     | ✓   |     | ✓   |     | ✓   |     |     |     |
| CO4   |     | ✓   |     | ✓   |     | ✓   |     |     |     |
| CO5   |     | ✓   |     | ✓   |     | ✓   |     |     |     |

#### Evaluation Scheme:

| Sr. No. | Evaluation Elements                                                | Weightage (%) |
|---------|--------------------------------------------------------------------|---------------|
| 1       | MST                                                                | 25            |
| 2       | EST                                                                | 45            |
| 3       | Sessional (Assignments/Projects/Tutorials/Quizzes/Lab Evaluations) | 30            |

### UCS417: Introduction to Operating Systems (Elective-I)

| L  | T | P  | SL | Cr  |
|----|---|----|----|-----|
| 30 | 0 | 30 | 30 | 3.0 |

**Course Objective:** To understand the role, responsibilities, and the algorithms involved for achieving various functionalities of an Operating System.

#### Syllabus:

**Introduction and System Structures:** Computer-System Organization, Computer-System Architecture, Operating-System Structure, Operating-System Operations, Process Management, Memory Management, Storage Management, Protection and Security, Computing Environments, Operating-System Services, User and Operating-System Interface, System Calls, Types of System Calls, System Programs, Operating-System Design and Implementation, Operating-System Structure.

**Process Management:** Process Concept, Process Scheduling, Operations on Processes, Inter-process Communication, Multi-threaded programming: Multi-core Programming, Multithreading Models, Process Scheduling: Basic Concepts, Scheduling Criteria, Scheduling Algorithms, Multiple-Processor Scheduling, Algorithm Evaluation.

**Deadlock:** System Model, Deadlock Characterization, Methods for Handling Deadlocks, Deadlock Prevention, Deadlock Avoidance, Deadlock Detection, Recovery from Deadlock.

**Memory Management:** Basic Hardware, Address Binding, Logical and Physical Address, Dynamic linking and loading, Shared Libraries, Swapping, Contiguous Memory Allocation, Segmentation, Paging, Structure of the Page Table, Virtual Memory Management: Demand Paging, Copy-on-Write, Page Replacement, Allocation of Frames, Thrashing, Allocating Kernel Memory.

**File Systems:** File Concept, Access Methods, Directory and Disk Structure, File-System Mounting, File Sharing, Protection, File-System Structure, File-System Implementation, Directory Implementation, Allocation Methods, Free-Space Management.

**Disk Management:** Mass Storage Structure, Disk Structure, Disk Attachment, Disk Scheduling, Disk Management, Swap-Space Management, RAID Structure.

**Protection and Security:** Goals of Protection, Principles of Protection, Domain of Protection, Access Matrix, Implementation of the Access Matrix, Access Control, Revocation of Access Rights, Capability-Based Systems, The Security Problem, Program Threats, System and Network Threats, User Authentication, Implementing Security Defenses, Firewalling to Protect Systems and Networks.

**Concurrency:** The Critical-Section Problem, Peterson's Solution, Synchronization Hardware, Mutex Locks, Semaphores, Classic Problems of Synchronization, Monitors.

**Laboratory Work:** To explore detailed architecture and shell commands in Linux / Unix environment, and to simulate CPU scheduling, Paging, Disk-scheduling and process synchronization algorithms.

#### Course Outcomes (COs)

After completion of the course, the students will be able to:

1. Explain the basic of an operating system viz. system programs, system calls, user mode and kernel mode.
2. Select particular CPU scheduling algorithms for specific situation, and analyze the environment leading to deadlock and its rectification.

3. Explicate memory management techniques viz. caching, paging, segmentation, virtual memory, and thrashing.
4. Understand the concepts related to file systems, disk-scheduling, and security, protection.
5. Comprehend the concepts related to concurrency.

#### Text Books

1. Silberschatz A., Galvin B. P. and Gagne G., Operating System Concepts, John Wiley & Sons Inc (2013) 9<sup>th</sup> ed.
2. Stallings W., Operating Systems Internals and Design Principles, Prentice Hall (2018) 9<sup>th</sup> ed.

#### Reference Books

1. Bovet P. D., Cesati M., Understanding the Linux Kernel, O'Reilly Media (2006), 3<sup>rd</sup> ed.
2. Kifer M., Smolka A. S., Introduction to Operating System Design and Implementation: The OSP 2 Approach, Springer (2007).

#### CO MAPPING WITH PO and PSO

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|
| CO1   | 1   | 1   | -   | -   | -   | -   | -   | -   | -   | -    | -    | 3    | -    |
| CO2   | 2   | 2   | 3   | 3   | -   | -   | -   | -   | -   | -    | -    | 3    | -    |
| CO3   | 2   | 2   | -   | -   | -   | -   | -   | -   | -   | -    | -    | 3    | -    |
| CO4   | 1   | 1   | -   | -   | -   | -   | -   | -   | -   | -    | -    | 3    | -    |
| CO5   | 1   | 1   | -   | -   | -   | -   | -   | -   | -   | -    | -    | 3    | -    |

#### CO MAPPING WITH WK

| CO/WK | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| CO1   |     | ✓   |     |     |     |     |     |     |     |
| CO2   |     | ✓   | ✓   |     | ✓   |     |     | ✓   |     |
| CO3   |     | ✓   | ✓   |     |     |     |     |     |     |
| CO4   |     | ✓   |     |     |     |     |     |     |     |
| CO5   |     | ✓   |     |     |     |     |     |     |     |

#### Evaluation Scheme

| S. No. | Evaluation Elements                                                | Weightage (%) |
|--------|--------------------------------------------------------------------|---------------|
| 1.     | MST & EST                                                          | 70            |
| 2.     | Sessional (Assignments/Projects/Tutorials/Quizzes/Lab Evaluations) | 30            |

## UCS541: FOUNDATIONS OF ARTIFICIAL INTELLIGENCE

| L  | T | P  | SL | Cr  |
|----|---|----|----|-----|
| 45 | 0 | 30 | 45 | 4.0 |

**Course Objectives:** The student should study the concepts of artificial intelligence and learn the methods of solving problems using artificial intelligence.

**Overview:** Definition, scope, foundations, approaches, and applications of AI; AI: past, present, and future.

**Agents and Environments:** agents; rationality; types of agents; properties of environments.

**State Space Representation:** State and operators; state space; representation real world problems as state space, problem characteristics.

**Searching Strategies:** uninformed searching methods (DFS, BFS, DFS-ID); informed searching methods such as best first search, hill climbing, A\*, iterative deepening A\*; problem reduction; constraint satisfaction problems; neural, stochastic, and evolutionary algorithms, local search and optimization problems in different environment.

**Game Playing:** Game theory and optimal decisions; Turn-taking games; Adversarial search; Minimax principle; Monte-Carlo tree search; Alpha-Beta pruning.

**Reasoning:** Representation, Inference, Propositional Logic, predicate logic (first order logic), syntax and semantics, logical reasoning, forward chaining, backward chaining.

**Dealing with uncertainty:** probability, connection to logic, independence, Bayes rule, Bayesian networks, probabilistic inference; time and uncertainty, hidden Markov model; Decision making- Utility theory, utility functions, Decision theoretic expert systems

**Fuzzy Systems:** Fuzzy sets, Operation on fuzzy sets, Fuzzy relations, Fuzzy measures, Fuzzy reasoning, Fuzzy controller,

**Neural Network as Learning Machine:** Mathematical model of neuron, activation functions, types of learning, learning methods, classification of neural networks, perceptron and multilayer perceptron, gradient and error back-propagation learning algorithms, typical applications of feedforward neural network, recurrent and temporal neural network, recurrent network use for optimization, Neuro-Fuzzy hybrid system; Engineering Applications

### Course Outcomes (COs):

At the end of the course, the student should be able to:

1. Identify appropriate AI methods to solve a given problem that are amenable to solution by AI.
2. Formalize a given problem in the language/framework of different AI methods.
3. Implement basic Fuzzy operations for engineering applications.
4. Implement neural network as learning machine for engineering applications.

**Text Books:**

1. Kevin Night and Elaine Rich, Nair B., “Artificial Intelligence (SIE)”, McGraw Hill- 2008. (Units-I,II,VI & V).
2. Dan W. Patterson, “Introduction to AI and ES”, Pearson Education, 2007. (Unit-III).
3. Ross, J. T., *Fuzzy Logic with Engineering Applications*, McGraw-Hill (1995).
4. S. Haykin, *Neural Network: A Comprehensive Foundation*, Pearson Education (2003).

**References Books**

1. Peter Jackson, “Introduction to Expert Systems”, 3rd Edition, Pearson Education, 2007.
2. Stuart Russel and Peter Norvig “AI – A Modern Approach”, 2nd Edition, Pearson Education 2007.
3. Deepak Khemani “Artificial Intelligence”, Tata McGraw Hill Education 2013.

**CO MAPPING WITH PO and PSO**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PSO 1 | PSO 2 |
|-------|------|------|------|------|------|------|------|------|------|------|------|-------|-------|
| CO1   | 3    | 3    | -    | 3    | 2    | -    | -    | -    | -    | -    | -    | 2     | -     |
| CO2   | 3    | 3    |      | 3    | 2    | -    | -    | -    | -    | -    | -    | 1     | -     |
| CO3   | 3    | 3    | -    | 3    | 2    | -    | -    | -    | -    | -    | -    | 2     | -     |
| CO4   | 3    | 3    | -    | 3    | 2    | -    | -    | -    | -    | -    | -    | 2     | -     |

**CO MAPPING WITH WK**

| CO/WK | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| CO1   |     | ✓   | ✓   | ✓   |     | ✓   |     | ✓   |     |
| CO2   |     | ✓   | ✓   | ✓   |     | ✓   |     | ✓   |     |
| CO3   |     | ✓   | ✓   | ✓   |     | ✓   |     | ✓   |     |
| CO4   |     | ✓   | ✓   | ✓   |     | ✓   |     | ✓   |     |

**Evaluation Scheme**

| S. No. | Evaluation Elements                                                | Weightage (%) |
|--------|--------------------------------------------------------------------|---------------|
| 1.     | MST & EST                                                          | 70            |
| 2.     | Sessional (Assignments/Projects/Tutorials/Quizzes/Lab Evaluations) | 30            |

## Semester VI

### UCS540: Data Structures and Algorithms

| L  | T | P  | SL | Cr  |
|----|---|----|----|-----|
| 45 | 0 | 30 | 45 | 4.0 |

**Course Objective:** To become familiar with different types of data structures and their applications and learn different types of algorithmic techniques and strategies.

#### **Syllabus:**

**Introduction and Overview:** Basic Terminology, Elementary Data Organization, Data Structures, Control Structures, Asymptotic Notations for Algorithms, Big O notation: formal definition and use, Little o, big omega and big theta notation, Arithmetic Expressions, Polish Notations, Arrays, Records, Pointers, Storing Strings, String Operations, Pattern Matching Algorithms, Stacks, Queues, Recursion, Towers of Hanoi.

**Searching and Sorting:** Linear Arrays, Traversing and Searching in Linear Arrays, Inserting and Deleting, Bubble Sort, Linear Search, Binary Search, Insertion Sort, and Selection Sort.

**Non-Linear Data Structures:** Trees, Binary Trees, Traversing Binary Trees, Binary Search Trees, Searching and Inserting in Binary Search Trees, Deleting in a Binary Search Tree, Preorder, Postorder and Inorder Traversal, Heaps, Graph, Graph Algorithms, Breadth First Search, Depth First Search.

**Linked List:** Introduction, Insertion into a linked list, Deletion into a linked list. Stack, Queues, trees using linked list, Hashing, Hash Functions.

**Laboratory Work:** Implementation of Arrays, Recursion, Stacks, Queues, Lists, Binary trees, Sorting techniques, Searching techniques. Implementation of all the algorithmic techniques.

