P D A College of Engineering

**B.E. in Electrical and Electronics Engineering**

**Scheme of Teaching and Examinations 2022**

Outcome Based Education(OBE) and Choice Based Credit System(CBCS)

(Effective from the academic year 2024-25)

**V SEMESTER**

| Sl .No | Course and Course Code | | Course Title | Teaching Department (TD) and Question Paper Setting Board (PSB) | Teaching Hours/Week | | | | Examination | | | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Theo | Tutorial | Practical/Dra | Self-Study | Duration | CIE Marks | SEE Marks | Total Marks | |
| | | | | | L | T | P | S | | | | | |
| 1 | HSMS/ PC | 22EE51 | Power Electronics | EEE | 2 | 2 | 0 | | 03 | 50 | 50 | 100 | 4 |
| 2 | IPCC | 22EE52 | Microcontrollers | EEE | 3 | 0 | 2 | | 03 | 50 | 50 | 100 | 4 |
| 3 | PCC | 22EE53 | Power System Analysis and Stability | EEE | 4 | 0 | 0 | | 03 | 50 | 50 | 100 | 4 |
| 4 | PCCL | 22EEL54 | Power Electronics Lab | EEE | 0 | 0 | 2 | | 03 | 50 | 50 | 100 | 1 |
| 5 | PEC | 22EE55A | Utilization of Electrical Power | EEE | 3 | 0 | 0 | | 03 | 50 | 50 | 100 | 3 |
| 6 | PROJ | 22EEMP56 | Mini Project | TD-Respective Dept. PSB- Respective Dept. | 0 | 0 | 4 | | - | 50 | | 50 | 2 |
| 7 | AEC | 22RMI57 | Research Methodology and IPR | Any Department | 2 | 2 | 0 | | 03 | 50 | 50 | 100 | 3 |
| 8 | BSC | 22ES58 | Environmental Studies | TD:CV/Env/Chem PSB:CV | 2 | 0 | 0 | | 03 | 50 | 50 | 100 | 2 |
| 9 | NCMC | 22NS59 | Mandatory Course | NSS coordinator | 0 | 0 | 2 | | | 50 | | 50 | 0 |
| | | 22PH59 | Mandatory Course | Physical Education Director | | | | | | | | | |
| | | 22YO59 | Mandatory Course | Yoga Teacher | | | | | | | | | |
| | | | | | | | | | **Total** | **450** | **350** | **800** | **23** |

**Professional Elective Course**

| | | | |
|---|---|---|---|
| 22EE55A | Utilization of Electrical Power | 22EE55C | Reactive Power Management |
| 22EE55B | Operational Amplifiers and Linear IC's | 22EE55D | Digital Signal Processing |

**PCC**:ProfessionalCoreCourse,**PCCL**:ProfessionalCoreCourselaboratory,**UHV**:UniversalHumanValueCourse,**MC**:MandatoryCourse(Non-credit),

**AEC**:Ability Enhancement Course, **SEC**:Skill Enhancement Course, **L:** Lecture, **T**: Tutorial, **P**: Practical **S= SDA**: Skill Development Activity, **CIE**: Continuous Internal Evaluation, **SEE**:SemesterEndEvaluation. **K:**Theletterinthecoursecodeindicates commontoalthestreamofengineering.**PROJ**:Project/MiniProject.**PEC**:ProfessionalElective Course

**Professional Core Course (IPCC):** Refers to Professional Core Course Theory Integrated with practical of the same course. Credit for IPCC can be 04 and its Teaching–Learning hours (L : T : P) can be considered as(3 : 0 : 2) or (2 : 2 : 2). The theory part of the IPCC shall be evaluated both by CIE and SEE. The practical part shall beevaluatedbyonlyCIE (no SEE).However,questionsfrom thepracticalpart ofIPCCshallbeincluded in theSEEquestion paper.Formoredetails,theregulationgoverningtheDegreeofBachelorofEngineering/Technology(B.E./B.Tech.)2022-23

**National Service Scheme /Physical Education/Yoga:**All students have to register for any one of the courses namely National Service Scheme (NSS), Physical Education(PE)(Sports and Athletics), andYoga(YOG) with the concerned coordinator of the course during the first week of III semestersActivities shall be carried out between IIIsemester to the VI semester (for 4 semesters). Successful completion of the registered course and requisite CIE score is mandatory for the award of the degree. Theeventsshallbeappropriatelyscheduledbythecollegesandthesameshallbereflectedin thecalendarpreparedfortheNSS,PE,and Yogaactivities.Thesecoursesshallnotbeconsidered forvertical progressionaswell asfor thecalculationofSGPAandCGPA, butcompletionofthecourseismandatoryforthe awardofdegree.

**Mini-project work:** Mini Project is a laboratory-oriented/hands on course that will provide a platform to students to enhance their practical knowledge and skills by thedevelopmentofsmallsystems/applicationsetc.Basedontheability/abilitiesofthestudent/sandrecommendationsofthementor,asingledisciplineoramultidisciplinaryMini-project canbe assigned to anindividual studentor to agrouphavingnotmorethan4 students.

**CIEprocedureforMini-project:**

**(i) Single discipline:** The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two faculty members of the Department,one of them being the Guide. The CIE marks awarded for the Mini-project work shall be based on the evaluation of the project report, project presentation skill, andquestionand answersessionintheratio of50:25:25.The marks awardedfor theproject reportshallbe thesameforall thebatchesmates.

**(ii) Interdisciplinary:**ContinuousInternalEvaluationshallbegroup-wiseatthecollegelevelwiththeparticipationofalltheguidesoftheproject.

The CIE marks awarded for the Mini-project shall be based on the evaluation of the project report, project presentation skill, and question and answer session in theratio50:25:25.Themarks awardedfortheprojectreport shallbethe sameforallthebatchmates.

**NoSEEcomponent forMini-Project.**

**Professional Elective Courses (PEC):** A professional elective (PEC) course is intended to enhance the depth and breadth of educational experience in the Engineering andTechnology curriculum. Multidisciplinary courses that are added supplement the latest trend and advanced technology in the selected stream of engineering. Eachgroupwillprovideanoptiontoselectonecourse.Theminimumnumberofstudents'strengthsforofferingaprofessionalelectiveis10.However,thisconditionalshall Notbeapplicable to caseswheretheadmissionto theprogram is less than10.

P D A College of Engineering

**B.E. in Electrical and Electronics Engineering**

**Scheme of Teaching and Examinations 2022**

Outcome Based Education(OBE) and Choice Based Credit System(CBCS)

(Effective from the academic year 2024-25)

**VI Semester**

| Sl .No | Course and Course Code | | Course Title | Teaching Department (TD) and Question Paper Setting Board (PSB) | Teaching Hours/Week | | | | Examination | | | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Theo | Tutorial | Practical/Dra | Self-Study | Duration | CIE Marks | SEE Marks | Total Marks | |
| | | | | | L | T | P | S | | | | | |
| 1 | HSMS/ PC | 22 HU61 | Entrepreneurship, Management and Finance | PSB- Respective Dept. | 2 | 2 | 2 | | 03 | 50 | 50 | 100 | 3 |
| 2 | PCC | 22EE62 | Computer Applications to Power System | EEE | 3 | 2 | 0 | | 03 | 50 | 50 | 100 | 4 |
| 3 | PEC | 22EE63A | Elective – I (Signal and Systems) | EEE | 3 | 0 | 0 | | 03 | 50 | 50 | 100 | 3 |
| 4 | OEC | 22EEOE64x | Open Elective -I | TD-Respective Dept. PSB- Respective Dept. | 3 | 0 | 0 | | 03 | 50 | 50 | 100 | 3 |
| 5 | PROJ | 22EE65 | Major Project Phase - I | EEE | 0 | 0 | 4 | | 03 | 50 | -- | 50 | 2 |
| 6 | PCCL | 22EEL66 | Power System Simulation Lab | EEE | 0 | 0 | 2 | | 03 | 50 | 50 | 100 | 1 |
| 7 | AEC/SDC | 22EEAE671 | Indian Knowledge System ( Ability Enhancement Course/Skill Development Course V) | | If the course is offered as a Theory: 0 | 2 | 0 | | 02 03 | 50 | 50 | 100 | 1 |
| | | | | | If a course is offered as a practical: 0 | 0 | 2 | | | | | | |
| 8 | NCMC | 22NS68 | Mandatory Course (Non-credit), | NSS coordinator | 0 | 0 | 2 | | | 50 | --- | 50 | 0 |
| | | 22PE68 | Mandatory Course (Non-credit), | Physical Education Director | | | | | | | | | |
| | | 22YO68 | Mandatory Course (Non-credit), | Yoga Teacher | | | | | | | | | |
| | | | | | | | | | **Total** | **400** | **300** | **700** | **17** |

**Professional Elective Course**

| | | | |
|---|---|---|---|
| 22EE63A | Signal and Systems | 22EE63C | Distributed Generation |
| 22EE63B | Electric Vehicles | 22EE63D | PLC & SCADA |

| Open Elective Course | | | |
|---|---|---|---|
| 22EEOE641 | Essentials of Information Technology | 22EEOE642 | Operation & Maintenance of Solar Electric System |
| 22EEOE643 | VLSI & Design | 22EEOE644 | Illumination Engineering |
| **Ability Enhancement Course/Skill Enhancement Course-V** | | | |
| 22XXAE671 | Indian Knowledge System | 22XXAE672 | Estimation and Costing Lab |
| 22XXAE673 | | 22XXAE674 | |

**PCC**: Professional Core Course, **PCCL**: Professional Core Course laboratory, **UHV**: Universal Human Value Course, **MC**: Mandatory Course (Non-credit), **AEC**: AbilityEnhancement Course, **SEC**:Skill Enhancement Course, **L:** Lecture, **T**: Tutorial, **P**: Practical **S= SDA**: Skill Development Activity, **CIE**: Continuous Internal Evaluation, **SEE**:SemesterEndEvaluation.**K:**Theletterinthecoursecodeindicatescommontoalthestreamofengineering.**PROJ**:Project/MiniProject.**PEC**:ProfessionalElective Course.**PROJ**:ProjectPhase-I,**OEC**:OpenElectiveCourse

**Professional Core Course (IPCC):** Refers to Professional Core Course Theory Integrated with practical of the same course. Credit for IPCC can be 04 and its Teaching–Learning hours (L : T : P) can be considered as(3 : 0 : 2) or (2 : 2 : 2). The theory part of the IPCC shall be evaluated both by CIE and SEE. The practical part shall beevaluated by only CIE (no SEE). However, questions from the practical part of IPCC shall be included in the SEE questionpaper. For more details, the regulationgoverningtheDegreeofBachelorofEngineering/Technology(B.E./B.Tech.)2022-23

**National Service Scheme /Physical Education/Yoga:**All students have to register for any one of the courses namely National Service Scheme (NSS), Physical Education(PE)(Sports and Athletics), andYoga(YOG) with the concerned coordinator of the course during the first week of III semesters.Activities shall be carried out between IIIsemester to the VI semester (for 4 semesters). Successful completion of the registered course and requisite CIE score is mandatory for the award of the degree. TheeventsshallbeappropriatelyscheduledbythecollegesandthesameshallbereflectedIn thecalendarpreparedfortheNSS,PE,andYogaactivities.Thesecoursesshall notbeconsidered forvertical progressionaswell asfor thecalculationofSGPAandCGPA, butcompletionofthecourseismandatoryfortheawardofdegree.

**Professional Elective Courses (PEC):** A professional elective (PEC) course is intended to enhance the depth and breadth of educational experience in the Engineering andTechnology curriculum. Multidisciplinary courses that are added supplement the latest trend and advanced technology in the selected stream of engineering. Eachgroupwillprovideanoptiontoselectonecourse.Theminimumnumberofstudents'strengthsforofferingprofessionalelectivesis10.However,thisconditionalshall notbeapplicableto caseswheretheadmissionto theprogramis lessthan10.

**OpenElectiveCourses:**

Students belonging to a particular stream of Engineering and Technology are not entitled to the open electives offered by their parent Department. However, they canopt for an elective offered by other Departments, provided they satisfy the prerequisite condition if any. Registration to open electives shall be documented under theguidanceoftheProgramCoordinator/Advisor/Mentor.Theminimumnumbersofstudents'strengthforofferingOpenElectiveCourseis10.However,thiscondition shallnotbeapplicabletoclasswhere theadmissiontotheprogramislessthan10.

