# University of Mumbai

No. AAMS_UGS/ICC/2022-23/ 112

**CIRCULAR :-**

Attention of the Principals of the Affiliated Colleges and Directors of the recognized Institutions in Faculty of Science & Technology is invited to this office circular No.UG/41 of 2018-19 dated 25th June, 2018 relating to the revised syllabus for the T.E. & B.E. in Electrical Engineering (Sem.– V to VIII) (CBCS).

They are hereby informed that the recommendations made by the Board of Studies in Electrical Engineering at its meeting held on 09th May, 2022 and subsequently passed in the Faculty and then by the Board of Deans at its meeting held on 5th July, 2022 vide item No. 6.21 (R) have been accepted by the Academic Council at its meeting held on 11th July, 2022 **vide** item No. 6.21 (R) and that in accordance therewith, the revised syllabus of B.E.(Electrical Engineering) (Sem.– VII & VIII) (CBCS) (REV-2019 'C' Scheme) has been brought into force with effect from the academic year 2022-23. (The circular is available on the University's website www.mu.ac.in).

(Dr. Shailendra Deolankar)
I/c Registrar

MUMBAI – 400 032
20th October, 2022

To

The Principals of the Affiliated Colleges and Directors of the recognized Institutions in Faculty of Science & Technology.

**A.C/6.21(R)/11/07/2022**

**********

No. AAMS_UGS/ICC/ 2022-23/ 112

20th October, 2022

Copy forwarded with Compliments for information to:-

1) The Dean, Faculty of Science & Technology,
2) The Chairman, Board of Studies in Electrical Engineering,
3) The Director, Board of Examinations and Evaluation,
4) The Director, Board of Students Development,
5) The Director, Department of Information & Communication Technology,
6) The Co-ordinator, MKCL.

(Dr. Shailendra Deolankar)
I/c Registrar

Desktop/Circular of Engineering/Priya

**Copy to :-**

1. **The Deputy Registrar, Academic Authorities Meetings and Services (AAMS),**
2. **The Deputy Registrar, College Affiliations & Development Department (CAD),**
3. **The Deputy Registrar, (Admissions, Enrolment, Eligibility and Migration Department (AEM),**
4. **The Deputy Registrar, Research Administration & Promotion Cell (RAPC),**
5. **The Deputy Registrar, Executive Authorities Section (EA),**
6. **The Deputy Registrar, PRO, Fort, (Publications Section),**
7. **The Deputy Registrar (Special Cell),**
8. **The Deputy Registrar, Fort/Vidyanagari Administration Department (FAD) (VAD), Record Section,**
10. **The Professor-cum- Director, Institute of Distance and Open Learning (IDOL Admin), Vidyanagari,**

**They are requested to treat this as action taken report on the concerned resolution adopted by the Academic Council referred to in the above circular and that on separate Action Taken Report will be sent in this connection.**

1. **P.A. to Hon'ble Vice-Chancellor,**
2. **P.A. to Pro-Vice-Chancellor,**
3. **P.A. to Registrar,**
4. **All Deans of all Faculties,**
5. **P.A. to Finance & Account Officer, (F. &. A.O.),**
6. **P.A. to Director, Board of Examination & Evaluation,**
7. **P.A. to Director, Innovation, Incubation and Linkages,**
8. **P.A. to Director, Board of Lifelong Learning and Extension (BLLE),**
9. **The Director, Dept. Of Information and Communication Technology (DICT) (CCF & UCC), Vidyanagari,**
10. **The Director of Board of Student Development,**
11. **The Director, Department of Students Welfare (DSD),**
12. **All Deputy Registrar, Examination House,**
13. **The Deputy Registrars, Finance & Accounts Section,**
14. **The Assistant Registrar, Administrative sub-campus Thane,**
15. **The Assistant Registrar, School of Engg. & Applied Sciences, Kalyan,**
16. **The Assistant Registrar, Ratnagiri Sub-centre, Ratnagiri,**
17. **The Assistant Registrar, Constituent Colleges Unit,**
18. **BUCTU,**
19. **The Receptionist,**
20. **The Telephone Operator,**
21. **The Secretary MUASA,**