#### **Course Outcomes (COs)**

After completion of the course, the students will be able to:

1. Implement the basic data structures and solve problems using fundamental algorithms.
2. Implement appropriate searching & sorting techniques for Problem solving
3. Apply tree and graph data structures and algorithms for specific applications.
4. Analyze, evaluate and choose appropriate data structure and algorithmic technique to solve real-world problems.

#### **Text Books**

1. Seymour Lipschutz Data Structures, TATA McGraw Hill (2016).
2. Corman, Leiserson&Rivest, Introduction to Algorithms, MIT Press (2009).
3. Narasimha Karumanchi, Data Structures and Algorithms Made Easy (2014).

| CO MAPPING WITH PO and PSO |     |     |     |     |     |     |     |     |     |      |      |      |      |
|----------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|
| CO/PO                      | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1                        | 2   | 2   | -   | -   | 3   | -   | -   | -   | -   | -    | 1    | 2    | 3    |
| CO2                        | 2   | 2   | -   | -   | 3   | -   | -   | -   | -   | -    | 1    | 2    | 2    |
| CO3                        | 2   | 2   | -   | -   | 3   | -   | -   | -   | -   | -    | 1    | 3    | 2    |
| CO4                        | 2   | 2   | -   | -   | 3   | -   | -   | -   | -   | -    | 1    | 2    | 3    |

  

| CO MAPPING WITH WK |     |     |     |     |     |     |     |     |     |  |
|--------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|--|
| CO/WK              | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |  |
| CO1                |     | ✓   |     | ✓   |     | ✓   |     | ✓   |     |  |
| CO2                |     | ✓   |     | ✓   |     | ✓   |     | ✓   |     |  |
| CO3                |     | ✓   |     | ✓   |     | ✓   |     | ✓   |     |  |
| CO4                |     | ✓   |     | ✓   |     | ✓   |     | ✓   |     |  |

  

| Evaluation Scheme |                                                                    |               |
|-------------------|--------------------------------------------------------------------|---------------|
| S. No.            | Evaluation Elements                                                | Weightage (%) |
| 1.                | MST & EST                                                          | 70            |
| 2.                | Sessional (Assignments/Projects/Tutorials/Quizzes/Lab Evaluations) | 30            |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |    |   |    |    |     |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|---|----|----|-----|
| <b>UEE613: Industrial Drives and Automation</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |    |   |    |    |     |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | L  | T | P  | SL | Cr  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 45 | 0 | 30 | 45 | 4.0 |
| <b>Course Objective:</b> To introduce the concept of electric drives and its features. To get familiarize with power converter-controlled drives and automation.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |    |   |    |    |     |
| <b>Syllabus:</b><br><b>Electric Drives:</b> Concept of electric drive and its classifications, Types of loads, Quadrant diagram, Dependence of load torque on various factors, Dynamics of motor-load combination, Steady state stability of an electric drive system, Load Equalization.<br><b>Estimation of Motor Rating:</b> Thermal modeling of motors, Types of duty cycles, Calculation of motor rating for duty cycles, Overload factor calculation for short and intermittent duty cycle, Use of load diagrams.<br><b>DC Motor Drives:</b> Control of DC drives fed through single-phase and three-phase semi converter and full-converter phase-controlled configurations, their analysis, Regeneration and braking through static power converters.<br><b>Special purpose drives:</b> Synchronous motor drives, servo drives, Step motor and BLDC motor drives<br><b>Introduction to automation:</b> Architecture of industrial automation systems and operations, Industrial control Systems-Process. Measurement of industrial parameters, signal conditioning and processing, estimation of errors and calibration.<br><b>Sequence control:</b> Introduction, power and control circuit layout, structured design approach, Relay ladder logic (RLL) programming, hardware environment, Networking of Sensors, and Controllers: The Fieldbus, The Fieldbus communication protocols, Introduction to Production Control Systems. |    |   |    |    |     |
| <b>Laboratory Work:</b> Starting and running characteristics of converter fed AC and DC motor control, Harmonic analysis of AC and DC Drives, V/f based drive, Microprocessor based Drive, PLC based drive, Project on drives using standard software.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |    |   |    |    |     |
| <b>Minor Project</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |    |   |    |    |     |
| <b>Course Outcomes (COs)</b><br>After completion of the course, the students will be able to: <ol style="list-style-type: none"> <li>1. Conceptualize the basic drive system and analyse it for different types of loads</li> <li>2. Analyse the motor situation during starting and braking</li> <li>3. Develop control circuitry and devices for control of motor</li> <li>4. Estimate the motor rating for different condition of load</li> <li>5. Develop the converter circuit for control purpose along with its different configuration</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |    |   |    |    |     |
| <b>Text Books</b> <ol style="list-style-type: none"> <li>1. Dubey, G.K., <i>Power Semiconductor Controlled Drives</i>, Prentice Hall Inc. (1989).</li> <li>2. Pillai, S.K., <i>A First Course on Electric Drives</i> New Age International (P) Limited, Publishers (1989), Reprint 2004.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |    |   |    |    |     |

**Reference Books:**

1. Bose, B.K., *Modern Power Electronics and AC Drives*, Prentice-Hall of India Private Limited (2006).
2. Dubey, G.K., *Fundamentals of Electric Drives*, Narosa Publications (2001).
3. Sen, P.C., *Thyristor DC Drives*, John Wiley and Sons (1981).

**CO MAPPING WITH PO and PSO**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PSO 1 | PSO 2 |
|-------|------|------|------|------|------|------|------|------|------|------|------|-------|-------|
| CO1   | 3    | 3    | -    | -    | -    | -    | -    | -    | -    | -    | -    | 3     | -     |
| CO2   | 3    | 3    | -    | 2    | -    | -    | -    | -    | -    | -    | -    | 3     | 2     |
| CO3   | 3    | 3    | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | 3     | -     |
| CO4   | 3    | 3    | -    | -    | -    | -    | -    | -    | -    | -    | -    | -     | 2     |
| CO5   | 3    | 3    | 3    | 2    | -    | -    | -    | -    | -    | -    | -    | 3     | 2     |

**CO MAPPING WITH WK**

| CO/WK | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| CO1   |     | ✓   | ✓   | ✓   |     |     |     |     |     |
| CO2   |     | ✓   | ✓   | ✓   |     |     |     | ✓   |     |
| CO3   |     | ✓   | ✓   | ✓   | ✓   |     |     | ✓   |     |
| CO4   |     | ✓   | ✓   | ✓   |     |     |     |     |     |
| CO5   |     | ✓   | ✓   | ✓   | ✓   |     |     | ✓   |     |

**Evaluation Scheme**

| S. No. | Evaluation Elements                                                | Weightage (%) |
|--------|--------------------------------------------------------------------|---------------|
| 1.     | MST & EST                                                          | 70            |
| 2.     | Sessional (Assignments/Projects/Tutorials/Quizzes/Lab Evaluations) | 30            |

**UEE610: Power System Protection**

| L  | T | P  | SL | Cr  |
|----|---|----|----|-----|
| 45 | 0 | 30 | 45 | 4.0 |

**Course Objective:** To introduce the concept of power system protection, circuit breakers, earthing, relays, protection schemes and analysis of symmetrical and unsymmetrical faults.

**Syllabus:**

**Introduction:** General Background, Functions of a Substation, Substation Layouts, Types of Substations, Components of Substation, Bus-bar Schemes, Preventive and predictive maintenance of substation, concept of live line maintenance.

**Fuses and Circuit Breakers:** LV and MV fuses and their characteristics, Circuit breakers as a switch: Arc formation and its extinction (AC and DC), re-striking and recovery voltage, Current chopping, specifications of circuit breakers, types of circuit breakers like oil, Air, Vacuum and SF<sub>6</sub>, comparative merits and demerits, HVDC circuit breaker system.

**Substation Earthing practices:** Earthing requirements and practices, Neutral grounding and neutral shift, Earth resistivity, Step, Touch and mesh potential, Substation Earthing Mat, Fencing, Procedure of Laying Earthing-Mat, Earthing bonding, earthing materials, Dimensioning of Earth Conductors, Measurement of Earthing Resistance.

**Protective Relays: Functions,** Constructional and operating principles of electromagnetic type like over-current, directional, differential and distance relays, their characteristics, General equation. Basic principles of static relaying, Phase and amplitude comparator, Microprocessor based relays, Digital relaying and protection, relay coordination.

**Protection, Control and Automation in Substations:** Control Panels, Protective Relaying in Substations, Power Transformer Protection, Bus Zone Protection, Protection of Transmission Lines, Protection of Generators, Carrier Assisted Distance Protection, Control and Automation.

**Fault Analysis:** Symmetrical component Transformation Technique, Sequence modelling of power system components, Analysis of Symmetrical and unsymmetrical shunt and series faults, Bus impedance matrix, short circuit algorithm, Fault Diagnostics in substation.

**Laboratory Work:** Symmetrical and unsymmetrical fault level measurement, analysis of various types of faults, Measurement of ground resistivity and resistance of a ground electrode, obtain characteristics of different types of relays, generator and transmission line protections, short circuit simulation studies and relay coordination.

**Course Outcomes (COs)**

After completion of the course, the students will be able to:

1. Demonstrate various protection strategies applied for power system protection.
2. Design the basic earthing requirement for residential and other purposes.
3. Select required protection measures against overcurrent, overvoltage in transmission lines and other power system equipment.
4. Analyse balanced and unbalanced faults and decide circuit breaker ratings.

**Text Books**

1. Pathinkar, Y.G. and Bhide, S.R., *Fundamentals of Power System Protection*, PHI Learning Pvt. Limited (2008).
2. Nagrath, I.J. and Kothari, D.P., *Power System Engineering*, Tata McGraw Hill (2007).
3. Rao, S.S., *Switchgear and Protection*, Khanna Publishers (2007).
4. Chakraborti, A., Soni, M.L., Gupta, P.V. and Bhatnagar, U.S., *A Text Book on Power System Engineering*, Dhanpat Rai and Co. (P) Ltd. (2008).

**Reference Books:**

1. Deshpande, M.V., *Switchgear and Protection*, Tata McGraw Hill (2005).
2. Elmore, W.A., *Protective Relaying Theory and Applications*, ABB Power

- T and D Company Inc. (2003).*
3. *John D. McDonald, Electric Power Substations Engineering, Second Edition, CRC Press, (2007)*

**CO MAPPING WITH PO and PSO**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|
| CO1   | 3   | 3   | -   | -   | -   | -   | -   | -   | -   | -    | -    | 2    | 1    |
| CO2   | 3   | 3   | 3   | -   | -   | -   | -   | -   | -   | -    | -    | 2    | 1    |
| CO3   | 3   | 3   | -   | -   | -   | -   | -   | -   | -   | -    | -    | 2    | 2    |
| CO4   | 3   | 3   | -   | 2   | -   | -   | -   | -   | -   | -    | 1    | 2    | 1    |

**CO MAPPING WITH WK**

| CO/WK | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| CO1   |     | ✓   | ✓   | ✓   |     |     |     |     |     |
| CO2   |     | ✓   | ✓   | ✓   | ✓   |     |     |     |     |
| CO3   |     | ✓   | ✓   | ✓   |     |     |     |     |     |
| CO4   |     | ✓   | ✓   | ✓   |     |     |     | ✓   |     |

**Evaluation Scheme**

| S. No. | Evaluation Elements                                                | Weightage (%) |
|--------|--------------------------------------------------------------------|---------------|
| 1.     | MST & EST                                                          | 70            |
| 2.     | Sessional (Assignments/Projects/Tutorials/Quizzes/Lab Evaluations) | 30            |

## ULC402: Fundamentals of Signal Processing

| L  | T | P  | SL | Cr |
|----|---|----|----|----|
| 45 | 0 | 30 | 45 | 4  |

**Course Objective:** To explain the concepts of Fourier analysis, digital signal processing, stability analysis of digital system, and to design digital filters.