**ProjectPhase-I:**Studentshave todiscusswiththementor/guideandwiththeir helphe/shehastocompletetheliteraturesurveyandpreparethe reportandfinally definetheproblemstatementfortheprojectwork.

| Course Title: **POWER ELECTRONICS** | | | |
|---|---|---|---|
| Course Code | 22EE51 | Credits: 04 | CIE: 50 |
| Number of Lecture Hours/Week | 2hrs (Theory)<br>2 hrs (Tutorial) | | SEE: 50 |
| Total Number of Lecture Hours | 42 | | SEE Hours: 03 |

**Prerequisite:**
1. Digital electronics
2. Knowledge of Electronic Circuit is needed

**Course Objectives:**
1. To study Power MOSFET's IGBT.
2. To understand Thyristors, GTOs and Commutation Techniques.
3. To know about AC Voltage Controllers & Controlled Rectifiers.
4. To understand the use and Application of DC Choppers.

| Modules | Teaching Hours |
|---|---|
| **Module I**<br>**Power MOSFETs & Insulated Gate Bipolar Transistors (IGBTs):**<br>Power MOSFETs Junction Structure, Principle of Operation, Output Characteristics, Safe Operating Area (SOA), Gate Electrode Capacitance, Power MOSFET Switching Times.<br>**Insulated Gate Bipolar Transistors (IGBTs) :**IGBTs compared with power MOSFETs and power BJT, Junction Structure, Principle of Working, Terminal Capacitances, Gate Drive Requirements, Switching Times. | **09 hrs** |
| **Module II**<br>**Thyristors & The Gate Turn Off Thyristor (GTO):**<br>Thyristors Characteristics, Two-Transistor model of Thyristor, Turn-On and Turn-Off of Thyristor. Series operation of Thyristors, Parallel operation of Thyristors, di/dt Protection, dv/dt Protection.<br>The Gate Turn Off Thyristor (GTO), Junctions Structures of Symmetrical and Anode Short GTO. GTO Switching characteristics. | **08 hrs** |
| **Module III**<br>**Commutation Techniques & AC Voltage Controllers:**<br>Introduction, Natural commutation, Forced commutation, self commutation, impulse commutation.<br>**AC Voltage Controllers:** Introduction, Principle of ON-OFF and Phase Control. Single-phase bidirectional controllers with resistive and inductive loads. | **08 hrs** |
| **Module IV**<br>**Controlled Converters:**<br>Introduction principle and operation of Phase controlled converter and operation. Single phase converters, Full converters. Three-phase full-wave converters.<br>**PWM Inverters:** Introduction, principle of operation, performance parameters, single phase bridge inverters, voltage control of single phase inverters, Three phase inverter (120 and 180 degree conduction mode only) | **09 hrs** |
| **Module V**<br>**DC Choppers:**<br>Introduction, principle of step-down and step-up chopper with R and R-L load, Performance parameters. Chopper classification. | **08 hrs** |

**Question paper pattern:** Total ten questions will be asked. Two from each module. The student has to answer five questions, selecting at least one from each module.

**Reference Books:**
1. Power Electronics, M.H. Rashid 3rd Edition, P.H.I. / Pearson, New Delhi, 2006
2. "Power Electronics –Converters, Applications and Design", Ned Mohan, Tore M. Undeland, and William

P.Robins, Third Edition, John wjley and sons.1989
3. Power Electronics circuit, Devices and applications. Rashid PHI, Third Edition 2013
4. Joseph Vithayathil "Power Electronics Principles and Applications" (Edition 2010)

**Course outcomes:**
**On completion of the course, the student will have the ability to:**

| Course Code | CO | Course Outcome (CO) | |
|---|---|---|---|
| 22EE51 | CO1 | **Illustrate the working of specified power electronic devices – MOSFET, IGBT, GTO, SCR. C3** | |
| | CO2 | **Analyze natural and forced commutation techniques.** | |
| | CO3 | **Assess AC voltage controllers at resistive and inductive loads.** | |
| | CO4 | **Analyze controlled rectifier for single and three phase converters for resistive and inductive loads.** | |
| | CO5 | **Analyze and categorize DC choppers.** | |

| S.No. | PO CO | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | CO1 | 3 | 1 | 2 | | | | | | | | | 1 | 3 | 3 | 1 |
| 2 | CO2 | 3 | 1 | 2 | | | | | | | | | 1 | 3 | 3 | 1 |
| 3 | CO3 | 3 | 1 | 2 | | | | | | | | | 1 | 3 | 3 | 1 |
| 4 | CO4 | 3 | 3 | 2 | | | | | | | | | 1 | 3 | 3 | 1 |
| 5 | CO5 | 3 | 3 | 2 | | | | | | | | | 1 | 3 | 3 | 1 |
| | | 3 | 1.8 | 2 | | | | | | | | | 1 | 3 | 3 | 1 |

| Course Title: **MICROCONTROLLERS** | | | |
|---|---|---|---|
| Course Code | 22EE52 | Credits:04 | CIE: 50 |
| Number of Lecture Hours/Week | 3 hrs.(Theory) + 2hrs (Practical) | | SEE: 50 |
| Total Number of Lecture Hours | 42 | | SEE Hours: 03 |

**Prerequisite:**

1. Knowledge of Digital Electronics subject is required
2. Knowledge of Signal and system subject is needed
3. Knowledge of Microprocessors and its applications.

**Course Objectives:**

1. To study architecture of 8051 family.
2. To understand about instruction and programming.
3. To know about different types of interrupts.
4. To study I/O port interfacing.
5. To understand interfacing of external memory and 8255.

| Modules | Teaching Hours |
|---|---|
| **Module I**<br>**Introduction:** Overview of 8051 family, Architecture, Addressing modes, Registers, External Memory.<br>**Instructions and Programming**: Arithmetic, Logic, Single bit, Jump and Call instructions and Programming. | **09 Hours** |
| **Module II**<br>**Interrupts:** Counters and Timers, 8051 Interrupts, Timer interrupts, External hardware interrupts, Serial communication interrupts and Interrupts priority and its Programming. | **09 Hours** |
| **Module III**<br>**I/O Port Interfacing**: I/O programming, ADC, DAC, LCD, Stepper motor Keyboard Interfacing. | **08 Hours** |
| **Module IV**<br>**Interfacing to External Memory**: Semiconductor memory, Memory address decoding, Interface with External ROM, Data memory space. | **08 Hours** |
| **Module V**<br>**Interfacing to the Program Peripheral Interface:** 8255 Modes, Interfacing and its programming.<br>**Arm 64-Bit Microcontroller:** Thumb-2 technology and application of ARM, Architecture of ARM, various units of Architecture, debugging techniques, registers and interrupts. | **08 Hours** |

**Question paper pattern:** Two questions from each module will be set. The student has to answer five full questions, selecting at least one full question from each module.

**Reference Books:**

**1.** Muhammad Ali Mazidi & Janice Gillespie Mazidi: 8051 Controller and Embedded Systems – Pearson Education, Second edition, 2008.
2. Kenneth . J. Ayala: The 8051 Microcontroller Architecture, Programming and Application, 2E, Pen Ram International, 1991.
3. Predko: Programming and Customizing the 8051 Microcontroller" TMH, 2008.
4. Raj Kamal: Microcontroller: Architecture, Programming Interfacing and Systems Design" Pearson Education,2009.
5. Andrew N. Sloss, Dominic Symes, Chris Wright, "ARM Systems Developer's Guides- Designing

| & Optimizing System Software", 2008, Elsevier | | | |
|---|---|---|---|
| **Course outcomes:**<br>**On completion of the course, the student will have the ability to:** | | | |
| **Course Code** | **CO** | **Course Outcome (CO)** | |
| 22EE52 | CO1 | **Describe the architecture and operation of 8051 microcontroller** | |
| | CO2 | **Apply the knowledge of instruction set & addressing modes for writing programs** | |
| | CO3 | **Use of timer & Interrupts through programs** | |
| | CO4 | **Discuss the different applications such as ADC, DAC, LCD & develop the programs for interfacing.** | |
| | CO5 | **Experiment I/O and memory interfacing** | |
| | CO6 | **Develop the program and interfacing of 8255** | |

| S.No. | PO<br>CO | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | CO1 | 3 | | | | | | | | | | | 1 | 3 | | |
| 2 | CO2 | 3 | 2 | | | | | | | | | | 1 | 3 | 2 | 2 |
| 3 | CO3 | 3 | | 2 | | | | | | | | | 1 | 3 | 2 | 2 |
| 4 | CO4 | 3 | | 1 | | | | | | | | | 1 | 3 | 2 | 2 |
| 5 | CO5 | 3 | | | | | | | | | | | 1 | 3 | 2 | 2 |
| 6 | CO6 | 3 | | | | | | | | | | | 1 | 3 | 2 | 2 |
| | | 3 | 2 | 1.5 | | | | | | | | | 1 | 3 | 2 | 2 |

| Course Title: **POWER SYSTEM ANALYSIS AND STABILITY** | | | |
|---|---|---|---|
| Course Code | **22EE53** | Credits:04 | CIE: 50 |
| Number of Lecture Hours/Week | **4hrs. (Theory)** | | SEE: 50 |
| Total Number of Lecture Hours | 42 | | SEE Hours: 03 |

Prerequisite: Knowledge of Transmission and Distribution
Knowledge of Electrical Machine is needed

Course Objectives:

1. To study power system network with its basic knowledge.
2. To analysis different types of faults and short circuit studies in power system network.
3. To Calculate balanced and unbalanced load in Power system network.
4. To understand the concept of stability in power system engineering

| **Modules** | **Teaching Hours** |
|---|---|
| **Module I**<br>**Representation of Power System Components**: Circuit models of transmission line, synchronous machines, transformer on load, single line diagram, calculation of per unit quantities and per unit impedance and reactance diagram, advantages of P.U system, change in base quantities. | **8Hrs** |
| **Module II**<br>**Symmetrical Three Phase faults:** Short circuit on unloaded transmission line, short-circuit currents and the reactance of synchronous machines on no load and load condition, current oscillograms. Analysis of short circuits, Selection of Circuit Breakers. | **8Hrs** |
| **Module III**<br>**Symmetrical Components**: Resolution of unbalanced phase into their symmetrical components & vice versa, phase shift of symmetrical components through star - delta transformer. Power invariance. Analysis of balanced and unbalanced load using balanced and unbalanced three phase supply. Sequence impedances, sequence networks of power system elements. (Alternator, transformer and transmission line) positive, negative and zero sequence networks of power system elements. | **8Hrs** |
| **Module IV**<br>**Unsymmetrical Faults:** Single line to ground (L-G), line to line (L-L), Double line to Ground (L-L-G) faults on unloaded alternator with and without fault impedance. Unsymmetrical faults on a power system with and without fault impedance. Open conductor faults in power systems. | **9Hrs** |
| **Module V**<br>**Stability Studies**: Rotor dynamics and the swing equation of synchronous machine, constant M and H of rotating machines, Power angle equation, Stability studies, steady state stability and pull out curve. Transient stability, dynamic stability, equal-area criterion of stability studies and its applications, factors affecting on stability. | **9Hrs** |

**Question paper pattern:** Total ten questions will be asked. Two from each module. The student has to answer five questions, selecting at least one from each module.

**Reference Books:**

1. I.J. Nagrath and D.P. Kothari, "Modern power system analysis", Tata Mcgraw hill, 2nd edition. 2003..
2. W.D. Stevenson," Elements of power system analysis", McGraw Hill Higher Education; 4th Revised edition (1 September 1982)
3. Power system analysis by Hadi sadat, TMH. 3rd Edition, 2011.

4. Computer Aided PSA, GL Kusic, PHI.3rd Edition 2010
5. Power system Analysis and stability by Neelakantan. 2013 Edition.