**for information.**

AC – 11/7/2022
Item No. – 6.21 (R)

# University of Mumbai

**Revised Syllabus for**

## B.E. (Electrical Engineering)

**Semester – VII and VIII**

**(Choice Based Credit System)**

**(With effect from the academic year 2022-23)**

# University of Mumbai

## Syllabus for Approval

| | |
|---|---|
| O:_____ Title of Course | B.E. (Electrical Engineering) |
| O:_____ *Eligibility* | After Passing Third Year Engineering as per the Ordinance 0.6243 |
| R:_____ Passing Marks | 40% |
| No. of years/ Semesters: | Years- 4 / Semesters - 8 |
| Level: | U.G. |
| Pattern: | Semester |
| Status: | Revised |
| To be implemented from Academic Year : | From the academic year 2022-23 |

Dr. Sushil Thale
Chairman,
Board of Studies,
Electrical Engineering
Faculty of Technology

Dr. Suresh K. Ukarande
Associate Dean,
Faculty of Science and Technology

Dr Anuradha Majumdar
Dean,
Faculty of Science and Technology

# Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Science and Technology (in particular Engineering) of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 13 weeks and remaining 2 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

There was a concern that the earlier revised curriculum more focused on providing information and knowledge across various domains of the said program, which led to heavily loading of students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of entire program will be of 170, wherein focus is not only on providing knowledge but also on building skills, attitude and self-learning. Therefore, in the present curriculum skill based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self-learning of students. The overall credits and approach of curriculum proposed in the present revision is in line with AICTE model curriculum.

The present curriculum will be implemented for Fourth Year of Engineering from the academic year 2022-23.

**Signature:** **Signature:**

**Chairman, Board of Studies** **Faculty of Dean**

**Program Structure for Fourth Year Electrical Engineering**
**(Semester VII & VIII)**
**University of Mumbai**
**(With Effect from 2022-2023)**

**Semester VII**

| Course Code | Course Name | Teaching Scheme (Contact Hours) | | Credits Assigned | | |
|---|---|---|---|---|---|---|
| | | Theory | Pract. Tut. | Theory | Pract. | Total |
| EEC701 | Electrical Drives & Control | 3 | -- | 3 | -- | 3 |
| EEC702 | Electrical Power System III | 3 | -- | 3 | | 3 |
| EEDO701X | Department Optional Course – 3 | 3 | -- | 3 | -- | 3 |
| EEDO702X | Department Optional Course – 4 | 3 | -- | 3 | -- | 3 |
| EEIO701X | Institute Optional Course – 1 | 3 | -- | 3 | -- | 3 |
| EEL701 | Electrical Drives & Control Lab | -- | 2 | -- | 1 | 1 |
| EEL702 | Simulation Lab III | -- | 2 | -- | 1 | 1 |
| EEL703 | Power Electronics Design Lab | -- | 2 | -- | 1 | 1 |
| EEP701 | Major Project I | -- | 6# | -- | 3 | 3 |
| **Total** | | **15** | **12** | **15** | **6** | **21** |

| Course Code | Course Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory | | | | | Term Work | Prac /oral | Total |
| | | Internal Assessment | | | End Sem Exam | Exam. Duration (in Hrs) | | | |
| | | Test1 | Test2 | Avg | | | | | |
| EEC701 | Electrical Drives & Control | 20 | 20 | 20 | 80 | 3 | -- | -- | 100 |
| EEC702 | Electrical Power System III | 20 | 20 | 20 | 80 | 3 | -- | -- | 100 |
| EEDO701X | Department Optional Course – 3 | 20 | 20 | 20 | 80 | 3 | -- | -- | 100 |
| EEDO702X | Department Optional Course – 4 | 20 | 20 | 20 | 80 | 3 | -- | -- | 100 |
| EEIO701X | Institute Optional Course - 1 | 20 | 20 | 20 | 80 | 3 | -- | -- | 100 |
| EEL701 | Electrical Drives & Control Lab | -- | -- | -- | -- | -- | 25 | 25 | 50 |
| EEL702 | Simulation Lab III | -- | -- | -- | -- | -- | 25 | 25 | 50 |
| EEL703 | Power Electronics Design Lab | -- | -- | -- | -- | -- | 25 | 25 | 50 |
| EEP701 | Major Project I | -- | -- | -- | -- | -- | 50 | -- | 50 |
| **Total** | | **--** | **--** | **100** | **400** | **--** | **125** | **75** | **700** |