### Syllabus:

**Introduction:** Signals and Systems, Classification of signals, Continuous and discrete time signals and its classifications, Nyquist rate, Sampling theorem, Aliasing, Convolution, Correlation.

**Fourier Series and Fourier Transform:** Introduction to Fourier Series and Fourier Transform, Dirichlet Conditions, Determination of Fourier Coefficients, Properties of Fourier Transform, Energy density, Power Spectral Density.

**Z-Transform:** Region of Convergence (ROC), Properties of z-transform, Initial and Final Value theorems, Partial sum, Parseval's Theorem, z-transform of standard sequences, Inverse z-transform, Pole-Zero plot, System function of LTI system, Causality and Stability in terms of z-transform.

**DFT and FFT:** Discrete Fourier Series, Discrete Fourier Transform and its Properties, Efficient Computation of DFT using FFT algorithms, Linear Filtering Approach to Computation of DFT.

**Digital Filter Structure:** Describing Equation, Structures for FIR Systems, Structures for IIR Systems, Representation of Structures using Signal Flow Graph.

**Design of Digital Filters:** Introduction, Difference between analog and digital filters, Types of filters, LTI systems as filters, Design of IIR filters from analog filters, FIR filters design, Least square filter design, Designing digital filter from pole-zero placement, Butterworth filter design using Bilinear transformation, FIR filter design using windows, Design of filters using pole-zero combination, Analysis of coefficient quantization effects in FIR filters, Analysis of round-off errors, Dynamic range scaling, Low sensitivity digital filters, Limit cycles in IIR filters.

**Laboratory Work:** Convolution and correlation, Solution of difference equations using z-Transform and Fourier tools, FFT and spectrum analysis, design of high pass, low pass, band pass and band stop FIR filter using window method, design of IIR filter using Matched Z Transform (MZT), Bilinear Z Transform (BZT), Pole Zero Placement and Impulse invariant methods.

### Course Outcomes (COs)

After completion of the course, the students will be able to:

1. Analyse the basics of signals and systems.
2. Solve different type of problems related to Fourier series and Fourier transforms
3. Carry out spectrum analysis using DFT.
4. Design digital filter and harmonic mitigation.

### Text Books

1. Proakis, J.G. and Manolakis, D.G., *Digital Signal Processing, Prentice Hall of India (1996). 4<sup>th</sup> edition 2007.*
2. Rabiner, C.R. and Gold, B., *Theory and Applications of Digital Signal Processing, Prentice Hall of India (2000)*

**Reference Books**

1. Antonion, A., Digital Filters: Analysis Design and Application, Prentice-Hall of India (1999).
2. Oppenheim, A.V. and Schafer, R.W., Digital Signal Processing, Prentice-Hall of India (1998).
3. Helmut, U. and Willibald, W., Protection Techniques in Electrical Engg. Systems, Marcel Dekker Inc. (2001)

**CO MAPPING WITH PO and PSO**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|
| CO1   | 3   | 3   | -   | 3   | -   | -   | -   | -   | -   | -    | -    | 3    | -    |
| CO2   | 3   | 3   | -   | -   | 3   | -   | -   | -   | -   | -    | -    | 3    | 3    |
| CO3   | 3   | 3   | -   | -   | 3   | -   | -   | -   | -   | -    | -    | 3    | 3    |
| CO4   | 3   | 3   | 3   | 3   | 3   | -   | -   | -   | -   | -    | -    | 3    | 3    |

**CO MAPPING WITH WK**

| CO/WK | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| CO1   |     | ✓   | ✓   | ✓   |     |     |     | ✓   |     |
| CO2   |     | ✓   | ✓   | ✓   |     | ✓   |     |     |     |
| CO3   |     | ✓   | ✓   | ✓   |     | ✓   |     |     |     |
| CO4   |     | ✓   | ✓   | ✓   | ✓   | ✓   |     |     |     |

**Evaluation Scheme**

| S. No. | Evaluation Elements                                                | Weightage (%) |
|--------|--------------------------------------------------------------------|---------------|
| 1.     | MST & EST                                                          | 70            |
| 2.     | Sessional (Assignments/Projects/Tutorials/Quizzes/Lab Evaluations) | 30            |

## UEE612: Machine Learning Techniques

| L  | T | P  | SL | Cr  |
|----|---|----|----|-----|
| 45 | 0 | 30 | 45 | 4.0 |

**Course Objective:** To understand the need, latest trends and design appropriate machine learning algorithms for problem solving

### Syllabus:

**Introduction:** Definitions of learning systems, machine learning, training data, concept representation, function approximation for learning system; Objective functions for classification, regression and ranking.

**Concept of Optimization:** Convex function, gradients and sub-gradients, Unconstrained smooth convex minimization, gradient descent, Constrained optimization, Stochastic gradient descent

**Regression and Supervised learning** Linear regression and LMS algorithm, Perceptron and logistic regression, Nonlinear function estimation, Multilayer perceptron and backpropagation, recurrent networks, Generalization, Underfitting, overfitting, Cross-validation, Regularization, mixture of Gaussians

**Support Vector Machines:** Maximum margin linear separators, solution approach to finding maximum margin separators, Radial basis function network, Kernels for learning non-linear functions, support vector regression

**Decision Tree Learning:** Representing concepts as decision trees, Recursive induction, splitting attributes, simple trees and computational complexity, Overfitting, noisy data, and pruning.

**Bayesian Learning:** Probability and Bayes rule, Naive Bayes learning algorithm, Parameter smoothing, Generative vs. discriminative training, Logistic regression, Bayes nets and Markov nets for representing dependencies.

**Clustering and Unsupervised Learning:** Learning from unclassified data. Clustering. k-means partitional clustering, Fuzzy C-means, Expectation maximization (EM) for soft clustering, Gaussian Mixture Model

**Dimension Reduction Techniques:** Feature selection, Principle Component Analysis (PCA), Linear Discriminant Analysis (LDA)

**Applications to Power System:** Some of the Power System applications but not restricted to energy pricing estimation, energy meter analytics, renewable generation forecasting, load profile and consumer classification, Controller design for ALFC, Filter design.

**Laboratory Work:** The laboratory work includes supervised learning algorithms, linear regression, logistic regression, decision trees, k-nearest neighbor, Bayesian learning and the naïve Bayes algorithm, support vector machines and kernels and neural networks with an introduction to Deep Learning and basic clustering algorithms.

### Course Outcomes (COs)

After completion of the course, the students will be able to:

1. Demonstrate the concept of optimization for various learning functions

2. Analyze the complexity of machine learning algorithms and their limitations
3. Realize learning algorithms as neural computing machine
4. Demonstrate the ability to evaluate and compare learning models and learning algorithms
5. Realize algorithms on power system problems.

#### Text Books

1. Mitchell T.M., *Machine Learning*, McGraw Hill (1997).
2. Alpaydin E., *Introduction to Machine Learning*, MIT Press(2010).

#### Reference Books

1. Bishop C., *Pattern Recognition and Machine Learning*, Springer-Verlag(2006).
2. Michie D., Spiegelhalter D. J., Taylor C. C., *Machine Learning, Neural and Statistical Classification*. Overseas Press (2009).

#### CO MAPPING WITH PO and PSO

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|
| CO1   | 3   | 3   | -   | -   | 2   | -   | -   | -   | -   | -    | -    | 2    | -    |
| CO2   | 3   | 3   | -   | 3   | 3   | -   | -   | -   | -   | -    | -    | 2    | 1    |
| CO3   | 3   | 3   | -   | -   | 3   | -   | -   | -   | -   | -    | -    | 3    | 3    |
| CO4   | 3   | 3   | -   | -   | 3   | -   | -   | -   | -   | -    | -    | 2    | 3    |
| CO5   | 3   | 3   | 3   | -   | 3   | -   | -   | -   | -   | -    | -    | 3    | 3    |

#### CO MAPPING WITH WK

| CO/WK | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| CO1   |     | ✓   | ✓   | ✓   |     | ✓   |     |     |     |
| CO2   |     | ✓   | ✓   | ✓   |     | ✓   |     | ✓   |     |
| CO3   |     | ✓   | ✓   | ✓   |     | ✓   |     |     |     |
| CO4   |     | ✓   | ✓   | ✓   |     | ✓   |     |     |     |
| CO5   |     | ✓   | ✓   | ✓   | ✓   | ✓   |     |     |     |

#### Evaluation Scheme

| S. No. | Evaluation Elements                                                | Weightage (%) |
|--------|--------------------------------------------------------------------|---------------|
| 1.     | MST & EST                                                          | 70            |
| 2.     | Sessional (Assignments/Projects/Tutorials/Quizzes/Lab Evaluations) | 30            |

**UCS653: Data Mining and Visualization (Elective- II)**

| L  | T | P  | SL | Cr  |
|----|---|----|----|-----|
| 30 | 0 | 30 | 30 | 3.0 |

**Course Objective:** What is data mining, data mining objectives, data mining process, input-output data knowledge representation and applications, standard data repositories.

**Syllabus:**

**Overview:** What is data mining, data mining objectives, data mining process, input-output data knowledge representation and applications, standard data repositories.

**Data Pre-processing:** Data cleaning, Data transformation, Data reduction, Discretization and generating concept hierarchies, Multidimensional data model

**Data Analysis and Classification:** Attribute generalization and class comparison, Statistical measures, mining through association rules, pattern mining methods, mining diverse frequent patterns, pattern evaluation, sequential pattern mining, graph pattern mining, constraint-based mining and pattern discovery, text mining examples.

**Data Clustering:** Issues in clustering, Partitioning methods: k-means, expectation maximization (EM), Hierarchical distance-based agglomerative and divisible clustering,

**Data Visualization:** Data visualization library and tools, 1D, 2D and 3D charts, Regression plot, Histogram plot, Box and Violin plots, Kernel density estimate plot, Heat maps and clustered matrix, Tree maps;

**Visualizing large data:** Decision Tree Analysis.

**Course Outcomes (COs)**

After completion of the course, the students will be able to:

1. Apply basic concepts and techniques of Data Mining.
2. Develop skills of using data mining libraries for solving practical problems.
3. Gain experience of doing independent study.
4. Present the data traits through different visualization.

**Text Books**

1. Ian H. Witten and Eibe Frank, Data Mining: Practical Machine Learning Tools and Techniques (Second Edition), Morgan Kaufmann, 2005, ISBN: 0-12-088407-0.
2. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying Ye, "Probability & Statistics for Engineers & Scientists", (9<sup>th</sup> Edn.), Prentice Hall Inc.
3. Trevor Hastie Robert Tibshirani Jerome Friedman, "The Elements of Statistical Learning, Data Mining, Inference, and Prediction", (2<sup>nd</sup> Edn.), Springer, 2014.