**Course outcomes:**
**On completion of the course, the student will have the ability to:**

| Course Code | CO | Course Outcome (CO) | |
|---|---|---|---|
| 22EE53 | CO1 | **Illustrate power system network with its basic knowledge** | |
| | CO2 | **Identify the different types of faults in power system network.** | |
| | CO3 | **Calculate power of balanced and unbalanced load** | |
| | CO4 | **Analyze the short circuit studies in power system network** | |
| | CO5 | **Examine the stability concept in power system engineering** | |

| S.No. | PO CO | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | CO1 | 3 | 3 | 1 | | | | | | | | | 2 | 3 | 2 | 1 |
| 2 | CO2 | 3 | 3 | 1 | 1 | | 2 | | | | | | 2 | 3 | 2 | 2 |
| 3 | CO3 | 3 | 3 | 3 | 1 | | | | | | | | 2 | 3 | 2 | 2 |
| 4 | CO4 | 3 | 3 | 3 | 1 | | | | | | | | 2 | 3 | 2 | 2 |
| 5 | CO5 | 3 | 3 | 1 | 1 | | | | | | | | 2 | 3 | 2 | 2 |
| | | 3 | 3 | 1.8 | 1 | | 2 | | | | | | 2 | 3 | 2 | 1.8 |

| Course Title: **POWER ELECTRONICS LAB** | | | |
|---|---|---|---|
| Course Code | 22EEL54 | Credits:01 | CIE: 50 |
| Number of Lecture Hours/Week | 2hrs (Practical) | | SEE: 50 |
| Total Number of Lecture Hours | 14 hrs | | SEE Hours: 03 |

| Sl.No. | List of Experiments |
|---|---|
| 1 | Static characteristics of SCR. |
| 2 | Static characteristics of MOSFET |

| | |
|---|---|
| 3 | Static characteristics IGBT. |
| 4 | SCR turn-on circuit using synchronized UJT relaxation oscillator |
| 5 | SCR Digital triggering circuit for a single-phase controlled rectifier / A.C voltage controller. |
| 6 | Single-phase full-wave rectifier with R and R-L loads. |
| **7** | A.C. voltage controller using TRIAC and DIAC combination connected to R and R~L loads. |
| **8** | DC-Chopper with RL load. |
| **9** | Single phase converter R load. |
| **10** | 3-ϕ controlled rectifier R Load |
| **11.** | Single phase Full bridge Inverter with R load. |
| **12.** | Three phase Full bridge inverter with R load. |

**Course outcomes: On completion of the course, the student will have the ability to:**

| **Course Code** | **CO** | **Course Outcome (CO)** | |
|---|---|---|---|
| **22EEL54** | CO1 | **Describe static characteristics of power electronic devices.** | |
| | CO2 | **Experiment to trigger SCR using UJT relaxation oscillator and Calculate the RMS o/p voltage of AC voltage controller.** | |
| | CO3 | **Calculate the DC o/p voltage of chopper.** | |
| | CO4 | **Calculate the average o/p voltage of 1-ϕ Controlled converter and inverter.** | |
| | CO5 | **Calculate the average o/p voltage of 3 - ϕ Controlled converter and inverter.** | |

| S.No. | PO CO | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | CO1 | 3 | | | 1 | | | | | 2 | | | 1 | 3 | 1 | 1 |
| 2 | CO2 | 3 | | | 1 | | | | | 2 | | | 1 | 3 | 1 | 1 |
| 3 | CO3 | 3 | | | 1 | | | | | 2 | | | 1 | 3 | 1 | 1 |
| 4 | CO4 | 3 | | | 1 | | | | | 2 | | | 1 | 3 | 1 | 1 |
| 5 | CO5 | 3 | | | 1 | | | | | 2 | | | 1 | 3 | 1 | 1 |
| | | 3 | | | 1 | | | | | 2 | | | 1 | 3 | 1 | 1 |

| Course Title: **UTILIZATION OF ELECTRICAL POWER** | | | |
|---|---|---|---|
| Course Code | 22EE55A | Credit:3 | CIE: 50 |
| Number of Lecture Hours/Week | 3hrs. (Theory) | | SEE: 50 |
| Total Number of Lecture Hours | 42 | | SEE Hours: 03 |

**Prerequisite:**

1. Knowledge of Electrical Machines
2. Applications of Electrical energy

**Course Objectives:**

1. To study Heating and Welding
2. To understand Illumination.
3. To know Electrolytic Process.
4. To understand Power Factor Considerations
5. To Get an Exposure about Electric traction and hybrid Vehicles.

| Modules | Teaching Hours |
|---|---|
| **Module I**<br>**Heating and Electrolytic process:** Different methods of Electric heating and their advantages, Resistance heating, Resistance ovens, Induction heating, Arc furnace. Fundamental principles of Electrolysis process, Extraction, refining of metals, Electroplating, Factors effecting electro deposition process. | **09 hrs** |
| **Module II**<br>**Illumination:** Introduction, Radiant energy, Definitions, Laws of illumination, Polar curves, Photometry, Energy radiation and luminous efficiency, lighting calculations, Factory lighting, Flood lighting, street lighting.<br>**Lamps:** Construction and working of Incandescent, Fluorescent, Mercury vapor, sodium vapor lamps, CFL and LED. | **08 hrs** |
| **Module III**<br>**Power Tariffs:** Electric Tariff, Types, Domestic and Non –Domestic prevailing tariffs and their structures. Introduction to Availability-Based Tariff (ABT).<br>**Power Factor and its Improvement:** Causes, disadvantages and improvement of Low Power Factor (LPF), Economic aspects. | **08 hrs** |
| **Module IV**<br>**Electric Traction:** Introduction to traction system, requirement of an ideal traction system, supply system for electrical traction, Motors for Electric traction, Speed- Time curves for train movement.<br>**Electrical Braking:** Introduction, and types of braking, Regenerative braking with three phase induction motors, Braking with single phase series motors, Magnetic track brake, and Electro-Mechanical Drum brakes. | **09 hrs** |
| **Module V**<br>**Electric Vehicle:** Introduction to Electric vehicle, components of electric vehicle. Overview of charging, motors, and Storage of Electric Vehicle.<br>**Hybrid Electric Vehicles:** Introduction, Concept and working of Hybrid Electric Drive trains.<br>**Electric Drive-trains:**<br>Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis. | **08 hrs** |

**Question paper pattern:** Total ten questions will be asked. Two from each module. The student has to answer five questions, selecting at least one from each module.

**Reference Books:**


1. Soni Gupta and Bhatnagar, "A Course in Electrical Power", Dhanpatrai and Sons Edition 2002
2. G.C Garg, "Utilization of Electrical Power and Electric Traction", Khanna Publishers 6th Edition 1999.
3. Open Shaw Taylor, "Utilization of Electrical Energy", 12th Impression Universities Press-2009
4. Dr. S.L.Uppal, "Electrical Power", Khanna Publishers Eighth Reprint -1999.
5. Mehrbad Ehsani, Yimin Gao, Sabastian E. Gay Ali Emadi, "Modern Electric Hybrid Electric and Fuel cell

vehicles", CRC Press, 2010.

6. Utilization of Electrical Power, 2nd Edition, R.K.Rajput, Laxmi publications, New Delhi
7. Mehrda Ehsani et al, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamental theory and Design", Ist Edition 2005, CRC Press.

**Course outcomes: On completion of the course, the student will have the ability to:**

| Course Code | CO | Course Outcome (CO) |
|---|---|---|
| 22EE55A | CO1 | Describe the specified heating & welding methods and electrolysis process |
| | CO2 | Define the laws of illumination and compute the illumination for specified applications, |
| | CO3 | Discuss the causes, disadvantages and methods of improving, low power factor. |
| | CO4 | Classify the power tariffs. |
| | CO5 | Discuss about of hybrid vehicles and analyze electric traction |

## Course Articulation Matrix for the Academic Year 2024-25

| S.No. | PO CO | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | CO1 | 3 | | 1 | | | | | | | | | 1 | 3 | 2 | 1 |
| 2 | CO2 | 3 | 3 | | | | | | | | | | 1 | 3 | 2 | 1 |
| 3 | CO3 | 3 | 2 | | | | | | | | | | 1 | 3 | 1 | 1 |
| 4 | CO4 | 3 | | | | | | | | | | | 1 | 3 | 1 | 1 |
| 5 | CO5 | 3 | | | | | | | | | | | 1 | 3 | 1 | 1 |
| | | 3 | 2.5 | 1 | | | | | | | | | 1 | 3 | 1 | 1 |

| Course Title: RESEARCH METHODOLOGY & INTELLECTUAL PROPERTY RIGHTS | | |
|---|---|---|
| Course Code | 22RMI57 | CIE: 50 |
| Credits | **03** | SEE: 50 |
| Course Type | Theory | Total Marks : 100 |
| Lecture Hours/Week (L-T-P) | 2-2-0-0 | |
| Total Hours | 28 Hours | SEE: 3 Hrs |

**Course Objectives:**

CO1: To Understand the knowledge on basics of research and its types.
CO2: To Learn the concept of defining research problem and Literature Review, Technical Reading.
CO3: To learn the concept of attributions and citation and research design.
CO4: Concepts, classification, need for protection, International regime of IPRs - WIPO , TRIPS, Patent - Meaning, Types, surrender, revocation, restoration, Infringement , Procedure for obtaining Patent and Patent Agents.
CO5: Meaning, essential requirements, procedure for registration and Infringement of Industrial Designs, Copyright.

| Modules | Teaching Hours |
|---|---|
| **Module-1**<br>Introduction: Meaning of Research, Objectives of Engineering Research, and Motivation in Engineering Research, Types of Engineering Research, Finding and Solving a Worthwhile Problem. Ethics in Engineering Research, Ethics in Engineering Research Practice, Types of Research Misconduct, Ethical Issues Related to Authorship. | **06 hrs** |
| **Module II**<br>Defining the research problem - Selecting the problem. Necessity of defining the problem Techniques involved in defining the problem- Importance of literature review in defining a problem Literature Review and Technical Reading, New and Existing Knowledge, Analysis and Synthesis of Prior Art Bibliographic Databases, Web of Science, Google and Google Scholar,<br>Effective Search: The Way Forward Introduction to Technical Reading Conceptualizing Research, Critical and Creative Reading, Taking Notes While Reading, Reading Mathematics and Algorithms, Reading a Datasheet. | **06hrs** |
| **Module III**<br>Research design and methods - Research design - Basic principles. Need of research design Features of good design- Important concepts relating to research design - Observation and Facts<br>Attributions and Citations: Giving Credit Wherever Due, Citations: Functions and Attributes, Impact of Title and Keywords on Citations, Knowledge Flow through Citation, Citing Datasets, Styles for Citations, Acknowledgments and Attributions, What Should Be<br>Acknowledged, Acknowledgments in, Books Dissertations, Dedication or Acknowledgments. | **06hrs** |
| **Module - IV**<br>Basic Concepts of Intellectual Property (IP), Classification of IP, Need for Protection<br>of IP, International regime of IPRs - WIPO , TRIPS.<br>**Patents:** Meaning of a Patent – Characteristics/ Features . Patentable and Non-Patentable Invention. Procedure for obtaining Patent. Surrender of Patent, revocation &restoration of Patents, Infringement of Patents and related remedies (penalties) . Different prescribed forms used in Patent Act. Patent agents qualifications and disqualifications Case studies on patents - Case study of Neem petent, Curcuma(Turmeric)patent and Basmati rice patent, Apple inc.v Samsung electronics co.Ltd | **05 hrs** |
| **Module - V**<br>Industrial Design : Introduction to Industrial Designs. Essential requirements of Registration. Designs which are not registrable, who is entitled to seek Registration,<br>Procedure for Registration of Designs Copy Right Meaning of Copy Right. Characteristics of Copyright. Who is Author, various<br>rights of owner of Copyright. Procedure for registration. Term of copyright, Infringement of<br>Copyright and Its remedies. Software Copyright. | **05 hrs** |
| **Question paper pattern:** Total ten questions will be asked. Two from each module. The student has to answer five questions, selecting at least one from each module. | |
| Assessment Details(both CIE and SEE)<br>The weight age of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is | |