# indicates work load of Learner (Not Faculty), for Major Project

# Semester VIII

| Course Code | Course Name | Teaching Scheme (Contact Hours) | | Credits Assigned | | |
|---|---|---|---|---|---|---|
| | | Theory | Pract./ Tut. | Theory | Pract. | Total |
| EEC801 | Electrical System Design, Management and Auditing | 4 | -- | 4 | -- | 4 |
| EEDO801X | Department Optional Course – 5 | 3 | -- | 3 | -- | 3 |
| EEDO802X | Department Optional Course – 6 | 3 | -- | 3 | -- | 3 |
| EEIO801X | Institute Optional Course - 2 | 3 | -- | 3 | -- | 3 |
| EEL801 | Electrical System Design and Audit Lab | -- | 2 | -- | 1 | 1 |
| EEL802 | Measurement and Instrumentation Lab | -- | 2 | -- | 1 | 1 |
| EEP801 | Major Project II | -- | 12# | -- | 6 | 6 |
| **Total** | | **13** | **16** | **13** | **8** | **21** |

| Course Code | Course Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory | | | | | Term Work | Prac/ oral | Total |
| | | Internal Assessment | | | End Sem Exam | Exam. Duration (in Hrs) | | | |
| | | Test1 | Test2 | Avg | | | | | |
| EEC801 | Electrical System Design, Management and Auditing | 20 | 20 | 20 | 80 | 3 | -- | -- | 100 |
| EEDO801X | Department Optional Course – 5 | 20 | 20 | 20 | 80 | 3 | -- | -- | 100 |
| EEDO802X | Department Optional Course – 6 | 20 | 20 | 20 | 80 | 3 | -- | -- | 100 |
| EEIO801X | Institute Optional Course - 2 | 20 | 20 | 20 | 80 | 3 | -- | -- | 100 |
| EEL801 | Electrical System Design and Audit Lab | -- | -- | -- | -- | -- | 25 | 25 | 50 |
| EEL802 | Measurement and Instrumentation Lab | -- | -- | -- | -- | -- | 25 | 25 | 50 |
| EEP801 | Major Project II | -- | -- | -- | -- | -- | 100 | 50 | 150 |
| **Total** | | **--** | **--** | **80** | **320** | **--** | **150** | **100** | **650** |

**Students group and load of faculty per week**.

**Major Project I and II:**

Students can form groups with minimum 3 (Three) and not more than 4 (Four)

Faculty Load: In Semester VII – ½ hour per week per project group
In Semester VIII – 1 hour per week per project group

## Department Optional Courses

| Course Code | Sem. VII: Department Optional Course- 3 | | Course Code | Sem. VII: Department Optional Course - 4 |
|---|---|---|---|---|
| EEDO7011: | Digital Control System | | EEDO7021: | Microgrid and Smart-grid |
| EEDO7012: | HVDC Transmission Systems | | EEDO7022: | Power System Dynamics and Control |
| EEDO7013: | Internet of Things | | EEDO7023: | Artificial Intelligence and Machine Learning |
| EEDO7014: | Digital Signal Processors and Applications | | EEDO7024: | Electrical Machine Design |

| Course Code | Sem. VIII: Department Optional Course- 5 | | Course Code | Sem. VIII: Department Optional Course - 6 |
|---|---|---|---|---|
| EEDO8011: | Power Quality and FACTs | | EEDO8021: | Power System Planning and Reliability |
| EEDO8012: | Automation and Control | | EEDO8022: | Lighting System Design |
| EEDO8013: | Advanced Electric Drives | | EEDO8023: | Cyber Physical Systems |
| EEDO8014: | High Power Switching Converters | | EEDO8024: | Electric Vehicle System Design |