**Reference Books**

1. G. James, D. Witten, T. Hastie, and R. Tibshirani, "An Introduction to Statistical Learning: with Applications in R", Springer, 2013
2. John M. Chambers, "Software for Data Analysis: Programming with R" (Statistics and Computing), Springer
3. Ralf I. Thomas, "Data Visualisation with R", Springer, 2019.

| CO MAPPING WITH PO and PSO |         |         |         |         |         |         |         |         |         |          |          |          |          |
|----------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|----------|----------|----------|----------|
| CO/P<br>O                  | PO<br>1 | PO<br>2 | PO<br>3 | PO<br>4 | PO<br>5 | PO<br>6 | PO<br>7 | PO<br>8 | PO<br>9 | PO1<br>0 | PO1<br>1 | PSO<br>1 | PSO<br>2 |
| CO1                        | 1       | 1       | -       | -       | 3       | -       | -       | -       | -       | -        | -        | 3        | 1        |
| CO2                        | 1       | 1       | -       | -       | 3       | -       | -       | -       | -       | -        | -        | 2        | 3        |
| CO3                        | -       | -       | -       | -       | -       | -       | 1       | -       | -       | -        | -        | 1        | 3        |
| CO4                        | 1       | 1       | -       | -       | 3       | -       | -       | -       | -       | -        | -        | -        | 2        |

| CO MAPPING WITH WK |     |     |     |     |     |     |     |     |     |  |
|--------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|--|
| CO/WK              | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |  |
| CO1                |     | ✓   |     |     |     | ✓   |     |     |     |  |
| CO2                |     | ✓   |     |     |     | ✓   |     |     |     |  |
| CO3                |     | ✓   |     |     |     | ✓   |     |     |     |  |
| CO4                |     | ✓   |     |     |     | ✓   |     |     |     |  |

| Evaluation Scheme |                                                                    |               |
|-------------------|--------------------------------------------------------------------|---------------|
| S. No.            | Evaluation Elements                                                | Weightage (%) |
| 1.                | MST & EST                                                          | 70            |
| 2.                | Sessional (Assignments/Projects/Tutorials/Quizzes/Lab Evaluations) | 30            |

**UEE638: PLC and SCADA (Elective- II)**

| L  | T | P  | SL | Cr  |
|----|---|----|----|-----|
| 30 | 0 | 30 | 30 | 3.0 |

**Course Objective:** To make the students understand the fundamentals of automation and various automation systems used in industry such as PLC and SCADA.

**Syllabus:****Programmable Logic Controller (PLC)**

Overview, Components of PLC, Principles of Operation, PLC and Computers, PLC Size and Applications, Input and Output hardware of PLC, CPU, Memory, PLC Programming Devices.

**PLC Programming**

Fundamentals of Logic, Basics of PLC programming, PLC programming languages, Ladder Programming, Logic functions, latching, Ladder logic for relays, motor starters, switches, transducers and sensors.

**Information and Communication Technology (ICT)**

ICT as Automation enabler, ICT Technologies and Protocols, Communication Basics, OSI Architecture, TCP/IP Architecture, Network Topology, Communication Protocol, Industry Open Protocols: RS-232, RS-422, RS-485.

**SCADA**

Structure of SCADA, distributed and supervisory control, SCADA and its organization and structure, centralized, hierarchical and decentralized control schemes, man machine interface, energy management system, RTU, Communication system requirements for Smart grid, SCADA communication topologies, SCADA communication protocols: Modbus, Distributed Network Protocol3 (DNP3), Ethernet, IEC 61850, Communication media for SCADA communication: Wired and Wireless communication. Optical Fiber, Power Line Carrier Communication (PLCC), interfacing of PLC with SCADA.

**Power System Automation**

Evolution of automation systems, Supervisory control and data acquisition (SCADA) systems, Components of SCADA systems, SCADA in power systems (generation, transmission and distribution), Advantages of SCADA in Power System.

**Laboratory Work:** Ladder logic for control panels, motor starters, relays and counters; traffic light control; experiment on industrial training kits.

**Course Outcomes (COs)**

After completion of the course, the students will be able to:

1. Design PLC based application by proper selection and sizing criteria
2. Develop ladder program using PLC.
3. Analyze communication in SCADA.
4. Develop any application based on SCADA.

**Text Books**

1. Thomas, M.S. and Donald, John, "Power System SCADA and Smart Grids", CRC Press.
2. Petruzella F, "Programmable Logic Controller" Third Edition, Tata McGraw Hills.

**Reference Books**

1. Forouzan, B. A, “Data Communications and Networking” Fourth Edition, Tata McGraw Hills.
2. Bolton, W, “Programmable Logic Controllers” Fourth Edition, Elsevier Press.

**CO MAPPING WITH PO and PSO**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|
| CO1   | 3   | 3   | 3   | -   | 3   | -   | -   | -   | -   | -    | -    | 2    | 3    |
| CO2   | 3   | 3   | -   | -   | 3   | -   | -   | -   | -   | -    | -    | 2    | 3    |
| CO3   | 3   | 3   | -   | 2   | -   | -   | -   | -   | -   | -    | -    | 2    | 3    |
| CO4   | 3   | 3   | 3   | 2   | 3   | -   | -   | -   | -   | -    | -    | 2    | 3    |

**CO MAPPING WITH WK**

| CO/WK | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| CO1   |     | ✓   | ✓   | ✓   | ✓   | ✓   |     |     |     |
| CO2   |     | ✓   | ✓   | ✓   |     | ✓   |     |     |     |
| CO3   |     | ✓   | ✓   | ✓   |     |     |     | ✓   |     |
| CO4   |     | ✓   | ✓   | ✓   | ✓   | ✓   |     | ✓   |     |

**Evaluation Scheme**

| S. No. | Evaluation Elements                                                | Weightage (%) |
|--------|--------------------------------------------------------------------|---------------|
| 1.     | MST & EST                                                          | 70            |
| 2.     | Sessional (Assignments/Projects/Tutorials/Quizzes/Lab Evaluations) | 30            |

| UEE636: Smart Grid Systems (Elective- II)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |    |   |    |    |     |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|---|----|----|-----|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | L  | T | P  | SL | Cr  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 30 | 0 | 30 | 30 | 3.0 |
| <p><b>Course Objective:</b> To explain general communication techniques used in smart grid power system communication infrastructure and information system for control centers. To familiarize with interconnection issues related with integration of distributed generation technologies for microgrid.</p>                                                                                                                                                                                                                                                                                                                                                                                                                           |    |   |    |    |     |
| <p><b>Introduction to Smart Grid:</b> Evolution of Electric Grid, Concept of Smart-Grid, Definitions, Need of Smart-Grid, Concept of Robust &amp; Self-Healing Grid Present development &amp; International policies in Smart-Grid.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |    |   |    |    |     |
| <p><b>Communication Technologies for Smart Grid Power System:</b> Fiber Optical Networks, WAN based on Fiber Optical Networks, IP based Real Time data Transmission, Substation communication network, Zigbee.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |    |   |    |    |     |
| <p><b>Information System for Control Centers (ICCS):</b> ICCS Configuration, ICCS communication Network, ICCS Time Synchronization, E-Commerce of Electricity, GIS, GPS.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |    |   |    |    |     |
| <p><b>Smart-grid:</b> Smart-grid infrastructure, Load dispatch centers, wide-area monitoring system (WAMS), PMU; Smart sensors/telemetry, advanced metering infrastructure (AMI); smart metering; smart grid system monitoring; communication infrastructure and technologies; self-healing.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                         |    |   |    |    |     |
| <p><b>Distributed Energy Resources (DERs):</b> Distributed Generation (DG), Distributed Generation Technologies and its benefits, Combined heat and power (CHP) systems, Wind energy conversion systems (WECS), Solar photovoltaic (PV) systems, Small-scale hydroelectric power generation, Other renewable energy sources, storage devices.</p>                                                                                                                                                                                                                                                                                                                                                                                        |    |   |    |    |     |
| <p><b>Integration of Distributed Generation:</b> Distributed Generation Utilization Barriers, Integration of Distributed Energy Resources: Concept of Microgrid, Distributed Generation integration to power grid.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |    |   |    |    |     |
| <p><b>Microgrid:</b> Integration of distributed energy sources; Hybrid power system; Microgrid Concept; Layout, Advantages and challenges in Microgrid system, Interconnection issues, AC and DC Microgrid, Comparison, Operation, Control and Protection Issues of Microgrid; Need of Communication Infrastructure in Microgrid, Smart grid and Microgrid: Correlations.</p>                                                                                                                                                                                                                                                                                                                                                            |    |   |    |    |     |
| <p><b>Course Outcomes (COs)</b><br/>After completion of the course, the students will be able to:</p> <ol style="list-style-type: none"> <li>1. Interpret various aspects of the smart Grid, including technologies, components, architectures and applications.</li> <li>2. Suggest modern communication infrastructure and control centre components of smart grid</li> <li>3. Illustrate various integration aspects of distributed energy resources and microgrid.</li> <li>4. Demonstrate distributed generation coordination including monitoring of smart grid using modern communication infrastructure.</li> <li>5. Analyse operation, control and protection issues in micro grid in the perspective of smart grid.</li> </ol> |    |   |    |    |     |
| <p><b>Text Books</b></p> <ol style="list-style-type: none"> <li>1. <i>INIEWSKI , Smart Grid Infrastructure And Networking, McGraw-Hill Education India Pvt. Ltd (2012), 1<sup>st</sup> Edition</i></li> <li>2. <i>James Momoh, Smart Grid: Fundamentals of Design and Analysis, IEEE Computer Society Press (2012)</i></li> <li>3. <i>Microgrids: Architectures and Control, Nikos Hatziargyriou (Editor), ISBN: 978-1-118-72068-4, 340 pages, December 2013, Wiley-IEEE Press</i></li> <li>4. <i>Microgrids and Active Distribution Networks, S. Chowdhury, S.P. Chowdhury and P. Crossley, The Institution of Engineering and Technology, London, U.K.,2009.</i></li> </ol>                                                            |    |   |    |    |     |

## Reference Books

1. Ekanayake J., Jenkins N., Liyanage K., Wu, J., Yokoyama A., *Smart Grid: Technology and applications*, Wiley Publications.
2. Momoh J., *Smart Grid: Fundamentals of design and analysis*, John Wiley & Sons.
3. Flick T., Morehouse J., *Securing the smart grid: Next generation power grid security*, paper back.

### CO MAPPING WITH PO and PSO

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|
| CO1   | 3   | 3   | -   | -   | -   | -   | -   | -   | -   | -    | -    | 2    | 1    |
| CO2   | 3   | 3   | 3   | 3   | -   | -   | -   | -   | -   | -    | -    | 2    | -    |
| CO3   | 3   | 3   | -   | -   | -   | -   | -   | -   | -   | -    | -    | 2    | 1    |
| CO4   | 3   | 3   | -   | -   | -   | -   | -   | -   | -   | -    | -    | 2    | 2    |
| CO5   | 3   | 3   | -   | 3   | -   | -   | -   | -   | -   | -    | -    | 2    | -    |

### CO MAPPING WITH WK

| CO/WK | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| CO1   |     | ✓   | ✓   | ✓   |     |     |     |     |     |
| CO2   |     | ✓   | ✓   | ✓   | ✓   |     |     | ✓   |     |
| CO3   |     | ✓   | ✓   | ✓   |     |     |     |     |     |
| CO4   |     | ✓   | ✓   | ✓   |     |     |     |     |     |
| CO5   |     | ✓   | ✓   | ✓   |     |     |     | ✓   |     |

### Evaluation Scheme

| S. No. | Evaluation Elements                                                | Weightage (%) |
|--------|--------------------------------------------------------------------|---------------|
| 1.     | MST & EST                                                          | 70            |
| 2.     | Sessional (Assignments/Projects/Tutorials/Quizzes/Lab Evaluations) | 30            |

**UCS312: Database Management Systems (Elective- II)**

| L  | T | P  | SL | Cr  |
|----|---|----|----|-----|
| 30 | 0 | 30 | 30 | 3.0 |

**Course Objective:** Emphasis is on the need of database systems. Main focus is on E-R diagrams, relational database, concepts of normalization and de-normalization and SQL commands.

**Syllabus:**

**Introduction:** Data, data processing requirement, desirable characteristics of an ideal data processing system, traditional file based system, its drawback, concept of data dependency, Definition of database, database management system, 3-schema architecture, database terminology, benefits of DBMS.

**Relational Database:** Relational data model: Introduction to relational database theory: definition of relation, keys, relational model integrity rules.

**Database Analysis:** Conceptual data modeling using E-R data model -entities, attributes, relationships, generalization, specialization, specifying constraints, Conversion of ER Models to Tables, Practical problems based on E-R data model.

**Relational Database Design:** Normalization- 1NF, 2NF, 3NF, BCNF, 4NF and 5NF. Concept of De- normalization and practical problems based on these forms.