50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester end
examination (SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE(Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.
Continuous Internal Evaluation:
Three Unit Tests each of 20Marks(duration 01hour)
1.First test at the end of 5th week of the semester
2.Second test at the end of the 10th week of the semester
3.Third test at the end of the15th week of the semester
Two assignments each of 10Marks
4.First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester Group discussion/ Seminar/quizanyoneofthreesuitablyplannedtoattaintheCOsandPOsfor20 Marks (duration 01 hours)
6.At the end of the 13th week of the semester
The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be scaled down to 50marks (to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).
CIE methods/question paper is designed to attain the different levels of Bloom's taxonomy as per the Outcome defined for the course.
Semester End Examination:
Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (duration 03 hours)
1. The question paper will be set for 100marks.Marks scored shall be proportionally reduced to50 marks
2. The question paper will have ten questions. Each question is set for 20marks.
3. There will be 2questions from each module .Each of the two questions is under a module (with a maximum of 2 sub-questions).
4. The students have to answer 5 full questions, selecting one full question from each module.
Marksscoredbythestudentswillbeproportionallyscaleddownto50marks
Course Outcomes
At the end of the course the student will be able to:
CO1.To know them leaning of engineering research.
CO2.To know the defining of research problem and procedure of Literature Review.
CO3.To know the Attributions and Citations and research design.
CO4. Highlights the basic Concepts and types of IPRs and Patents
CO5.Analyse and verify the procedure for Registration of Industrial Designs & Copyrights.
Textbook
1. Research Methodology: Methods and Techniques C.R.Kothari, Gaurav Garg New Age International 4thEdition,2018
2. Dipankar Deb•RajeebDey,ValentinaE.Balas "EngineeringResearchMethodology",ISSN1868- 4394 ISSN 1868-4408 (electronic), Intelligent Systems Reference Library, ISBN 978-981-13- 2946-3 ISBN 978-981-13-2947-0 (eBook), https://doi.org/10.1007/978-981-13-2947-0.3
3. Dr. M.K. Bhandari"Law relating to Intellectual property" January 2017 (Publisher By Central Law Publications).
4. Dr. R Radha Krishna and Dr. S Balasubramanain "Text book of Intellectual Property Right". First edition, New Delhi 2008. Excel books.
5. P Narayan "Text book of Intellectual Property Right". 2017 ,Publisher: Eastern Law House

Reference Book:
1. DavidV.Thiel“ResearchMethodsforEngineers”CambridgeUniversityPress,978-1-107-03488- 4-
2. Nishith Desai Associates - Intellectual property law in India – Legal, Regulatory & Tax
NPTEL:
INTELLECTUAL PROPERTY by PROF.FEROZ ALI , Department of Humanities and Social Sciences IIT Madras
https://nptel.ac.in/content/syllabus_pdf/109106137.pdf
www.wipo.int
www.ipindia.nic.in

| Course Title: **OPERATIONAL AMPLIFIERS AND LINEAR IC'S** | | | |
|---|---|---|---|
| Course Code | 22EE55B | Credits:03 | CIE: 50 |
| Number of Lecture Hours/Week | 3hrs (Theory) | | SEE: 50 |
| Total Number of Lecture Hours | 42 | | SEE Hours: 03 |

**Prerequisite:** Knowledge of Analog and digital electronics is required.

**Course Objectives:**

1. To study op-amp & AC Amplifiers
2. To know about Op-Amp Frequency Response and Compensation
3. To understand about Signal Processing Circuits Op-amp Nonlinear Circuits.
4. To study Multivibrator & Signal Generator.
5. To study Active Filter & Voltage Regulators.

| **Modules** | **Teaching Hours** |
|---|---|
| **Module I**<br>**Basics of OP-amps and AC Amplifiers:** Basics of op-amp (Introduction, Block diagram & Characteristics), capacitor coupled voltage follower, High Zinc Capacitor coupled voltage follower, capacitor coupled Non-inverting amplifier, High Zinc capacitor coupled Non-inverting amplifier, Capacitor coupled inverting amplifier, setting upper cutoff frequency, capacitor coupled Difference amplifier, use of single polarity supply. | **9 Hrs** |
| **Module II**<br>**Op-amps Frequency Response and Compensation:** Op-amp circuit stability, frequency and phase response, frequency compensating methods, op-amp circuit bandwidth, slew rate effects, stray capacitance effects, load capacitance effects, circuit stability precautions. | **8 Hrs** |
| **Module III**<br>**Signal Processing Circuits and Op-amps Nonlinear Circuits :** Precision half wave and full wave rectifiers, limiting circuits, clamping circuits, peak detectors, Sample and Hold circuit, Crossing detectors, Inverting Schmitt trigger circuit, Non- inverting Schmitt circuits. | **8 Hrs** |
| **Module IV**<br>**Multivibrator & Signal generator:** Astable multivibrator, Monostable multivibrator. Triangular/Rectangular wave generator, waveform generator design, phase shift oscillator, oscillator amplitude stabilization, Wein bridge oscillator, amplitude stabilization. | **8 Hrs** |
| **Module V**<br>**Active filters & DC Voltage regulators:** First and second order, high pass , low pass, Band pass and Band stop filters. Basics of Voltage regulator, voltage follower regulator, adjustable o/p regulator, precision voltage regulator, IC LM723. | **9 Hrs** |

**Question paper pattern:** Total ten questions will be asked. Two from each module. The student has to answer five questions, selecting at least one from each module.

**Reference Books:**

1. Operational Amplifiers and Linear IC's by David A. Bell, PHI, Second Edition, 2008

2. Operational Amplifiers and Linear IC's by Ramakanth PHI Pearson 4th Edition, 2004
3. Linear integrated circuits by Roy Choudary, New Age International second edition, 2004.
4. Operational Amplifiers with linear integrated circuit by Stanley William D, Pearson Education, Fourth Edition, 2009.

**Course outcomes: On completion of the course, the student will have the ability to:**

| Course Code | CO | Course Outcome (CO) | |
|---|---|---|---|
| 22EE55B | CO1 | **Describe the basics of Op-Amps** | |
| | CO2 | **Calculate the frequency response of Op-Amps and Identify compensation methods of op-amp** | |
| | CO3 | **Illustrate different types of signal processing circuit and Non-linear circuits** | |
| | CO4 | **Design different types of multivibrator and signal generators** | |
| | CO5 | **Identify and Illustrate the active filters and DC voltage regulators** | |

| S.No. | PO CO | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | CO1 | 3 | | | | | | | | | | | 1 | 3 | | 1 |
| 2 | CO2 | 3 | | 1 | | | | | | | | | 1 | 3 | 2 | 1 |
| 3 | CO3 | 3 | 2 | | | | | | | | | | 1 | 3 | 2 | 1 |
| 4 | CO4 | 3 | 3 | | | | | | | | | | 1 | 3 | 2 | 1 |
| 5 | CO5 | 3 | 1 | | | | | | | | | | 1 | 3 | 2 | 1 |
| | | 3 | 2 | 1 | | | | | | | | | 1 | 3 | 2 | 1 |

| Course Title: Reactive Power Management | | | |
|---|---|---|---|
| Course Code | 22EE55C | Credits:3 | CIE: 50 |
| Number of Lecture Hours/Week | **3Hrs (Theory)** | | SEE: 50 |
| Total Number of Lecture Hours | 42 | | SEE Hours: 03 |

**Prerequisite:** Knowledge of Electric power generation, transmission and distribution system and utilization.

**Course Objectives:**

1. Students will be able to learn different methods of load compensation.
2. Students will be able to understand reactive power compensation in transmission system under steady state.
3. Students will be able to understand reactive power coordination and their problems
4. Students will be able to understand DSM and DSRM methods.
5. Students will be able to understand USRM and reactive power management in other utility sectors.

| Modules | Teaching Hours |
|---|---|
| **Module-I**<br>**Load Compensation:** Objectives and specifications, reactive power characteristics, inductive and capacitive approximate biasing, Load compensator as a voltage regulator, phase balancing and power factor correction of unsymmetrical loads. | **08 Hrs** |
| **Module-II**<br>**Steady – State Reactive Power Compensation in Transmission System:** Uncompensated line, types of compensation, Passive shunt and series and dynamic shunt compensation, examples Transient state reactive power compensation in transmission systems: Characteristic time periods, passive shunt compensation, static compensations, series capacitor compensation, compensation using synchronous condensers. | **09 Hrs** |
| **Module-III**<br>**Reactive Power Coordination:** Objective, Mathematical modeling, Operation planning, transmission benefits, Basic concepts of quality of power supply, disturbances, steady –state variations, effects of under voltages, frequency, Harmonics, radio frequency and electromagnetic interferences. | **08 Hrs** |
| **Module-IV**<br>**Demand Side Management:** Load patterns, basic methods load shaping, power tariffs, KVAR based tariffs penalties for voltage flickers and Harmonic voltage levels.<br><br>Distribution side Reactive power Management: System losses, loss reduction methods, examples, Reactive power planning, objectives, Economics Planning capacitor placement, retrofitting of capacitor banks. | **09 Hrs** |
| **Module-V**<br>**User Side Reactive Power Management:** KVAR requirements for domestic appliances, Purpose of using capacitors, selection of capacitors, deciding factors, types of available capacitor, characteristics and Limitations. | **08 Hrs** |

| | |
|---|---|
| Reactive power management in electric traction systems and are furnaces: Typical layout of traction systems, reactive power control requirements, distribution transformers, Electric arc furnaces, basic operations, furnaces transformer, filter requirements, remedial measures, power factor of an arc furnace. | |

**Question paper pattern:** Total ten questions will be asked. Two from each module. The student has to answer five questions, selecting at least one from each module.

Text Books:

01. Reactive power control in Electric power systems by T.J.E. Miller, John Wiley and sons, 1982.
02. Reactive power Management by D. M. Tagare, Tata McGraw Hill, 2004.

**Reference Books:**

01. Reactive Power Compensation: A Practical Guide, Wolfgang Hofmann, Jurgen Schlabbach, Wolfgang Just, Wiely publication 2012.
02. Reactive Power Compensation, Dr. Hidaia Mahmood Alassouli, Notion Press, 2020

**Course outcomes:**

**On completion of the course, the student will have the ability to:**

| Course Code | CO | Course Outcome (CO) |
|---|---|---|
| 22EE55C | CO1 | Distinguish the importance of load compensation in symmetrical as well as unsymmetrical loads |
| | CO2 | Observe various compensation methods in transmission lines |
| | CO3 | Construct model for reactive power coordination |
| | CO4 | Distinguish demand side reactive power management & user side reactive power management |
| | CO5 | Observe various compensation methods for electric traction and other electric utility sectors |

## Course Articulation Matrix for the Academic Year 2024-25

| S.No. | PO CO | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | CO1 | 3 | | 2 | | | | | | | | | | | | |
| 2 | CO2 | 3 | | 2 | 3 | | | | | | | | | | | |
| 3 | CO3 | 3 | 3 | 3 | | | | | | | | | | | | |
| 4 | CO4 | 3 | 3 | | | | | | | | | | 3 | | | |
| 5 | CO5 | 3 | 3 | | | | | | | | | | 3 | | | |
| | Avg | 3.0 | 3.0 | 2.3 | 3.0 | | | | | | | | 3.0 | 3.0 | 3.0 | 2.3 |

| Course Title: **DIGITAL SIGNAL PROCESSING** | | | |
|---|---|---|---|
| Course Code | 22EE55D | Credits:3 | CIE: 50 |
| Number of Lecture Hours/Week | 3hrs (Theory) | | SEE: 50 |
| Total Number of Lecture Hours | 42 | | SEE Hours: 03 |

**Prerequisite: 1.** Knowledge of signals and systems is needed
2.Knowledge of Digital Electronics is needed.

**Course Objectives:**

1. To study Discrete Fourier Transforms.
2. To understand Fast Fourier Transforms Algorithms.
3. To know Realization of Digital Systems
4. To Design IIR and FIR Digital Filters.

| **Modules** | **Teaching Hours** |
|---|---|
| **Module I**<br>**Discrete Fourier Transforms:** Introduction**,** properties-linearity, shift symmetry periodic convolution, circular convolution, linear convolution. | **08 hrs** |
| **Module II**<br>**Fast Fourier Transforms Algorithms:** Introduction decimation in time algorithm, decimation in frequency algorithm, decomposition for N a composite numbers, calculation of numbers of computations, and computational efficiency. | **07 hrs** |
| **Module – III**<br>**Realization of Digital Systems:** Introduction, block diagrams and signal Flow graphs, matrix representation, realization of IIR systems-direct form, cascade form, parallel form realization of FIR systems-direct form, cascade form and linear phase realization. | **08 hrs** |
| **Module IV**<br>**Design of IIR Digital Filters:** Introduction, Impulse Invariant, bilinear transformation and approximation of derivative, all pole analog filters Butterworth, chebyshev and Elliptic filters, frequency transformations. | **10 hrs** |
| **Module V**<br>**Design of FIR Digital Filters:** Introduction, symmetric /Asymmetric FIR filters and linear phase property windowing, rectangular hamming, hamming windows, frequency sampling technique. | **08 hrs** |

**Question paper pattern:** Total ten questions will be asked. Two from each module. The student has to answer five questions, selecting at least one from each module.