**Transaction Management and Concurrency control:** Concept of Transaction, States of Transaction and its properties, Need of Concurrency control, concept of Lock, Two phase locking protocol.

**Recovery Management:** Need of Recovery Management, Concept of Stable Storage, Log Based Recovery Mechanism, Checkpoint.

**Database Implementation:** Introduction to SQL, DDL, aspect of SQL, DML aspect of SQL – update, insert, delete & various form of SELECT- simple, using special operators, aggregate functions, group by clause, sub query, joins, co-related sub query, union clause, exist operator. PL/SQL, cursor, stored function, stored procedure, triggers, error handling, and package.

**Laboratory Work:** Students will perform SQL commands to demonstrate the usage of DDL and DML, joining of tables, grouping of data and will implement PL/SQL constructs. They will also implement one project.

**Project:** It will contain database designing & implementation, should be given to group of 2-4 students. While doing projects emphasis should be more on back-end programming like use of SQL, concept of stored procedure, function, triggers, cursors, package etc. Project should have continuous evaluation and should be spread over different components.

**Course Outcomes (COs)**

After completion of the course, the students will be able to:

1. Analyze the Information Systems as socio-technical systems, its need and advantages as compared to traditional file-based systems.
2. Analyze and design database using E-R data model by identifying entities, attributes and relationships.
3. Apply and create Relational Database Design process with Normalization and De-normalization of data.
4. Comprehend the concepts of transaction management, concurrence control and recovery management.

5. Demonstrate use of SQL and PL/SQL to implementation database applications.

**Text Books**

1. Silverschatz A., Korth F. H. and Sudarshan S., Database System Concepts, Tata McGraw Hill (2010) 6<sup>th</sup> ed.

2. Elmasri R. and Navathe B. S., Fundamentals of Database Systems, Pearson (2016) 7<sup>th</sup> ed.

**Reference Books:**

1. Bayross I., SQL, PL/SQL the Programming Language of Oracle, BPB Publications (2009) 4<sup>th</sup> ed.

2. Hoffer J., Venkataraman, R. and Topi, H., Modern Database Management, Pearson (2016) 12<sup>th</sup> ed.

**CO MAPPING WITH PO and PSO**

| CO/P<br>O | PO<br>1 | PO<br>2 | PO<br>3 | PO<br>4 | PO<br>5 | PO<br>6 | PO<br>7 | PO<br>8 | PO<br>9 | PO1<br>0 | PO1<br>1 | PSO<br>1 | PSO<br>2 |
|-----------|---------|---------|---------|---------|---------|---------|---------|---------|---------|----------|----------|----------|----------|
| CO1       | 1       | 1       | -       | -       | 2       | -       | -       | -       | -       | -        | -        | 3        | -        |
| CO2       | 1       | 1       | -       | -       | 2       | -       | -       | -       | -       | -        | -        | 3        | 3        |
| CO3       | 1       | 1       | -       | -       | 2       | -       | -       | -       | -       | -        | -        | 3        | 3        |
| CO4       | 1       | 1       | -       | -       | 2       | -       | -       | -       | -       | -        | -        | 3        | 3        |
| CO5       | 1       | 1       | -       | -       | 2       | -       | -       | -       | -       | -        | -        | 3        | 3        |

**CO MAPPING WITH WK**

| CO/WK | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| CO1   |     | ✓   |     |     |     | ✓   |     | ✓   |     |
| CO2   |     | ✓   |     |     | ✓   | ✓   |     | ✓   |     |
| CO3   |     | ✓   |     |     |     | ✓   |     |     |     |
| CO4   |     | ✓   |     |     |     | ✓   |     |     |     |
| CO5   |     | ✓   |     |     |     | ✓   |     |     |     |

**Evaluation Scheme**

| S. No. | Evaluation Elements                                                | Weightage (%) |
|--------|--------------------------------------------------------------------|---------------|
| 1.     | MST & EST                                                          | 70            |
| 2.     | Sessional (Assignments/Projects/Tutorials/Quizzes/Lab Evaluations) | 30            |

## SEMESTER-VII

### UEE705: SUSTAINABLE ENERGY SYSTEMS

| L  | T | P  | SL | Cr  |
|----|---|----|----|-----|
| 30 | 0 | 30 | 30 | 3.0 |

**Course objective:** To introduce the students about Electric vehicles and renewable energy sources like Solar and Wind, their technical challenges, benefits, and perspectives. To make the students familiar with the working and integration with grid.

Introduction to renewable energy resources and policies of renewable energy, Environmental issues, renewable sources integration – overcoming intermittence, centralized vs. distributed generation.

Wind Energy: Speed and Power Relations, Power Extracted from the Wind, different types of Wind Turbines, Aerodynamic Power Control: Pitch and Tip Speed Ratio control, Wind Generators, Fixed and Variable-Speed Wind Energy Systems, Induction Generator Based WECS, Synchronous Permanent Magnet Generator (PMG) based wind generators, Control of DFIG & PMG.

Solar energy: Solar Cell Physics, Solar Cell Efficiency variation with band-gap and temperature, High efficiency cells, Principle of photovoltaic conversion of solar energy, types of solar cells and PV cell panel, Solar heating, cooling and thermal system; domestic photovoltaic applications, Stand-alone & Grid connected systems: PV Inverters, Optimal economic coordinated operation of conventional and renewable sources, Operational issues and challenges.

Energy mix in generation, planning scheduling and forecasting of renewable energy systems, variability issues in renewable energy systems, study of solar radiation and design, concept of virtual power plant.

Introduction to Electric vehicles: Types of EVs, architecture and working of electric vehicles, integration of EVs in smart grid, economic advantages and challenges in installation of EVs.

Electric Propulsion unit, Configuration and control of DC Motor drives, Induction Motor drives, Permanent Magnet Motor drives, switched reluctance motor, Bidirectional DC-DC converters, Inverters and motor drives Chargers, Electric Vehicle dynamics.

Battery management system, hybridization of different energy storage devices, Sizing the drive system, Design of Plug-in Electric Vehicle, Energy Management Strategies, Automotive networking and communication, EV and EV charging standards, V2G, G2V concepts.

**Laboratory work:** Experiments involving simulation and hardware which will involve working of Electric vehicle using DC-DC buck-boost converter, hardware involving Renewable energy sources like Solar and Wind energy systems, Demonstration of I-V and P-V characteristics of series and parallel combination of PV modules, Demonstration of the effect of shading on module output power, Demonstration of diode as bypass diode and blocking diode, Study of charging and discharging characteristics of battery, Analysis of Maximum Power Point (MPPT) manually by varying the resistive load across the PV panel.

**Course Outcomes (COs):**

After the completion of the course, the students will be able to:

1. Analyse the working of Wind and Solar energy systems.
2. Demonstrate the concepts of Grid integration of Renewable energy sources and associated challenges.
3. Demonstrate the energy storage capability of electric vehicles.
4. Analyse the Grid integration of Electric vehicles and its challenges.
5. Establish the communication and networking in Electric vehicles.

**Text Books:**

6. *M.H.Rashid, Power Electronics, Prentice-Hall of India.*
7. *Emadi,A.(Ed.),Miller,J.,Ehsani,M., VehicularElectricPowerSystems,BocaRaton,CRC Press, 2003.*
8. *Larminie, James, and John Lowry, Electric Vehicle Technology Explained, John Wiley and Sons, 2012.*
9. *Simon,ChristopherA.,AlternateSourceofEnergy,RowmanandLittleFieldPublishersInc. (2007).*
10. *Patel, M. R., Wind and Solar Power Systems, Boca Raton, FL: CRC Press,(1999).*

**Reference Books:**

11. *P.S Bhimbra, Power Electronics, KhannaPublishers.*
12. *Tariq Muneer and Irene Illescas García, The automobile, In Electric Vehicles: Prospects and Challenges, Elsevier,2017.*
13. *Sheldon S. Williamson, Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles, Springer,2013.*
14. *Masters G. M., Renewable and Efficient Electric Power Systems, John Wiley &Sons, (2004).*
15. *Garg H P., Prakash J., Solar Energy: Fundamentals & Applications, Tata McGrawHill, New Delhi,1997.*

**CO MAPPING WITH PO and PSO**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PSO 1 | PSO 2 |
|-------|------|------|------|------|------|------|------|------|------|------|------|-------|-------|
| CO1   | 3    | 3    | -    | -    | -    | 3    | -    | -    | -    | -    | 1    | 2     | 3     |
| CO2   | 3    | 3    | -    | -    | -    | 3    | -    | -    | -    | -    | 1    | 3     | 2     |
| CO3   | 3    | 3    | -    | -    | -    | 3    | -    | -    | -    | -    | 1    | 2     | 2     |
| CO4   | 3    | 3    | -    | 3    | -    | 3    | -    | -    | -    | -    | 1    | 1     | 2     |
| CO5   | 3    | 3    | -    | -    | -    | 3    | -    | -    | -    | -    | 1    | 2     | 1     |

| CO MAPPING WITH WK |     |     |     |     |     |     |     |     |     |
|--------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| CO/WK              | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |
| CO1                | ✓   | ✓   | ✓   | ✓   |     |     | ✓   | ✓   |     |
| CO2                |     | ✓   | ✓   | ✓   |     |     | ✓   |     |     |
| CO3                |     | ✓   | ✓   | ✓   |     |     | ✓   |     |     |
| CO4                |     | ✓   | ✓   | ✓   |     |     | ✓   | ✓   |     |
| CO5                |     | ✓   | ✓   | ✓   |     |     | ✓   |     |     |

**Evaluation Scheme:**

| S. No. | Evaluation Elements                                                | Weightage (%) |
|--------|--------------------------------------------------------------------|---------------|
| 1.     | MST                                                                | 25            |
| 2.     | EST                                                                | 45            |
| 3.     | Sessional (Assignments/Projects/Tutorials/Quizzes/Lab Evaluations) | 30            |

## UEE706: IoT AND REAL TIME SYSTEMS

| L  | T | P  | SL | Cr  |
|----|---|----|----|-----|
| 45 | 0 | 30 | 15 | 3.0 |

**Course Objectives:** The objective of the course is to provide basic understanding of Internet of Things, its architecture, communication protocols, platforms and its deployment, applications; to introduce the students about important contemporary issues due to the integration of DG: technical challenges, benefits, and perspectives in real time environment; to make them familiar with hardware components including measurement and control in hardware in loop system.

### Internet of Things

Introduction to Internet of Things (IoT), vision and challenges for realizing the Internet of Things, IoT architecture, design, Introduction to IoT based measurements, Smart sensors, Digital transducers, Solid state relay, Arduino and Raspberry Pi as IoT Gateways, IoT enabled Applications: Home and Building Automation, Smart Grid, Smart City, Smart Farming, Smart Healthcare.

### IoT in Power System

IoT structure, Communication Protocol, Physical/Link Layer, IEEE 802.3 (Ethernet), Network Layer, IPv6 and IPv4, Transport Layer, TCP and UDP, Application Layer, Interoperability in IoT, Interoperable communication standards: IEC 61850, concepts of clouds in IoT

Role of IoT in Power System, Monitoring and control for Wide Area Application, Phasor Measurement Unit (PMU), Phasor Data Concentrator (PDC), IEEE C37.118 standard for PMU, IEC 61850-90-5 based PMU communication.

**Data Acquisition System:** Role of dedicated computers, analog and digital control, computer systems for real time applications, Hardware-in-loop simulation systems, distributed control architecture, reliability enhancement by redundancy, Real time operating systems: Features, primary components, Structured design of real time systems. Developing a mathematical model for Power system and control, Mathematical model of the real time environment, Design of hardware device meant to be used in HIL. Testing and parameter adjustment for real time implementation of real-time simulator, Design of desired control schemes for AC and DC electrical machine drives and other applications: Micro-grid and renewable and its testing in HIL. Real time control strategy based on FPGA, dSpace, Understanding four-quadrant amplifier for HIL system.

**Real Time Control Applications:** Instrumentation and conditioning of drive signals, data acquisition of drive system, energy management system for AGC, VAR Control, state estimation, security monitoring, economic dispatch, on line load management, Power system digital relaying, Power plant instrumentation.

### Laboratory Work:

Deployment of an embedded system on IoT cloud using USB serial and /or Wi-Fi modules. Off-line simulations for the various experiments related to hardware in-loop simulation system to predict ahead of conducting the lab experiment, the operating characteristics and compare the

results, Microgrid operation and control using HIL, Implement hardware such as PV and Wind system on the simulated grid to test hardware device in the real time environment, Analysis of the Symmetrical components of Power System Network, Study of the principles of transient stability analysis, Demonstrate the load frequency control using PI and Fuzzy logic, Design and analysis of a 3 Level PWM generation in MATLAB/Simulink, Analysis of unsymmetrical Fault (LL, LG, LLG), Analysis of voltage disturbance in single phase model due to non-linear load, Power quality improvement using STATCOM, Analysis of voltage sag during high power induction motor starting and Harmonic analysis for nonlinear load.

**Course Outcomes (COs):**

After the completion of the course, the students will be able to:

1. Exhibit the concept and benefits of IoT
2. Implement IoT system using protocols and IoT cloud
3. Demonstrate about Hardware-in-loop simulation systems.
4. Develop the mathematical modelling of power system and control in real time environment.
5. Demonstrate the concepts of real time control strategy based on FPGA, dSpace.
6. Demonstrate the various Real time control applications.

**Text Books:**

1. *IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things*, Robert Barton, Patrick Grossetete, David Hanes, Jerome Henry, Gonzalo Salgueiro by Cisco Press, 2017.
2. *Internet of Things: A Hands-on Approach*, by Arshdeep Bahga and Vijay Madisetti Universities Press, 2014.
3. *N. Hatziargyriou, Microgrids: Architectures and Control*, Wiley-IEEE Press, January (2014).
4. *Wood A. J. and Wollenberg B., Power generation operation and control*, John Wiley.
5. *Kusic C. L., Computer Aided Power System Analysis*, TMH, New Delhi.

**Reference Books:**

1. *Internet of Things*, Abhishek S Nagarajan, RMD Sundaram Shriram K Vasudevan, Wiley India 2019.
2. *Internet of Things*, Raj Kamal, McGraw Hill Education 2017.
3. *HIL System catalogues*, Opal-RT, RTDS and Typhoon.
4. *Torsten Cegrell, Power System Control Technology*, PHI, India.
5. *Cerni R.H and Foster L.E., Instrumentation for Engineering Management*, John Wiley and Sons.

**CO MAPPING WITH PO and PSO**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PSO 1 | PSO 2 |
|-------|------|------|------|------|------|------|------|------|------|------|------|-------|-------|
| CO1   | 3    | 3    | -    | -    | 3    | -    | -    | -    | -    | -    | -    | 3     | -     |
| CO2   | 3    | 3    | -    | -    | 3    | -    | -    | -    | -    | -    | -    | 2     | -     |
| CO3   | 3    | 3    | -    | -    | 3    | -    | -    | -    | -    | -    | -    | 3     | -     |
| CO4   | 3    | 3    | 2    | -    | 3    | -    | -    | -    | -    | -    | -    | 3     | -     |
| CO5   | 3    | 3    | -    | -    | 3    | -    | -    | -    | -    | -    | -    | 3     | -     |
| CO6   | 3    | 3    | -    | -    | 3    | -    | -    | -    | -    | -    | -    | 3     | -     |

| CO MAPPING WITH WK |     |     |     |     |     |     |     |     |     |  |
|--------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|--|
| CO/WK              | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |  |
| CO1                |     | ✓   | ✓   |     |     | ✓   |     |     |     |  |
| CO2                |     | ✓   | ✓   | ✓   |     | ✓   |     |     |     |  |
| CO3                |     | ✓   | ✓   | ✓   |     | ✓   |     |     |     |  |
| CO4                |     | ✓   | ✓   | ✓   | ✓   | ✓   |     |     |     |  |
| CO5                |     | ✓   | ✓   | ✓   |     | ✓   |     |     |     |  |
| CO6                |     | ✓   | ✓   | ✓   |     | ✓   |     |     |     |  |

**Evaluation Scheme:**

| S. No. | Evaluation Elements                                                | Weightage (%) |
|--------|--------------------------------------------------------------------|---------------|
| 1      | MST                                                                | 25            |
| 2      | EST                                                                | 45            |
| 3      | Sessional (Assignments/Projects/Tutorials/Quizzes/Lab Evaluations) | 30            |

**UEE795: Capstone Project**

|   |   |      |     |     |
|---|---|------|-----|-----|
| L | T | P    | SL  | Cr  |
| 0 | 0 | 30** | 210 | 8.0 |

**Course Objective:** To facilitate the students learn and apply an engineering design process in electrical engineering, including project resource management. As a part of a team, the students will make a project, that emphasizes, hands-on experience, and integrates analytical and design skills. The idea is to provide an opportunity to the students to apply what they have learned throughout the course of graduate program by undertaking a specific problem.

**Syllabus:**

Capstone Project is increasingly interdisciplinary, and requires students to function on multi-disciplinary teams. It is the process of devising a system, component or process to meet desired needs. It is a decision-making process (often iterative), in which the basic sciences, mathematics, and the engineering sciences are applied to convert resources optimally to meet these stated needs. It typically includes both analysis and synthesis performed in an iterative cycle. Thus, students should experience some iterative design in the curriculum. As part of their design experience, students have an opportunity to define a problem, determine the problem scope and to list design objectives. The project must also demonstrate that students have adequate exposure to design, as defined, in engineering contexts. Engineering standards and realistic constraints are critical in engineering design. The program must clearly demonstrate where standards and constraints are taught and how they are integrated into the design component of the project. Each group will have 4-5 students. Each group should select their team leader and maintain daily diary. Each Group will work under mentorship of a Faculty supervisor. Each group must meet the assigned supervisor (2hrs slot/week) till the end of the semester (record of attendance will be maintained), as per the time slot which will be provided to them by the respective supervisor. This is mandatory requirement for the fulfilment of the attendance as well as the successful completion of the project. The faculty supervisor of the project will continuously assess the progress of the works of the assigned groups. Some part of the analysis and design of the system will be done in the first section of project in semester VI. The second section would comprise of completion of the project in semester VII in which each team will have to submit a detailed report of the project along with a poster.

**Course Outcomes (COs)**

After completion of the course, the students will be able to:

1. Identify design goals and analyse possible approaches to meet given specifications with realistic Engineering constraints.
2. Design an electrical engineering project implementing an integrated design approach applying knowledge accrued in various professional courses.
3. Perform simulations and incorporate appropriate adaptations using iterative synthesis.
4. Use modern engineering hardware and software tools.
5. Work amicably as a member of an engineering design team.
6. Improve technical documentation and presentation skills.

**CO MAPPING WITH PO and PSO**

| CO/P<br>O | PO<br>1 | PO<br>2 | PO<br>3 | PO<br>4 | PO<br>5 | PO<br>6 | PO<br>7 | PO<br>8 | PO9 | PO10 | PO1<br>1 | PSO<br>1 | PSO<br>2 |
|-----------|---------|---------|---------|---------|---------|---------|---------|---------|-----|------|----------|----------|----------|
|-----------|---------|---------|---------|---------|---------|---------|---------|---------|-----|------|----------|----------|----------|

|     |   |   |   |   |   |   |   |   |   |   |   |   |   |
|-----|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 3 | 3 | 2 | - | 3 | 1 | 3 | 2 | 2 | 3 | 3 | 3 |
| CO2 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 2 | 2 | 2 | 3 | 3 |
| CO3 | 3 | 2 | 2 | 3 | 3 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 2 |
| CO4 | 3 | 2 | 2 | 2 | 3 | 2 | 2 | 3 | 2 | 2 | 3 | 3 | 3 |
| CO5 | 1 | - | 2 | - | - | 1 | 2 | 3 | 2 | 1 | 2 | 2 | 2 |
| CO6 | 1 | - | 2 | - | - | 2 | 3 | 3 | 3 | 1 | 2 | 2 | 2 |

| CO MAPPING WITH WK |     |     |     |     |     |     |     |     |     |
|--------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| CO/WK              | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |
| CO1                | ✓   | ✓   | ✓   | ✓   | ✓   |     | ✓   | ✓   | ✓   |
| CO2                | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   |
| CO3                | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   |
| CO4                | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   |
| CO5                | ✓   | ✓   | ✓   | ✓   | ✓   |     | ✓   | ✓   | ✓   |
| CO6                | ✓   | ✓   | ✓   | ✓   | ✓   |     | ✓   | ✓   | ✓   |

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |    |   |   |    |     |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|---|---|----|-----|
| <b>UEE741: Stochastic Modeling of Electrical Systems (Elective –III)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |    |   |   |    |     |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | L  | T | P | SL | Cr  |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 45 | 0 | 0 | 45 | 3.0 |
| <b>Course Objective:</b> The purpose is to understand the stochastic process and reliability concepts and their applications to power system problems such as power flow, expansion planning and protection etc.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |    |   |   |    |     |
| <b>Syllabus:</b><br><b>Introduction:</b> Basic concepts of probability theory, Probability of stochastic events, Random variables and its distribution, Numeral character of random variable, Convolution of random variables, Several usual random variable distributions, Markov process.<br><b>Probabilistic Component Models:</b> Probabilistic model of load, Probabilistic model of power system components, Outage table of power system components<br><b>Monte Carlo simulation:</b> Concept of constructing random walk, fundamental theory of Monte Carlo simulation method, Sampling of system operation state, State evaluation model, Indices of reliability evaluation, Flowchart of composite system adequacy evaluation, Markov Chain Monte Carlo (MCMC) simulation method<br><b>Stochastic load flow:</b> Cumulants of random distribution, Linearization of load flow equation, Computing process of probabilistic load flow, Probabilistic<br><b>Stochastic models for electric systems:</b> Introduction, Network-flow model, Lower boundary points of feasible flow solutions, power system protection, integrating the renewable energy systems.<br><b>Reliability of electrical systems:</b> Reliability, FOR, Preventive maintenance, Generation expansion planning, Power pooling and power trading, Reliability of transmission system, Transmission planning under uncertainty. |    |   |   |    |     |
| <b>Course Outcomes (COs)</b><br>After completion of the course, the students will be able to: <ol style="list-style-type: none"> <li>1. carryout sampling and Monte Carlo simulation.</li> <li>2. find stochastic model of electrical systems and develop the solution approach.</li> <li>3. compute the reliability indices of generating or transmission systems.</li> <li>4. identify the expansion of generator as per LOLP</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |    |   |   |    |     |
| <b>Text Books</b><br>1.Anders, George J (1990). Probability concepts in electric power systems. Wiley, NewYork<br>2.R.L. Sullivan “Power System Planning”, Tata McGraw Hill Publishing Company Ltd.<br>3.Roy Billinton & Ronald N. Allan “Reliability Evaluation of Power System”,Springer.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |    |   |   |    |     |
| <b>Reference Books</b><br>1.Rohatgi, V. K., & Saleh, A. M. E. <i>An introduction to probability and statistics</i> . John Wiley & Sons,(2015).<br>2.Ross, S. M. <i>Introduction to probability and statistics for engineers and scientists</i> . Academic Press,(2014).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |    |   |   |    |     |

| CO MAPPING WITH PO and PSO |     |     |     |     |     |     |     |     |     |      |      |      |      |
|----------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|
| CO/PO                      | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1                        | 3   | 3   | -   | -   | -   | -   | -   | -   | -   | -    | -    | 2    | 3    |
| CO2                        | 3   | 3   | 3   | -   | -   | -   | -   | -   | -   | -    | -    | 2    | 3    |
| CO3                        | 3   | 3   | -   | -   | -   | -   | -   | -   | -   | -    | -    | 2    | 3    |
| CO4                        | 3   | 3   | -   | -   | -   | -   | -   | -   | -   | -    | -    | 2    | 3    |

| CO MAPPING WITH WK |     |     |     |     |     |     |     |     |     |  |
|--------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|--|
| CO/WK              | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |  |
| CO1                |     | ✓   | ✓   | ✓   |     |     |     |     |     |  |
| CO2                |     | ✓   | ✓   | ✓   | ✓   |     |     |     |     |  |
| CO3                |     | ✓   | ✓   | ✓   |     |     |     |     |     |  |
| CO4                |     | ✓   | ✓   | ✓   |     |     |     |     |     |  |

| Evaluation Scheme |                                                                    |               |
|-------------------|--------------------------------------------------------------------|---------------|
| S. No.            | Evaluation Elements                                                | Weightage (%) |
| 1.                | MST & EST                                                          | 70            |
| 2.                | Sessional (Assignments/Projects/Tutorials/Quizzes/Lab Evaluations) | 30            |

**UEE742: Digital Controllers for Power Applications**

| L  | T | P  | SL | Cr  |
|----|---|----|----|-----|
| 30 | 0 | 30 | 30 | 3.0 |

**Course Objective:** To provide a deep insight into the various digital controller schemes used in power converters.

**Syllabus:**

**Introduction:** Digital signals and coding, Shannon's sampling theorem, sample and hold devices, analog-to-digital conversion, digital-to-analog conversion, energy quantization, reconstruction of sampled signals, data conversion: zero order hold, first order hold, second order hold.