**Reference Books:**


1. Digital signal processing: Principle, algorithms and application By Proakis, Pearson Education/ PHI.
2. Digital signal processing by Oppenheim's Pearson Education/PHI
3. Digital signal processing by Feachor Emmauel, Pearson Education.
4. Digital signal processing by J.S. Chitthode. Technical publishers, Pune


**Course outcomes:**
**On completion of the course, the student will have the ability to:**

| **Course Code** | **CO** | **Course Outcome (CO)** | |
|---|---|---|---|
| 22EE55D | CO1 | **Illustrate discrete Fourier transformation and FFT** | |
| | CO2 | **Interpret the different types of realization of digital systems** | |
| | CO3 | **Illustrate different types of IIR and FIR filters** | |

| | | | |
|---|---|---|---|
| | CO4 | **Analyze the IIR and FIR filters** | |
| | CO5 | **Design of FIR and IIR filters** | |

| **Course Title: COMPUTER APPLICATIONS TO POWER SYSTEMS** | | |
|---|---|---|
| **Course Code** | 22EE62 | **CIE: 50** |
| **Number of Lecture Hours/Week** | **03 hrs.(Theory) + 02hrs (Tutorial)** | **SEE: 50** |
| **Total Number of Lecture Hours** | **42** | **SEE Hours: 03** |
| | **Credits** | **04** |

**Prerequisite:**

1. Electrical Power Transmission and Distribution System.
2. Power System Stability and Analysis.

**Course Objectives:**

1. To Study the different methods of Admittance bus of power system networks.
2. To understand different types of buses and its analysis using load flow study.
3. To Study and analysis of transient stability systems.
4. To understand economic concept of power systems.
5. To Study of different voltage control method for power systems.

| **Modules** | **Teaching Hours** |
|---|---|
| **Module I**<br><br>**Formation of Y-Bus of a power system network by direct inspection method incidence matrices:**<br>Element node incidence matrix, Bus incidence matrix, Primitive network in impedance & admittance form, primitive {y} matrix. Formation of Y-bus by singular transformation method, Algorithm for formation of bus impedance matrix [z] on single phase basis. | **08hrs** |
| **Module II**<br>**Load flow studies:**<br>Types of buses, operating constraints, Classification of system variables load flow equations, solution of load flow equations by Gauss-Seidel method, andNewton Raphson method, Acceleration of convergence<br>LF solution by Fast-decoupled method. Comparison of LF methods, Representation of tap changing & phase shifting transformer. | **09hrs** |
| **Module III**<br><br>**Transient Stability Study:**<br>Swing equation representation of synchronous machine for transient stability studies, load representation network performance equation, solution techniqueswith flow charts. Transient stability solution by numerical solution of differential equations, modified Euler's method, Runge-Kutta 4th order method. | **08hrs** |
| | |

| | |
|---|---|
| **Module IV**<br><br>**Economic Operation of Power Systems.**<br>Performance curves, load sharing between the units within plants, load sharingbetween plants including transmission losses. Penalty factor, Derivation of transmission loss formula and loss coefficient, hydrothermal constraints. | **08hrs** |
| **Module V**<br><br>**Automatic Generation & Voltage control:**<br>Automatic load frequency control (ALFC) and Automatic voltage regulator (AVR), loop diagrams Automatic load frequency control for fly ball governing system Generator model. Load model, turbine model. governor model completeALFC Block diagrams steady state and dynamic response of ALFC loops singlearea and two area block diagram representation. | **09hrs** |

**Question paper pattern:** Total ten questions will be asked. Two from each module. The student has to answer five questions, selecting at least one from each module.

**Reference Books:**


1. Stag and EI-Abiad, "computer methods in power system Analysis", McGraw Hill International Edition 1968.
2. M.A. Pai " Computer Techniques in power system", Tata McGraw Hill, 2nd Edition 2006.
3. Nagrath & Kothari, "Modern Power System Analysis", Tata McGraw Hill, 2nd Edition 2003.
4. Uma Rao, "Computer Techniques", Tata McGraw Hill.
5. L.P. Singh, "Advanced Power System and Dynamics", New Age International Pvt.Ltd, New Age International Pvt.Ltd, New Delhi 2001.
6. R.N. Dhar, "computer Aided Power System Operations & Analysis", TMH 1984.
7. Hadi sadat, "Power system Analysis", TMH, 2nd Edition, 12th Reprint 2007.
8. Elgerd, "Electric Energy Systems Theory", TMH, 1983.


**Course outcomes:**
**On completion of the course, the student will have the ability to:**

| Course Code | CO # | Course Outcome (CO) |
|---|---|---|
| 22EE61 | **CO1** | Describing the Y-bus formation in power system network through matrices and inspection method. |
| | **CO2** | Calculation of Voltage magnitude and power in a power system network. |
| | **CO3** | Relate various load flow method in power system network. |
| | **CO4** | Analyse the transient stability and Economic operation of power systems. |
| | **CO5** | Construct the various model in power system network. |

## Course Articulation Matrix for the Academic Year 2024-25

| S.No. | PO<br>CO | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | CO1 | 3 | 3 | | 2 | 1 | | | | | | | 1 | 3 | 1 | 1 |
| 2 | CO2 | 3 | 3 | | 2 | 1 | | | | | | | 1 | 3 | 2 | 1 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 | CO3 | 3 | 3 | | 2 | 1 | | | | | | | 1 | 3 | 2 | 1 |
| 4 | CO4 | 3 | 3 | | 2 | 1 | | | | | | | 1 | 3 | 2 | 1 |
| 5 | CO5 | 3 | 3 | | 2 | 1 | | | | | | | 1 | 3 | 2 | 1 |
| | | **3** | **3** | | **2** | **1** | | | | | | | **1** | **3** | **2** | **1** |

| **Course Title: SIGNALS AND SYSTEMS** | | | |
|---|---|---|---|
| **Course Code** | 22EE63A | Credits:3 | CIE: 50 |
| **Number of Lecture Hours/Week** | 3hrs (Theory) | | SEE: 50 |
| **Total Number of Lecture Hours** | 42 | | SEE Hours: 03 |

**Prerequisite:**

1. Knowledge of basic Analog signals is needed
2. Knowledge of Laplace transformation, Solutions of Differential equations

**Course Objectives:**

1. To study Definitions classification and basic operation of signals.
2. To understand time-domain representation for LTI systems.
3. To know Fourier series representation.
4. To study Fourier and Z transformation and their applications.

| **Modules** | **Teaching Hours** |
|---|---|

| | |
|---|---|
| **Module I**<br>**Introduction:** Definitions of signal and system, classification of signals, basic operations on signals, elementary signals, and systems viewed as interconnections of operations, properties of systems. | **08 hrs** |
| **Module II**<br>**Time Domain Representations for LTI System:** Convolution, impulse representation, properties of impulse response representation, differential and difference equation representations, and block diagrams representation. | **08 hrs** |
| **Module III**<br>**Fourier Series Representation for Signals:** Introduction, Fourier representations for four signal classes, orthogonality of complex sinusoidal signals, DFTS representations, continuous-time –series representations. | **08 hrs** |
| **Module IV**<br>**Fourier Transformations and Applications of Fourier Representations:** DTFT representations, properties of representations. Frequency response of LTI systems, solution, of differential and difference equation using system function, Fourier transform representations for periodic signals, sampling of continuous time signals and signal reconstruction. | **10 hrs** |
| **Module V**<br>**Z-Transforms:** Introduction, Z- transform, properties of ROC, properties Z- transform, inverse transformation, analysis of LTI systems, transfer function, stability and causality, unilateral Z-transform and its application to difference equation. | **08 hrs** |

**Question paper pattern:** Total ten questions will be asked. Two from each module. The student has to answer five questions, selecting at least one from each module.

**Reference Books:**


1. Simon Haykin and Barry Van Veen, "Signal and Systems", John Willey and Sins, 2001. Reprint 2002.
2. Signal and Systems by Ganesh Rao and Satish Tonga. 3rd Edition, Sanguine Technical Publishers, 2005.
3. Signal and Systems by Uday kumar. Elite Publishers, 2004
4. Michel J Roberts, "Signal and Systems: Analysis through linear system", TMI, 2003.
5. Alan V.Oppenheim, Alan S Willsky and S. Hamid Nawab, "Signal and Systems", pearson Eduction Asia, 2nd Edition, 1997. Indian.


**Course outcomes:**

**On completion of the course, the student will have the ability to:**

| Course Code | CO | Course Outcome (CO) |
|---|---|---|
| 22EE63A | CO1 | **Classify different continuous and discrete signals** |
| | CO2 | **Illustrate the time domain representation for Linear Time Invariant systems** |
| | CO3 | **Analyze the fourier series and fourier transformation for discrete and continuous signals** |
| | CO4 | **Apply the fourier series and fourier transformation for LTI system** |
| | CO5 | **Illustrate fourier transform and Z-transform** |

## Course Articulation Matrix for the Academic Year 2024-25

| S.No. | PO CO | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | CO1 | 3 | 3 | 3 | | | | | | | | | 1 | 3 | | 1 |
| 2 | CO2 | 3 | 3 | 3 | | | | | | | | | 1 | 3 | | 1 |
| 3 | CO3 | 3 | 3 | 3 | | | | | | | | | 1 | 3 | 1 | 1 |
| 4 | CO4 | 3 | 3 | 3 | 1 | | | | | | | | 1 | 3 | 1 | 1 |
| 5 | CO5 | 3 | 3 | 3 | | | | | | | | | 1 | 3 | | 1 |
| | | **3** | **3** | **3** | **1** | | | | | | | | **1** | **3** | 1 | 1 |

| Course Title: **ESSENTIALS OF INFORMATION TECHNOLOGY** | | | |
|---|---|---|---|
| Course Code | 22EEOE641 | Credits:3 | CIE: 50 |
| Number of Lecture Hours/Week | 3 hrs.(Theory) | | SEE: 50 |
| Total Number of Lecture Hours | 42 | | SEE Hours: 03 |

**Prerequisite: Knowledge of Computer Organization, operating system and Computer language.**

**Course Objectives :**

1. To study basic of Computer Systems.
2. To understand about different types of Operating System concepts.
3. To know about Problem Solving Techniques.
4. To understand Programming basics.
5. To study structured programming and RDBMS data processing.

| **Modules** | **Teaching Hours** |
|---|---|
| **Module I**<br>**Introduction to Computer Systems:** Basic of computer systems-various hardware components, Data storage and various memory units, Central processing units, Execution cycle, Introduction to software and its classifications.<br>**Operating System Concepts:** Introduction, Memory management, Process management, Inter-process communication, Deadlocks, File management, Device management. | **09 Hours** |
| **Module II**<br>**Problem Solving Techniques:** Introduction to problem solving, Computational | |

| | |
|---|---|
| problem and its classification, Logic and its types. Introduction to Algorithms, implementation of algorithms using flowcharts, Implementation through RAPTOR tool searching and sorting algorithms. Introduction and classification to Data structures – Basic data structures, Advanced data structures. | **09 Hours** |
| **Module III**<br>**Programming Basics**: Introduction to programming paradigms and pseudo code, Basic Programming concepts, Program life cycle, Control structures, Introduction and demonstration of 1-D array and 2-D array, Searching and Sorting techniques, Demonstration concept of memory reference in arrays, strings, and compiler concepts – code optimization techniques. | **08 Hours** |
| **Module IV**<br>**Structured Programming**: Functions, Structures, File handling, Introduction to software Development life cycle, Industry coding standards and best practices, Testing and debugging code review. | **08Hours** |
| **Module V**<br>**RDBMS – Data Processing:** The Database technology models, ER modeling concept, notations, extended ER features, Logical database design, Normalization, SQL – DDL statement, DML statements, DCL statements, Joins, Sub queries, Views, Database design issues.<br>**Project:** Project briefing, Introduction to Embedded SQL, Project contact sessions and project evaluation. | **08 Hours** |
| **Question paper pattern:** Total ten questions will be asked. Two from each module. The student has to answer five questions, selecting at least one from each module. | |
| **Reference Books:**<br>1. Andrew S.Tenenbum: Structured Computer Organization, PHI, 4th Edition, 1999<br>2. John L.Hennessy, David Goldberg, David A.Petterson, Computer Architecture: A Quantitative Approach 2nd edition, Published by Morgan Kaufman Publishers, 1999 edition.<br>3. Silberschatz and Galvin, Operating System Concepts, John Wiley and sons, sixth edition, 2002.<br>4. Andrew Tanenbaum, Modern Operating Systems, Pearson Education, 1992.<br>5. Elmasri and Navate, Fundamentals of Database Systems, 5th Edition, Addison Wesley, 2007.<br>6. Ian Somerville, 8th Edition, Pearson Education, 2007.<br>7. E.Balagurusamy, Programming in ANSI C", Tata McGraw Hill, 3rd edition, 2008. | |

**Course outcomes:**

**On completion of the course, the student will have the ability to:**

| Course Code | CO | Course Outcome (CO) |
|---|---|---|
| 22EEOE641 | CO1 | Memorize the knowledge of computer hardware and software |
| | CO2 | Discuss the concept of problem solving techniques includes algorithms and flowcharts. Develop the knowledge of basic and advanced data structures. |
| | CO3 | Discuss the concept of various memory, process, device and file management techniques. |
| | CO4 | Explain the applications of C Programming, best practices and standards in writing programs |
| | CO5 | Explain the software development life cycle, various software models, testing and debugging methods |
| | CO6 | Apply the knowledge of database statements to handle the data and differentiate between the data base models. |

## Course Articulation Matrix for the Academic Year 2024-25

| S.No. | PO CO | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | CO1 | 3 | | | | | | | | | | | 2 | 3 | 2 | 1 |
| 2 | CO2 | 3 | 3 | | | | | | | | | | 2 | 3 | 2 | 1 |
| 3 | CO3 | 3 | | 3 | | | | | | | | 1 | 2 | 3 | 2 | 1 |
| 4 | CO4 | 3 | | 3 | | | | | | | | 1 | 2 | 3 | 2 | 1 |
| 5 | CO5 | 3 | | | | | | | | | | 1 | 2 | 3 | 2 | 1 |
| 6 | CO6 | 3 | | | | | | | | | | | 2 | 3 | 2 | 1 |
| | Avg | 3 | 3 | 3 | | | | | | | | 1 | 2 | 3 | 2 | 1 |

| Title | **Power Systems Simulation Lab** | **Credits: 01** |
|---|---|---|
| Course Code | **22EEL66** | CIE: 50 |
| Number of Lecture Hours/Week | **2hrs.(Practical)** | SEE: 50 |
| Total Number of Lecture Hours | 14 hrs | SEE Hours: 03 |

| **Modules** | **Teaching Hours** |
|---|---|
| **MATLAB**<br>1. MATLAB fundamentals, matrices, Vectors, matrix and array operations.<br>2. Using built in functions, saving and loading data, script files.<br>3. Function files, language specific features much as loops, branches and control flow. | |
| **Power system simulation using MATLAB, software packages and C++**<br>1. i) Y-Bus formation for systems with and without mutual coupling, by singular transformation and inspection method.<br>ii) Determination of Bus currents, bus power & line flows for a specified system voltage bus profile.<br>2. ABCD parameters<br>i) Formation for symmetric π/T configuration<br>ii) Verification of AD-BC=1<br>III) Determination of efficiency and regulation<br>3. Determination of power angle diagrams for salient and nonsalient pole synchronous machines, reluctance power, excitation emf and regulation.<br>4. To determine fault currents and voltages in a single transmission line system with star-delta transformers, at a specified location for SLGF, DLGF, and LLF.<br>5. To determine fault curve i) swing curve ii) critical clearing time for a single machine connected to infinite bus through a pair of identical transmission lines. for a 3-phase on one of the lines for variation of inertia constant/line parameters/fault location/prefault electrical output.<br>6. Load flow analysis for a 3 Bus system using Gauss Seidal method for at least 3 iterations (Y-bus to be given as data)<br>7. Formation of jacobian for a system not exceeding 4 buses (no PV buses) in polar co-ordinates.<br>8. For a given power system, computation of Jacobian to conduct load flow analysis using Newton Raphson method (no PV Buses)<br>9. Optimal generator scheduling for thermal power plants. | |

**Reference Books:**

1. Rudrapratap, " Matlab getting started with MATLAB", Oxford University press.

**Course outcomes:**

**On completion of the course, the student will have the ability to:**

| Course Code | CO # | Course Outcome (CO) | |
|---|---|---|---|
| **21EEL66** | **CO1** | **Describe Power System tools of MATLAB, determine Y bus by using inspection and singular transformation.** | |
| | **CO2** | **Determination of Bus Currents, Bus power and line flows for a specified power system networks.** | |
| | **CO3** | **Determination of power angle diagrams for synchronous machines, find fault currents and voltages in a single transmission line system with star delta transformers.** | |
| | **CO4** | **Load flow analysis for a power system network by using Gauss Seidal, Newton Raphson and fast decoupled load flow studies** | |
| | **CO5** | **Determine optimal generator scheduling for thermal power plants** | |

## Course Articulation Matrix for the Academic Year 2024-25

| S.No. | PO CO | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | CO1 | 3 | 3 | 3 | 1 | 1 | | | | 2 | | | 1 | 3 | 2 | 2 |
| 2 | CO2 | 3 | 3 | 3 | 1 | 1 | | | | 2 | | | 1 | 3 | 2 | 2 |
| 3 | CO3 | 3 | 3 | 3 | 1 | 1 | | | | 2 | | | 1 | 3 | 2 | 2 |
| 4 | CO4 | 3 | 3 | 3 | 1 | 1 | | | | 2 | | | 1 | 3 | 2 | 2 |
| 5 | CO5 | 3 | 3 | 3 | 1 | 1 | | | | 2 | | | 1 | 3 | 2 | 2 |
| | | **3** | **3** | **3** | **1** | **1** | | | | **2** | | | **1** | **3** | **2** | **2** |

| Course Title: **INDIAN KNOWLEDGE SYSTEMS**<br>**(As per Choice Based Credit System (CBSE) Scheme)**<br>**(From the academic year 2024-25)** | | |
|---|---|---|
| Course Code | 22EEAE671 | CIE: 50 |
| Credits | **01** | SEE: 50 |
| Course Type | Theory | Total Marks : 100 |
| Lecture Hours/Week (L-T-P) | 2-0-0 | |
| Total Hours | 15 Hours | SEE: 2 Hrs |

Course Objectives:
The subjects will be able to:

1. Facilitate the students with the concept of Indian traditional knowledge and to make them understand the importance of roots of knowledge system.
2. To make the students understand the traditional knowledge and analyse it and apply it to their day-to-day-life.

| **Modules** | **Teaching Hours** |
|---|---|
| **Module I**<br><br>**Introduction to Indian knowledge systems(IKS):** Overview, Vedic corpus, philosophy character scope and importance, traditional knowledge vis-à-vis indigenous knowledge, traditional knowledge V/s western knowledge. | **05 hrs** |
| **Module II**<br>**Traditional knowledge in Humanities and sciences:**<br>Linguistics, Number and measurements – Mathematics, chemistry, physics, art, astronomy, astrology and public administration, united nations sustainable development goals. | **05hrs** |
| **Module III**<br>**Traditional knowledge in professional domain:**<br>Town planning and architecture, construction, health wellness and psychology-medicine, agriculture, governance and public administration, united nations, sustainable development goals. | **05hrs** |

**Question paper pattern:** Total ten questions will be asked. Two from each module. The student has to answer five questions, selecting at least one from each module.

**Reference Books:**

1. **Introduction to Indian Knowledge System – Concept and Applications:** B. Mahadevan, Vinayak Rajat Bhat, Nagendra Pravana R.N. 2022, PHI Learning Private Ltd. ISBN : 978-93-91818-21-0

2. **Traditional Knowledge System in India:** Amit Jha, 2009, Atlantic Publishers and Distributors (P) Ltd.., ISBN: 13:978-8126912230.

3. **Knowledge Traditions and Practice of India:** Kapil Kapoor, Avadesh Kumar Singh, Volt1, 2005 DK Print Word (p)) Ltd. ISBN:81-246-0334.

Suggested Websites:

1.https://www.youtube.com/watch?v=LZPIStpYEPM

2. http://nptel.ac.in/courses/121106003

3. http://www.iitkgp.ac.in/department/ KS;jsessionid=C5042785F727F6EB46CBF432D7683B63

4. https://www.wipo.int/pressroom/en/briefs/tk_ip.html

5.https://unctad.org/system/files/official-document/ditcted10_en.pdf

| Sl.No, | Weightage | 50% (CIE) | 50%(SEE) |
|---|---|---|---|
| 1 | QUIZZES | | |
| | Quiz-I | Each Quiz is equivalent for 05 marks adding upto **10 marks** | --- |
| | Quiz-II | | |
| **THEORY COURSE:** (Blooms Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating and Creating | | | |
| 2 | TEST-I | Each test will be conducted for 25 marks adding upto 50 marks. Final test marks will be reduced to 20 marks. | --- |
| | TEST-II | | |
| **EXPERIMENTAL LEARNING** | | **20 Marks** | --- |
| 3 | Case Study-based Teaching-Learning | -- | |
| 4 | Sector wise study and consolidation (Viz. Engg. Semiconductor Design, Healthcare and Pharmaceutical, FMCG, Automobile, Aerospace and IT/ITeS) | -- | --- |
| 5 | Video Based Seminar (4-5 Minutes Per Student) | -- | |
| 6 | Maximum Marks for Theory | -- | 50 Marks |
| 7 | Practical | - | - |
| 8 | Total Marks for the Course | **50 Marks** | **50 Marks** |

**Course outcomes:**

**At the end of the course, the student will be able to:**

| Course Code | CO # | Course Outcome (CO) |
|---|---|---|
| | **CO1** | Provide an overview of the concept of the Indian knowledge system and its importance |
| | **CO2** | Appreciate the need and importance of protecting traditional knowledge. |

| | | |
|---|---|---|
| | **CO3** | Recognize the relevance of traditional knowledge in different domains. |
| | **CO4** | Establish the significance of Indian knowledge systems in the contemporary world. |

| Course Title: **DISTRIBUTED GENERATION** | | | |
|---|---|---|---|
| Course Code | 22EE63C | Credits:3 | CIE: 50 |
| Number of Lecture Hours/Week | 3hrs (Theory) | | SEE: 50 |
| Total Number of Lecture Hours | 42 | | SEE Hours: 03 |
| **Prerequisite:** Basics of Mechanical Engineering, Basic Electrical Engineering | | | |
| **Course Objectives:**<br>1. Knowledge of renewable energy sources<br>2. Introduce different DG Technologies | | | |

| **Modules** | **Teaching Hours** |
|---|---|
| **Module I**<br>**DG**: An introduction: Electricity production, DG Technologies, Economic consideration, Environmental issues.<br>**IC Engine - Generator sets**: IC Engine overview, past and present trends in engine development, Utilizing existing systems, Utility interaction, IC Stirling engine. | **9 hrs** |
| **Module II**<br>**Gas turbines:** Basic types, recuperated Brayton cycle, modified gas turbine cycles, turbine performance, future developments of fuels.<br>**PV system:** Semiconductor types, PV system efficiency and design, Technical developments and barriers, PV System Capacity, Credit. | **9 hrs** |

| | |
|---|---|
| **Module III**<br>**Micro turbines:** Some features of single shaft MT, twin shaft MT, applications, performance improvements, Rankine cycle MT, challenges.<br>**Fuel Cells:** Principles of operation, Types, Comparison, operating parameters, interconnection and control, Technology development and barriers. | **9 hrs** |
| **Module IV**<br>**Principles of control of DG systems:** Control techniques, threshold control, Buy back priority, cooling / heating priority control, optional control, complete optimization, system modeling. | **8 hrs** |
| **Module V**<br>**Economic & Financial Aspects of DG:** Comparing present and future costs, the life cycle cost, economic evaluation criteria, optimization. | **8 hrs** |
| **Question paper pattern:** Total ten questions will be asked. Two from each module. The student has to answer five questions, selecting at least one from each module. | |
| **Reference Books:**<br>1.Annie-Marie Borbely and Jan F. Kreider (editors), "Distributed Generation: the power paradigm for new millennium", CRC Press, Boca Raton, 2001.<br>2.Willis H.Lee, Scott, Walter G, " Distributed Power Gneration: Planning and Evaluation", Marcal Dekker, New York, 2000.<br>3.Thomas Ackermann, Goran Anderson, Lennart Soder, "Distributed Generation: a definition", Electric Power Systems Research", Vol 57,195-204, pp,2001. | |
| **Course outcomes:**<br>**On completion of the course, the student will have the ability to:** | |

| Course Code | CO | Course Outcome (CO) | |
|---|---|---|---|
| 22EE63C | **CO1** | **Define the DG technologies.** | |
| | **CO2** | **Illustrate and review different DG technologies.** | |
| | **CO3** | **Choose suitable DG technology based on economical and environmental consideration.** | |
| | **CO4** | **Appraise the principles of control of DG systems.** | |
| | **CO5** | **Evaluate suitable DG technologies based on cost analysis** | |