**Mathematical modelling of digital power electronics:** Introduction, zero order hold for AC/DC controlled rectifiers, first order transfer function for DC/AC PWM inverters, second order transfer function for DC/DC converters.

**Digitally controlled converters:** Detailed mathematical modelling of different types of DC/AC rectifiers, AC/DC PWM inverters, DC/DC choppers, AC/AC voltage controllers, cycloconverters and matrix converters.

**Open and Closed loop control of digital power electronics:** Stability analysis, step and impulse responses, PI control for AC/DC, DC/AC and AC/AC converters, PID control for DC/DC converters.

**Applications of digital controllers in FACTS devices:** Phase angle compensator, UPFC.

**Laboratory Work:** The laboratory work will emphasize on development of PI and PID controllers for various power converter topologies using MATLAB Simulink.

**Course Outcomes (COs)**

After completion of the course, the students will be able to:

1. Conceptualize sample and hold circuit
2. Develop mathematical model of different power converters
3. Devise a controller for different power converters.

**Text Books**

1. Luo, F.L., Ye, H., & Rashid, M.H. *Digital power electronics and applications*. Elsevier (2010).
2. Buso, S., & Mattavelli, P. Digital control in power electronics. *Synthesis Lectures on Power Electronics*, 5(1), 1-229, (2015).

**Reference Books**

1. Ogata, K., Discrete-time Control Systems, Pearson Education (2005).

| CO MAPPING WITH PO and PSO |     |     |     |     |     |     |     |     |     |      |      |      |      |
|----------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|
| CO/PO                      | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
| CO1                        | 3   | 3   | -   | -   | -   | -   | -   | -   | -   | -    | -    | 3    | 2    |
| CO2                        | 3   | 3   | -   | -   | -   | -   | -   | -   | -   | -    | -    | 3    | 2    |
| CO3                        | 3   | 3   | 3   | -   | -   | -   | -   | -   | -   | -    | -    | 3    | 2    |

  

| CO MAPPING WITH WK |     |     |     |     |     |     |     |     |     |  |
|--------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|--|
| CO/WK              | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |  |
| CO1                |     | ✓   | ✓   | ✓   |     |     |     |     |     |  |
| CO2                |     | ✓   | ✓   | ✓   |     |     |     |     |     |  |
| CO3                |     | ✓   | ✓   | ✓   | ✓   |     |     |     |     |  |

  

| Evaluation Scheme |                                                                    |               |
|-------------------|--------------------------------------------------------------------|---------------|
| S. No.            | Evaluation Elements                                                | Weightage (%) |
| 1.                | MST & EST                                                          | 70            |
| 2.                | Sessional (Assignments/Projects/Tutorials/Quizzes/Lab Evaluations) | 30            |

**UEE743: Cloud Computing Based Electrical Systems**

| L  | T | P | SL | Cr  |
|----|---|---|----|-----|
| 45 | 0 | 0 | 45 | 3.0 |

**Course Objective:** To realize and use the Cloud computing paradigms, familiarize with architectural models and resource allocation strategies, virtualization and electrical systems applications.

**Syllabus:**

**Introduction to Cloud Technologies:** Introduction to Cloud computing and its components, Cloud deployment models, Cloud enabling technologies, Internet of Things for miniaturization, wireless and intelligent transportation technologies, scalable Cloud architecture model and resource management

**Virtualization and Cloud Platforms:**

Exploring virtualization for Server, Storage and Network, Load balancing, Hypervisors, Machine imaging, Cloud marketplace overview, Comparison of Cloud providers.

**Data Processing and security:** Concept of Map Reduce for Simplified data processing on Large clusters, Data security and related issues, Identify and access management, Economics, Challenges like Cloud provider Lock-in, Security etc.

**Resource Management in Clouds:** Virtual machines, performance isolation and resource sharing between virtual machines, performance provisioning, introduction of RT-Xen for VM scheduling, VATC as network I/O and OpenStack for Cloud resource management.

**Cloud Computing for Electrical Systems:** Realization of Cloud based SCADA system, smart grid management, energy and load forecasting and scheduling, and power system protection etc.

**Course Outcomes (COs)**

After completion of the course, the students will be able to:

- 1.Explain the Cloud architectures and use the IoT technologies for Cloud formulation.
- 2.Explain the virtualization and resource management concepts in Cloud s.
- 3.Confront storage, processing and security issues for Cloud computing.
- 4.Apply the Cloud computing concept for electrical system application.

**Text Books**

1. Rajkumar Buyya, James Broberg and Goscinski, Cloud Computing Principles and Paradigms, John Wiley and Sons, Second Edition,2012.
2. Gerard Blokdijk, Ivanka Menken, The Complete Cornerstone Guide to Cloud Computing Best Practices, Emereo Pvt Ltd, Second Edition,2009.

**Reference Books**

1.Anthony Velte, Toby Velte and Robert Elsenpeter, *Cloud Computing: A practical Approach*, Tata McGrawHill, , Second Edition,2010.

| CO MAPPING WITH PO and PSO |     |     |     |     |     |     |     |     |     |      |      |       |       |
|----------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|-------|-------|
| CO/PO                      | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO 1 | PSO 2 |
| CO1                        | 3   | 3   | -   | -   | 2   | -   | -   | -   | -   | -    | -    | 2     | 3     |
| CO2                        | 3   | 3   | -   | -   | 2   | -   | -   | -   | -   | -    | -    | 3     | 2     |
| CO3                        | 3   | 3   | -   | -   | -   | -   | -   | -   | -   | -    |      | 2     | 2     |
| CO4                        | 3   | 3   | 3   | 3   | 2   | -   | -   | -   | -   | -    | 3    | 2     | 3     |

  

| CO MAPPING WITH WK |     |     |     |     |     |     |     |     |     |  |
|--------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|--|
| CO/WK              | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |  |
| CO1                |     | ✓   | ✓   | ✓   |     | ✓   |     |     |     |  |
| CO2                |     | ✓   | ✓   | ✓   |     | ✓   |     |     |     |  |
| CO3                |     | ✓   | ✓   | ✓   |     |     |     |     |     |  |
| CO4                |     | ✓   | ✓   | ✓   | ✓   | ✓   |     | ✓   |     |  |

  

| Evaluation Scheme |                                                                    |               |
|-------------------|--------------------------------------------------------------------|---------------|
| S. No.            | Evaluation Elements                                                | Weightage (%) |
| 1.                | MST & EST                                                          | 70            |
| 2.                | Sessional (Assignments/Projects/Tutorials/Quizzes/Lab Evaluations) | 30            |

## UCS414: COMPUTER NETWORKS

| L  | T | P  | SL | Cr  |
|----|---|----|----|-----|
| 30 | 0 | 30 | 30 | 3.0 |

**Course Objectives:** The subject will introduce the basics of computer networks to students through a study of layered models of computer networks and applications.

**Introduction:** Organization of the Internet, ISP, Network criteria, Categories of networks, Network performance and Transmission Impairments. Network Devices, OSI Model, TCP/IP Protocol Suite, Layering principles, Line Encoding, Switching technique and Multiplexing.

**Local Area Networks:** LAN topologies: Bus topology, Ring topology, Token passing rings, FDDI, Star topologies, Asynchronous transfer mode, Ethernet, IEEE standards 802.3, 802.5. Wireless LANs: IEEE 802.11 and Bluetooth, introduction to Virtual circuit switching including frame relay, X.25, and ATM.

**Reliable Data Delivery:** Error control (retransmission techniques, timers), Flow control (Acknowledgements, sliding window), Multiple Access, Performance issues (pipelining).

**Routing and Forwarding:** Routing versus forwarding, Static and dynamic routing, Unicast and Multicast Routing. Distance-Vector, Link-State, Shortest path computation, Dijkstra's algorithm, Network Layer Protocols (IP, ICMP), IP addressing, IPV6, Address binding with ARP, Scalability issues (hierarchical addressing).

**Process-to-Process Delivery:** UDP, TCP and SCTP, Multiplexing with TCP and UDP, Principles of congestion control, Approaches to Congestion control, Quality of service, Flow characteristics, Techniques to improve QoS.

**Network Applications:** Naming and address schemes (DNS, IP addresses, Uniform Resource Identifiers, etc.), Distributed applications (client/server, peer-to-peer, cloud, etc.), HTTP as an application layer protocol, Electronic mail, File transfer, Remote login.

**Laboratory work:** To design conceptual networks using E-Draw, Visual Studio etc. and to implement topologies BUS, RING, STAR, Mesh and configuring Router using Packet tracer or GNS3 platform.

### Course Outcomes (COs):

After the completion of the course, the student will be able to:

1. Conceptualize and explain the functionality of the different layers within a network architecture
2. Analyze the requirements for a given organizational structure and select the most appropriate networking architecture and technologies, subnetting and routing mechanism.
3. Demonstrate the operation of various routing protocols and their performance analysis.
4. Illustrate design and implementation of datalink, transport and network layer protocols within a simulated/real networking environment.

### Text Books:

1. Forouzan A. B., *Data communication and Networking*, McGraw Hill (2012) 5<sup>th</sup>ed.
2. Tanenbaum S. A. and Wetherall J. D., *Computer Networks*, Prentice Hall (2013) 5<sup>th</sup>ed.

**Reference Books:**

1. Kurose J. and Ross K., *Computer Networking: A Top Down Approach*, Perason (2017) 7<sup>th</sup>ed.
2. Stallings W., *Computer Networking with Internet Protocols and Technology*, Pearson (2004).