## Course Articulation Matrix for the Academic Year 2024-25

| S.No. | PO<br>CO | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | CO1 | 3 | | | | | 2 | | | | | | 1 | 3 | | 1 |
| 2 | CO2 | 3 | | | | | 2 | | | | | | 1 | 3 | | 1 |
| 3 | CO3 | 3 | | | | | 2 | | | | | | 1 | 3 | 1 | 1 |
| 4 | CO4 | 3 | | | | | 2 | | | | | | 1 | 3 | 1 | 1 |
| 5 | CO5 | 3 | | | | | 2 | | | | | | 1 | 3 | 1 | 1 |
| | | 3 | | | | | 2 | | | | | | 1 | 3 | 1 | 1 |

| Course Title: ELECTRIC VEHICLES | | | |
|---|---|---|---|
| Course Code | 22EE63B | Credits:3 | CIE: 50 |
| Number of Lecture Hours/Week | **3Hrs (Theory)** | | SEE: 50 |
| Total Number of Lecture Hours | 42 | | SEE Hours: 03 |

**Pre-requisites:**

**Course Objectives:**

- To develop basic schemes of electric vehicles and hybrid electric vehicles.
- To understand requirement of electric vehicle motors & their control
- To Choose a suitable drive scheme for developing an electric vehicle depending on resources
- To Choose proper energy storage and charging systems for vehicle applications

| Modules | Teaching Hours |
|---|---|
| **Module I**<br>**Introduction to Electrical Vehicle (EV):**<br>Past, Present & Feature of EV, Current Major Issues, Recent Development Trends, EV Concept, Key EV Technology, Social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies.<br>**Hybrid Electric Vehicle ( HEV):** Configuration of HEV (Series, Parallel, Series-parallel &Complex), Examples of HEV system performance, State-of-the Art EVs & HEVs, Comparison of EV Vs IC Engine. | **09 Hrs** |
| **Module II**<br>**Electric Drive-trains:**<br>Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis. | **08 Hrs** |
| **Module III**<br>**EV Motors:**<br>Requirement of EV motors, Comparison of EV motors, Types of EV motors: **DC Motor (**Basics of DC Motor, Torque speed characteristics), **Induction Motor (**Rotating Magnetic Field, Basics of Induction motor, Speed-Torque Curve) and construction & working of **Switched reluctance Motors**(SRM). | **08 Hrs** |
| **Module IV**<br>**EV Storages:**<br>**Battery parameters:** Cell and battery voltages, Charge capacity, Energy stored, Energy density, Specific power, charge efficiency, Energy efficiency, Self-discharge rates, Battery geometry, Battery temperature, heating and cooling needs, Battery life and number of deep cycles.<br>**EV Batteries:** Lead Acid, Nickel-based, Sodium-based, Lithium and Metal Air Batteries, Ultra-Capacitors. | **09 Hrs** |
| **Module V**<br>**EV Charging:** | **08 Hrs** |

| | |
|---|---|
| **Battery Chargers**: Charge equalization, Conductive (Basic charger circuits, Arrangement of an off-board conductive charger, Standard power levels of conductive chargers), Inductive (Principle of inductive charging, Soft-switching power converter for inductive charging), Battery indication methods.<br>**Charging Infrastructure**: Domestic and Public Charging Infrastructures, Normal, Occasional and Fast Charging Stations, Battery Swapping Station, Move-and-charge zone. | |

**Question paper pattern:** Total ten questions will be asked. Two from each module. The student has to answer five questions, selecting at least one from each module.

**Reference Books:**

**Text books / Reference Books:**


1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003
2. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.
3. Mehrdad Ehsani, YimiGao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
4. C.C Chan, K.T Chau: Modern Electric Vehicle Technology, Oxford University Press Inc., New York 2001
5. K Wang Hee Nam: AC Motor Control & Electrical Vehicle Application, CR Press, Taylor & Francis Group, 2019


**Course outcomes:**

**On completion of the course, the student will have the ability to:**

| Course Code | CO | Course Outcome (CO) |
|---|---|---|
| 22EE63B | CO1 | Analyze suitable drive scheme for Electric Vehicles depending on resources. |
| | CO2 | Relate the electric drive trains for EV |
| | CO3 | Identify appropriate motor and converter for EV applications |
| | CO4 | Distinguish battery, battery indication system for EV applications |
| | CO5 | Appraise battery charger for an EV |

## Course Articulation Matrix for the Academic Year 2024-25

| S.No. | PO<br>CO | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | CO1 | 3 | 2 | 1 | | | 3 | 2 | | | | | 2 | 3 | 2 | |
| 2 | CO2 | 3 | 2 | 1 | | | 3 | 2 | | | | | 2 | 3 | 2 | |
| 3 | CO3 | 3 | 2 | 1 | | | 3 | 2 | | | | | 2 | 3 | 2 | |
| 4 | CO4 | 3 | 2 | 1 | | | 3 | 2 | | | | | 2 | 3 | 2 | |
| 5 | CO5 | 3 | 2 | 1 | | | 3 | 2 | | | | | 2 | 3 | 2 | |

| Course Title: **Programmable Logic Controllers and SCADA** | | |
|---|---|---|
| Course Code | 22EE63D | CIE: 50 |

| | | |
|---|---|---|
| Number of Lecture Hours/Week | **3hrs.(Theory)** | SEE: 50 |
| Total Number of Lecture Hours | 42 | SEE Hours: 03 |

Prerequisite: Microcontroller.

Course Objectives:

1) To describe the hardware components: I/O modules CPU, memory devices, other support devices and the functions of PLC memory map.
2) To describe program sequence, the communication of information to the PLC using different languages.
3) To explain conversion of relay schematics into PLC ladder logic programs and writing PLC programs and directly from narrative descriptions.
4) To explain the functions of PLC counter instructions applying combinations of counters and timers to control systems.
5) To describe the operation of bit and word shift registers and develop programs that use shift registers.
6) To discuss the operation of various processes, structures of control system and the method of communication between different industrial processes.

| **Modules** | **Teaching Hours** |
|---|---|
| 1. **Programmable Logic Controller(PLC) Basics:** Definition and History, advantages and disadvantages, Types of PLC systems – CPU's and programmer/ Monitors, PLC input and output models, printing PLC Information, programming procedures, programming Formats, proper construction of PLC Diagrams, Devices to which PLC input and output modules are connected, input on/ off devices and output analog devices | 07 hours |
| 2. **Basic PLC Programming and Basic PLC Functions:** Programming on/ off input to produce on / off out puts , PLC input instructions, outputs operational procedures , contact and coil input / Out put programming examples, Relation to digital gate logic contact/ coil logic, PLC programming and conversion examples, creating ladder diagrams form process control descriptions, sequence listing sarge process ladder diagram constructions. | 08 hours |
| 3. **General Characteristics of Registers:** Modules addressing, holding registers, input registers, output registers, PLC timer functions, examples of timer functions. Industrial applications, PLC counter functions. | **06 hours** |
| 4. **Intermediate functions:** PLC Arithmetic functions, PLC additions and subtractions, the PLC repetitive clock,PLC multiplications, Division and square Root, PLC trigonometric and log functions, other PLC arithmetic Functions, PLC basic comparison functions applications, numbering systems and number conversion functions, PLC conversion between decimal and BCD Hexadecimal numbering systems. | 12 hours |
| 5. **Data Handling Functions:** The PLC skip and master control relay functions, Jump functions, jump with non return with return, PLC data move systems, PLC functions and applications, PLC functions working with bits, PLC digital bit functions and applications, PLC sequencer functions PLC matrix functions. Process control, network system and SCADA:- Types of processes, | 09 hours |

| | |
|---|---|
| structure of control system, on/off control, PLD control, motion control, data communication, supervisory control and data acquisition (SCADA). | |
| | |

**Question paper pattern:** Total ten questions will be asked. Two from each module. The student has to answer five questions, selecting at least one from each module.

**Text books:**

1. John W. Weff. Ronald A Rise. Programmable logic controllers , prentice Hall of India private Limited, Fifth edition, 2003.
2. Programmable Logic Controllers, Frank D Petruzella, McGraw Hill, 4th Edition, 2011.

**Reference Books:**

1. Programmable Logic Controllers an Engineer's Guide, E A Parr, Newnes, 3rd Edition, 2013.
2. Introduction Programmable Logic Controllers, Gary Dunning, Cengage, 3rd Edition, 2006.

**E books and online course materials:**

**Course outcomes:**
**On completion of the course, the student will have the ability to:**

| Course Code | CO # | Course Outcome (CO) |
|---|---|---|
| 22EE63D | **CO1** | Discuss history of PLC and describe the hardware components of PLC: I/O modules, cpu, memory devices, other support devices, operating modes and PLC programming. |
| | **CO2** | Analyze the ladder logic diagrams and describe the operation of different program instructions. |
| | **CO3** | To explain the functions of Counters, timers and characteristics of registers. |
| | **CO4** | Discuss the execution of data compare instructions, number conversion and the basic operation of PLC closed loop control system. |
| | **CO5** | Describe the operation of mechanical sequences, bit and word shift registers, processes and structure of central system and communication between the processes |

| S.No. | PO CO | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | CO1 | 3 | 2 | 2 | 2 | | | | | 1 | | | 2 | 2 | 2 | |
| 2 | CO2 | 3 | 2 | 2 | 2 | | | | | 1 | | | 2 | 2 | 2 | |
| 3 | CO3 | 3 | 2 | 2 | 2 | | | | | 1 | | | 2 | 2 | 2 | |
| 4 | CO4 | 3 | 2 | 2 | 2 | | | | | 1 | | | 2 | 2 | 2 | |
| 5 | CO5 | 3 | 2 | 2 | 2 | | | | | 1 | | | 2 | 2 | 2 | |
| | Total Average | 3 | 2 | 2 | 2 | | | | | 1 | | | 2 | 2 | 2 | |

| Course Title: Operation and Maintenance of Solar Electric Systems | | |
|---|---|---|
| Course Code | 22EEOE642 | CIE: 50 |
| Number of Lecture Hours/Week | **3hrs.(Theory)** | SEE: 50 |
| Total Number of Lecture Hours | 42 | SEE Hours: 03 |
| Prerequisite: Basic electrical engineering. | | |

**Objectives:**

To appreciate the importance of solar PV O & M.
To assess the impact of O and M.
To develop safety measures for Operation of solar PV system.
To document the O and M procedures.

| Modules | Teaching Hours |
|---|---|
| **Module I**<br>**Introduction To Solar PV Operation & Maintenance (O&M):**<br>Necessity of O and M, Expected Outcome, Benefits of O&M. Overview of PV System Components, Types of Rooftop PV Systems, System Components. Maintenance Categorization, Scheduled Maintenance, Unscheduled Maintenance. Common Tools & Equipments Used, Testing Methods and Techniques | 08 hrs |
| **Module II**<br>**Photovoltaic Modules:**<br>Inspection & Fault Identification, Dust accumulation, Module Shading , Module Mismatch, Physical Integrity. Maintenance & Troubleshooting, Basic Level, Advanced Level, Methods and Techniques for Shading Analysis, Key Points to Remember. | 08 hrs |
| **Module III**<br>**Inverters:**<br>Inspection and Fault Identification, Classification of Solar Inverters, Routine Inspection. Maintenance and Troubleshooting, Basic Level, Advanced Level, Key Points to Remember. | 08 hrs |
| **Module IV**<br>**Balance Of Systems:**<br>Inspection and Fault Identification, Cables, Protection Devices, Batteries. Maintenance and Trouble shooting , Basic Level, Advanced Level, Key points to Remember. | 08 Hrs |
| **Module V**<br>**Jobsite Safety**: General Safety Procedures, General safety, Specific safety, Personal Safety Procedures, Importance of Personal Protective Equipment , Major Safety Hazards, Key points to Remember.<br>**Electricity Bill:**<br>Calculation of consumption of electrical energy, Calculation of energy generated by RTPV system, Before and After Installation of Solar PV system. | 10 hrs |

**Documentation:** Importance of Documentation and its significance, System Documentation, Maintenance Documentation, Component Documentation.

**Question paper pattern:** Total ten questions will be asked. Two from each module.
The student has to answer five questions, delecting at least one from each module.

**Text books/Reference Books:**


01. Best Practices in OPERATION AND MAINTENANCE of Rooftop Solar PV Systems in India, JAYA VASITA, AKHILESH MAGAL, Gujarat Energy Research & Management Institute Hand book, 2018
02. ***Solar Photovoltaic Technology and Systems: A Manual for Technicians***, ***Trainers and Engineers,*** Chetan Singh Solanki, PHI, 2018.
03. PV System Operations and Maintenance Fundamentals, Josh Haney Adam Burstein Next Phase Solar. Inc. August 2013
04. Operation & Maintenance Best Practices Guidelines, Solar Power Europe, June 2018.
05. http://mnre.gov.in/file-manager/UserFiles/Best-Practices-Guide-on-State-Level-Solar-Rooftop-Photovoltaic-Programs.pdf
06. Best Practices for Operation and Maintenance of Photovoltaic and Energy Storage Systems, National Renewable Energy Laboratory, Sandia National Laboratory, SunSpec Alliance, and the SunShot National Laboratory Multiyear Partnership (SuNLaMP) PV O&M Best Practices Working Group, 3rd Edition, December 2018.


**Course outcomes:**
**On completion of the course, the student will have the ability to:**

| Course Code | CO # | Course Outcome (CO) |
|---|---|---|
| 22EEOE642 | **CO1** | Discuss O& M procedures for solar PV systems. |
| | **CO2** | Theorise the O & M procedures for PV Modules |
| | **CO3** | Establish the O&M procedures for inverters. |
| | **CO4** | Determine the O&M procedures for balance of systems |
| | **CO5** | Compile safety measures and summarise O&M data. |

## Course Articulation Matrix for the Academic Year 2024-25

| S.No. | PO CO | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | CO1 | 3 | 1 | | | | | | | | | 1 | | | | |
| 2 | CO2 | 3 | 1 | | 1 | 1 | | | | | | | 2 | | | |
| 3 | CO3 | 3 | 1 | | 1 | 1 | | | | | | | | | 1 | |
| 4 | CO4 | 3 | 1 | | | | 1 | | | | | | | | 1 | |
| 5 | CO5 | 3 | 1 | | | | 3 | 1 | | | | | | | 1 | 1 |
| | | 3 | 1 | | **1** | **1** | **2** | **1** | | | | **1** | **2** | | 1 | 1 |

| Course Title: **Very Large Scale Integrated Circuits and Design** | | | |
|---|---|---|---|
| Course Code | 22EEOE643 | Credits:3 | CIE: 50 |
| Number of Lecture Hours/Week | 3 hrs.(Theory) | | SEE: 50 |
| Total Number of Lecture Hours | 42 | | SEE Hours: 03 |

**Prerequisite: E**lectronic Circuits, Power Electronics, Linear integrated circuits.

**Objectives:**

1. To study Microelectronics & an introduction MOS technology
2. To understand about Basic Electrical properties of MOS and BIMOS circuit.
3. To know MOS and CMOS circuit design processes.
4. To study Basic circuit concepts.
5. To study Scaling of MOS circuits.
6. To understand Subsystem design & layout .

| **Modules** | **Teaching Hours** |
|---|---|
| **Module-I**<br>**Introduction to MOS Technology:** Introduction to IC technology, IC era, Basic MOS transistor, enhancement & depletion mode transistor action, NMOS fabrication, CMOS, Fabrication, thermal aspects of processing BICMOS technology, production of E-beam masks. | **08 Hours** |
| **Module-II**<br>**MOS and BiCMOS Circuits**: Drain-to-Source current $I_{ds}$ Versus voltage $\mathbf{V}_{ds}$ relationship, aspects of MOS transistor threshold voltage $V_t$, MOS transistor trans-conductance $G_m$ and output conductance, MOS transistor figure of merit $W_o$, The pass transistor, The nMOS inverter, determination of pull-up to pull-down ratio (Zpu/Zpd) for an nMOS inverter driven by another nMOS inverter. MOS layers, stick diagram design rules and layout, observation on design rules layout diagrams. | **10 Hours** |
| **Module-III**<br>**Basic Circuit Concepts:** Sheet resistance $R_s$, sheet resistance concept applied to MOS transistors and inverters, area capacitance of layers, standard unit of capacitance, area capacitance calculations, delay unit $\tau$, inverter delays, driving large capacitance loads, prorogation delays, wiring capacitance. | **08 Hours** |
| **Module-IV**<br>**Scaling of MOS Circuits:** Scaling models and scaling factors, scaling factors for device parameters, some discussions on & limitations of scaling, limitations due to sub-threshold current , limits on logic levels and supply voltage due to noise. | **08 Hours** |
| **Module-V**<br>**Subsystem Design & Layout:** Architectural issues, switch logic, gate logic, examples of structured design (Combinational logic), clocked sequential circuits, power dissipation for CMOS circuits, current limitation for $V_{DD}$ & $V_{SS}$ rails. | **08 Hours** |

**Question paper pattern:** Total ten questions will be asked. Two from each module. The student has to answer five questions, selecting at least one from each module.

**Reference Books:**

1. Douglas, Puknell, & Eshragian, "Basic VLSI Design", PHI, 3rd Edition -2009
2.John P. Uyemura, "Introduction to VLSI Circuits and Systems" John Wiley,

3.Wayne Wolf, "Modern VLSI design", Pearson Education 3rd Edition -2003.
4.Yuan Taur, Tak H.Ning "Fundamentals of Modern VLSI device" Cambridge press, South Asia Edition., 2015.
5.VLSI design by Debaprasad Das, Oxford University Press, Published 2010,3rd Edition.

**Course outcomes:**
**On completion of the course, the student will have the ability to:**

| Course Code | CO | Course Outcome (CO) |
|---|---|---|
| 22EEOE643 | CO1 | Explain the basic circuits concepts. |
| | CO2 | Explain the MOS and BiCMOS Circuits parameters and stick diagram design rules. |
| | CO3 | Explain Scaling of MOS circuits |
| | CO4 | Design of MOS & CMOS circuits. |
| | CO5 | Design of Layout & Subsystem design. |

## Course Articulation Matrix for the Academic Year 2024-25

| S.No. | PO CO | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | CO1 | 3 | | | | | | | | | | | | 1 | 1 | |
| 2 | CO2 | 2 | 2 | 1 | | | | | | | | | 1 | 1 | 1 | |
| 3 | CO3 | 2 | 1 | | | | | | | | | | | 1 | 1 | |
| 4 | CO4 | 3 | 3 | 3 | | | | | | | | | 2 | 2 | 2 | 1 |
| 5 | CO5 | 3 | 3 | 3 | | | | | | | | 1 | 1 | 2 | 2 | 1 |
| | | 2.6 | 2.3 | 2.3 | | | | | | | | 1.0 | 1.3 | 2.6 | 2.3 | 2.3 |

| Course Title: **Illumination Engineering** | | | |
|---|---|---|---|
| Course Code | 22EEOE644 | **Credits: 3** | CIE: 50 |
| Number of Lecture Hours/Week | **3hrs.(Theory)** | | SEE: 50 |
| Total Number of Lecture Hours | 42 | | SEE Hours: 03 |
| Prerequisite: Basic Terminologies of Electrical Engineering | | | |

**Course Objectives:**

**1.** To provide an introduction to the fundamentals of illumination engineering and architectural lighting designs.
**2.** To impart lighting fundamentals and measurements.
**3**. To gain knowledge on illumination technology and their application in lighting systems.

**4.** To design indoor and outdoor lighting systems.

| Modules | Teaching Hours |
|---|---|
| **Module I**<br>**Introduction of Light** : Types of illumination, Day lighting, Supplementary artificial lighting and total lighting, Quality of good lighting, Factors affecting the lighting-shadow, glare, reflection, Colour rendering and stroboscopic effect, Methods of artificial lighting, Lighting systems-direct, indirect, semi direct, semi indirect, Lighting scheme, General and localised | 07 hrs |
| **Module II**<br>**Measurement of Light** : Definition of luminous flux, Luminous intensity, Lumen, Candle power, Illumination, M.H.C.P, M.S.C.P, M.H.S.C.P, Lamp efficiency, Brightness or luminance, Laws of illumination, Inverse square law and Lambert's Cosine law, Illumination at horizontal and vertical plane from point source, Concept of polar curve, Calculation of luminance and illumination in case of linear source, round source and flat source | 07 hrs |
| **Module III**<br>**Design of Interior Lighting** : Definitions of maintenance factor, Uniformity ratio, Direct ratio, Coefficients of utilization and factors affecting it, Illumination required for various work planes, Space to mounting height ratio, Types of fixtures and relative terms used for interior illumination such as DLOR and ULOR, Selection of lamp and luminance, Selection of utilization factor, reflection factor and maintenance factor. Determination of Lamp Lumen output taking into account voltage and temperature variations, Calculation of wattage of each lamp and no of lamps needed, Layout of lamp luminaire, Calculation of space to mounting height ratio, Indian standard recommendation and standard practices for illumination levels in various areas, Special feature for entrance, staircase, Corridor lighting and industrial building | 10 hrs |
| **Module IV**<br>**Design of Outdoor Lighting** : Street Lighting : Types of street and their level of illumination required, Terms related to street and street lighting, Types of fixtures used and their suitable application, Various arrangements in street lighting, Requirements of good street lighting, Selection of lamp and luminaire, Calculation of their wattage, Number and arrangement, Calculation of space to mounting height ratio, Calculation of illumination level available on road.<br>**Design of Outdoor Lighting** : Flood Lighting : Terms related to flood lighting, Types of fixtures and their suitable applications, Selection of lamp and projector, Calculation of their wattage and number and their arrangement, Calculation of space to mounting height ratio, Recommended method for aiming of lamp | 10 hrs |
| **Module V**<br>**Special Features of Aesthetic Lighting** : Monument and statue lighting, Sports lighting, Hospital lighting, Auditorium lighting Case Study: On Domestic, Commercial, Industrial and community service buildings. | 08 hrs |
| **Question paper pattern:** Total ten questions will be asked. Two from each module.<br>The student has to answer five questions, selecting at least<br>one from each module. | |
| **Text books/Reference Books:**<br>1. D.C. Pritchard Lighting, Routledge, 2016<br>2. Jack L. Lindsey, Applied Illumination Engineering , PHI, 1991<br>3. John Matthews Introduction to the Design and Analysis of Building Electrical Systems, Springer, 1993<br>4. M.A. Cayless, Lamps and Lighting , Routledge, 1996 | |

| **Course outcomes:**<br>**On completion of the course, the student will have the ability to:** | |
|---|---|

| **Course Code** | **CO #** | **Course Outcome (CO)** |
|---|---|---|
| 22EEOE644 | **CO1** | **Outline the fundamentals of illumination engineering and architectural lighting designs.** |
| | **CO2** | **Describe lighting fundamentals and measurements.** |
| | **CO3** | **Design of indoor lighting** |
| | **CO4** | **Design of outdoor lighting** |
| | **CO5** | **Examine illumination technology and their application in lighting systems** |

## Course Articulation Matrix for the Academic Year 2024-25

| S.No. | PO<br>CO | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | CO1 | 3 | 2 | | | | 1 | 1 | 1 | | | 1 | | 1 | | |
| 2 | CO2 | 3 | 2 | | | | | | | | | | | | | |
| 3 | CO3 | 3 | | 2 | | 1 | | | | | | | | | | 1 |
| 4 | CO4 | 3 | 2 | 2 | | 1 | | | | | | | | | | 1 |
| 5 | CO5 | 3 | 2 | | | | | 1 | | | | 1 | 1 | | | |
| | | 3 | 2 | 2 | | 1 | 1 | 1 | 1 | | | 1 | 1 | 1 | | 1 |