**CO MAPPING WITH PO and PSO**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PSO 1 | PSO 2 |
|-------|------|------|------|------|------|------|------|------|------|------|------|-------|-------|
| CO1   | 1    | 1    | -    | -    | 2    | -    | -    | -    | -    | -    | -    | 3     | -     |
| CO2   | 1    | 1    | 3    | 3    | 2    | -    | -    | -    | -    | -    | 2    | 3     | 2     |
| CO3   | 1    | 1    | 3    | 3    | 2    | -    | -    | -    | -    | -    | 2    | 3     | -     |
| CO4   | 1    | 1    | 3    | 3    | 2    | -    | -    | -    | -    | -    | 2    | -     | 2     |

**CO MAPPING WITH WK**

| CO/WK | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| CO1   |     | ✓   |     |     |     | ✓   |     |     |     |
| CO2   |     | ✓   |     |     | ✓   | ✓   |     | ✓   |     |
| CO3   |     | ✓   |     |     | ✓   | ✓   |     | ✓   |     |
| CO4   |     | ✓   |     |     | ✓   | ✓   |     | ✓   |     |

**Evaluation Scheme:**

| S. No. | Evaluation Elements                                                | Weightage (%) |
|--------|--------------------------------------------------------------------|---------------|
| 1.     | MST                                                                | 25            |
| 2.     | EST                                                                | 45            |
| 3.     | Sessional (Assignments/Projects/Tutorials/Quizzes/Lab evaluations) | 30            |

## Semester VIII

### UEE894: Project Semester

| L | T | P | SL  | Cr |
|---|---|---|-----|----|
| 0 | 0 | 0 | 450 | 15 |

**Course Objective:** The project semester is aimed at developing the undergraduate education program in Electrical Engineering to include a practical training in a professional engineering set up (a company, top educational institution, research institute, etc.) hereafter referred to as host “organization” as deemed appropriate. The participating organizations are selected that are either already visiting Thapar Institute of Engineering & Technology (TIET), Patiala for placement or are forming new relationships of mutual benefit. The project semester gives the students, the opportunity to translate engineering theory into practice in a professional engineering environment. The technical activity in the project semester should be related to both the student’s engineering studies and to the host organization’s activities and it should constitute as significant body of engineering work at the appropriate level. It should involve tasks and methods that are more appropriately completed in a professional engineering environment and should, where possible, make use of human and technology resources provided by the organization. It consolidates the student’s prior learning and provides a context for later research studies. The student remains a fulltime registered student at TIET, Patiala during the project semester and this activity is therefore wholly distinct from any industrial interactions which may occur over vacation periods.

**Assessment Details:** Each student is assigned a faculty supervisor who is responsible for managing and assessment of the project semester. The faculty supervisor monitors the student’s progress in a semester and interacts with the industry mentor during his/her visit to the host organization twice. This includes a Reflective Diary which is updated throughout the project semester, an Interim Project Report, a Final Report with Learning Agreement/Outcomes and a Final Presentation & Viva which involves the faculty Supervisor and some other members from the department. The mentor from the host organization is asked to provide his assessment on the designated form. The faculty supervisor is responsible for managing and performing the assessment of the project semester experience.

#### **Course Learning Outcomes (CLO)**

After completion of the course, the students will be able to:

1. Acquire knowledge and experience of software and hardware practices in the area of project.
2. Carry out design calculations and implementations in the area of project.
3. Associate with the implementation of the project requiring individual and teamwork skills.
4. Communicate their work effectively through writing and presentation.
5. Demonstrate the knowledge of professional responsibilities and respect for ethics.

#### CO MAPPING WITH PO and PSO

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|
| CO1   | 3   | 2   | 2   | 2   | 2   | 2   | -   | -   | -   | 3    | 3    | 3    | 3    |
| CO2   | 3   | 3   | 3   | 3   | 2   |     | -   | -   | -   | 3    | -    | 3    | 3    |
| CO3   | -   | -   | -   | -   | -   | -   | -   | 3   | 3   | 3    | 2    | -    | 3    |
| CO4   | -   | -   | -   | -   | -   | -   | -   | -   | 3   | -    | 2    | -    | 3    |
| CO5   | -   | -   | -   | -   | -   | 1   | 3   | -   | -   | -    | 1    | -    | 3    |

| CO MAPPING WITH WK |     |     |     |     |     |     |     |     |     |
|--------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| CO/WK              | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |
| CO1                | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   |
| CO2                | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   |     | ✓   | ✓   |
| CO3                |     |     |     |     |     |     |     | ✓   | ✓   |
| CO4                |     |     |     |     |     |     |     | ✓   | ✓   |
| CO5                |     |     |     |     | ✓   |     | ✓   | ✓   | ✓   |

## UEE632: POWER GENERATION AND ECONOMICS

| L  | T  | P | SL | Cr  |
|----|----|---|----|-----|
| 45 | 15 | 0 | 45 | 3.5 |

**Course objective:** To impart learning about the principle and concept of conventional, non-conventional power plants and power plant economies.

**Introduction:** Energy sources and their availability, Principle types of power plants, their special features and applications, Present status and future trends.

**Hydro Electric Power Plants:** Essentials, Classifications, Hydroelectric survey, Rainfall run-off, Hydrograph, Flow duration curve, Mass curve, Storage capacity, Site selection, Plant layout, various components, Types of turbines, Governor and speed regulation, Pumped storage, Small scale hydro-electric plants (mini and micro).

**Thermal Power Plant:** General developing trends, Essentials, Plant layout, Coal & its storage, Preparation, Handling, Feeding and burning, Cooling towers, Ash handling, Water treatment plant, High pressure boilers and steam turbines, Components of thermal power plant.

**Gas Turbine Power Plants:** Field of use, Components, Plant layout, Comparison with steam power plants, combined steam and gas power plants.

**Nuclear Power Plant:** Nuclear fuels, Nuclear energy, Main components of nuclear power plant, Nuclear reactors types and applications, Radiation shielding, Radioactive and waste disposal safety aspect.

**Non-Conventional Power Generation:** Geothermal power plants, Electricity from biomass, Direct energy conversion systems (Solar and Wind) Thermo-electric conversion system, Fuel cells, Magneto Hydro dynamic system.

**Cogeneration:** Definition and scope, Cogeneration technologies, Allocation of costs, Sale of electricity and impact on cogeneration.

**Power Plant Economics:** Cost of electrical energy, Selection of type of generation and generation equipment, Performance and operating characteristics of power plants, Economic scheduling principle, Load curves, Effect of load on power plant design, Load forecasting, electric tariffs, Peak load pricing.

### Course Outcomes (COs):

After the completion of the course the students will be able to:

1. Apply knowledge of India's power scenario, power system structure and related agencies.
2. Harness power from conventional and renewable sources.
3. Select the methods and size of plant generating power for overall economy.
4. Decide the tariff structure for different type of users.

### Text Books:

1. Arora, S.C and Domkundawar, S., *A course in Power Plant Engineering*, Dhanpat Rai(2002).
2. Deshpande, M.V., *Power Plant Engineering*, Tata McGraw Hill(2004).
3. Gupta, B.R., *Generation of Electrical Energy*, S. Chand(1998).

### Reference Books:

1. Deshpande, M.V., *Electrical Power System Design*, McGraw Hill (2004).
2. Wood, A.J. and Wollenberg, B.F., *Power Generation and Control*, John Wiley

(2004).

**CO MAPPING WITH PO and PSO**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PSO 1 | PSO 2 |
|-------|------|------|------|------|------|------|------|------|------|------|------|-------|-------|
| CO1   | 1    | -    | -    | -    | -    | 3    | -    | -    | -    | -    | 2    | 1     | -     |
| CO2   | 2    | 2    | -    | -    | -    | 3    | -    | -    | -    | -    | 2    | 1     | -     |
| CO3   | -    | -    | -    | -    | -    | 3    | -    | -    | -    | 3    | 2    | 1     | -     |
| CO4   | -    | -    | -    | -    | -    | 3    | -    | -    | -    | 3    | 2    | 1     | -     |

**CO MAPPING WITH WK**

| CO/WK | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| CO1   |     |     |     |     | ✓   |     | ✓   |     |     |
| CO2   |     |     | ✓   | ✓   |     |     | ✓   |     |     |
| CO3   |     |     |     |     | ✓   |     | ✓   |     |     |
| CO4   |     |     |     |     |     |     | ✓   | ✓   |     |

**Evaluation Scheme:**

| Sr. No. | Evaluation Elements                                | Weightage (%) |
|---------|----------------------------------------------------|---------------|
| 1.      | MST                                                | 30            |
| 2.      | EST                                                | 45            |
| 3.      | Sessional (Assignments/Projects/Tutorials/Quizzes) | 25            |

## UEE522: ENERGY AUDITING AND MANAGEMENT

| L  | T  | P | SL | Cr  |
|----|----|---|----|-----|
| 45 | 15 | 0 | 45 | 3.5 |

**Course Objective:** To make the student understand about the energy scenario and its importance.

**Energy Scenario:** Energy scenario of growing economy, Energy pricing, Energy sector reforms, Energy and environment, Energy security, Energy conservation and its importance, Energy conservation Act-2001 and its features.

**Energy Management and Audit:** Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Benchmarking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution, Energy audit instruments

**Material and Energy Balance:** Methods for preparing process flow, Material and energy balance diagrams.

**Financial Management:** Investment-need, Appraisal and criteria, financial analysis techniques- Risk and sensitivity analysis, Financing options, Energy performance contracts and role of ESCOs.

**Electrical System:** Electricity tariff, Load management and maximum demand control, T&D losses. Losses and efficiency in induction motors, Factors affecting motor performance and remedial solutions, energy efficient motors. Light source, Choice of lighting, Luminance requirements, and Energy conservation avenues

**Compressed Air System:** Types of air compressors, Compressor efficiency, efficient compressor operation, Compressed air system components, Capacity assessment.

**HVAC and Refrigeration System:** Vapor compression refrigeration cycle, Coefficient of performance, Capacity, performance and savings opportunities, Vapour absorption refrigeration system: Working principle of fans, blowers and pumps-types, Performance evaluation, Flow control strategies and energy conservation opportunities.

### Course Outcomes (COs):

After the completion of the course the students will be able to:

1. Analyse energy scenario nationwide and worldwide
2. Decide about energy management in more effective way.
3. Analyse various energy related aspect of electrical system.
4. Carry out financial management.
5. Conduct studies related to operational aspects of compressed air system and refrigeration system.

### Text Books:

1. Abbi, Y.P. and Jain, S., *Handbook on Energy Audit and Environment Management*, Teri Bookstore (2006).
2. Diwan, P., *Energy Conservation*, Pentagon Press(2008).

### Reference Book:

1. Younger, W., *Handbook of Energy Audits*, CRC Press(2008)

| CO MAPPING WITH PO and PSO |      |      |      |      |      |      |      |      |      |      |      |       |       |
|----------------------------|------|------|------|------|------|------|------|------|------|------|------|-------|-------|
| CO/PO                      | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PSO 1 | PSO 2 |
| CO1                        | 1    | 1    | 3    | 3    | -    | -    | -    | -    | -    | -    | 2    | 2     | 2     |
| CO2                        | 1    | 1    | 3    | 3    | -    | -    | -    | -    | -    | -    | 2    | 1     | 2     |
| CO3                        | 1    | 1    | 3    | 3    | -    | -    | -    | -    | -    | -    | -    | 3     | 2     |
| CO4                        |      |      |      | 3    | -    | -    | -    | -    | -    | 3    | -    | 3     | 2     |
| CO5                        | 1    | 1    | 3    | 3    | -    | -    | -    | -    | -    | -    | -    | 3     | -     |

| CO MAPPING WITH WK |     |     |     |     |     |     |     |     |     |  |
|--------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|--|
| CO/WK              | WK1 | WK2 | WK3 | WK4 | WK5 | WK6 | WK7 | WK8 | WK9 |  |
| CO1                |     |     |     | ✓   | ✓   |     |     | ✓   |     |  |
| CO2                |     |     |     | ✓   | ✓   |     |     | ✓   |     |  |
| CO3                |     |     |     | ✓   | ✓   |     |     | ✓   |     |  |
| CO4                |     |     |     |     | ✓   |     |     | ✓   |     |  |
| CO5                |     |     | ✓   | ✓   | ✓   |     |     |     |     |  |

**Evaluation Scheme:**

| Sr. No. | Evaluation Elements                                | Weightage (%) |
|---------|----------------------------------------------------|---------------|
| 1       | MST                                                | 30            |
| 2       | EST                                                | 45            |
| 3       | Sessional (Assignments/Projects/Tutorials/Quizzes) | 25            |