## Institute Optional Courses

| Course Code | Institute Optional Course-I # | | Course Code | Institute Elective Course-II # |
|---|---|---|---|---|
| EEIO7011 | Product Lifecycle Management | | EEIO8021 | Project Management |
| EEIO7012 | Reliability Engineering | | EEIO8022 | Finance Management |
| EEIO7013 | Management Information System | | EEIO8023 | Entrepreneurship Development and Management |
| EEIO7014 | Design of Experiments | | EEIO8024 | Human Resource Management |
| EEIO7015 | Operation Research | | EEIO8025 | Professional Ethics and CSR |
| EEIO7016 | Cyber Security and Laws | | EEIO8026 | Research Methodology |
| EEIO7017 | Disaster Management and Mitigation Measures | | EEIO8027 | IPR and Patenting |
| EEIO7018 | Energy Audit and Management | | EEIO8028 | Digital Business Management |
| EEIO7019 | Development Engineering | | EEIO8029 | Environmental Management |

**# Common with all branches**

| ELECTRICAL ENGINEERING - SEMESTER-VII | | | | | | |
|---|---|---|---|---|---|---|
| Course Code | Course Name | Teaching Scheme (Contact Hours) | | Credits assigned | | |
| **EEC701** | **Electrical Drives & Control** | Theory | Pract./Tut. | Theory | Pract /Tut. | Total |
| | | **3** | **--** | **3** | **--** | **3** |

| Course Code | Course Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory | | | | | Term work | Pract./ Oral | Total |
| | | Internal Assessment | | | End Sem. Exam. | Exam. Duration (in Hrs) | | | |
| | | Test 1 | Test 2 | Avg | | | | | |
| **EEC701** | **Electrical Drives & Control** | **20** | **20** | **20** | **80** | **03** | **-** | **-** | **100** |

| | |
|---|---|
| **Course Objectives** | To impart knowledge on<br>1. the basic concepts of electrical drives<br>2. the speed and torque control techniques of both DC and AC drives |
| **Course Outcomes** | Upon successful completion of this course, the learner will be able:<br>1. To apply the knowledge of dynamics to solve problems on electrical drives.<br>2. To select the power rating of a motor based on duty cycle.<br>3. To illustrate the modes of operation and control schemes (both open and closed loop) of electrical drive.<br>4. To analyze the speed control of DC drives with waveforms.<br>5. To analyze various methods of speed control and braking methods used in induction motor drives.<br>6. To describe the advanced control techniques used in induction motor drives. |

| Module | Contents | Hours |
|---|---|---|
| 1 | Electrical Drives - Introduction & Dynamics:<br>Introduction, Advantages of Electrical Drives, Parts of Electrical Drives, Choice of Electrical Drives, Status of DC and AC Drives, Fundamental Torque equations, Speed-Torque conventions and Multi-quadrant Operation, Equivalent values of Drive Parameters, Measurement of Moment of Inertia, Components of Load Torques, Nature and Classification of Load Torques, Calculation of Time and Energy Loss in Transient Operations, Steady State Stability, Load Equalization | 10 |
| 2 | Selection of Motor Power Rating:<br>Thermal Model of Motor for Heating and Cooling, Classes of Motor Duty, Determination of Motor Rating: Continuous duty; Equivalent current, Torque and Power Methods for Fluctuating and Intermittent Loads; Short Time Duty; Intermittent Duty. | 05 |
| 3 | Control of Electrical Drives:<br>Modes of Operation, Speed Transitions during Acceleration and Deceleration, Static and Dynamic Performance Requirement of a Drive. Review of Hysteresis Band Current Control Technique and pulse width modulation (PWM) voltage control techniques. Closed loop control of drives – Torque control, Speed control loop with inner current control loop. | 05 |
| 4 | DC Drives:<br>Review of Basic multi-quadrant speed torque characteristics and equations of DC motors, Three Phase Fully Controlled Converter based Separately Excited DC Motor Drive. Chopper based Separately Excited DC Motor Drive (No Numerical on this Module) | 04 |
| 5 | AC Drives: | 08 |

| | | |
|---|---|---|
| | Induction Motor Drives: Review of Basic Multi-Quadrant Speed-Torque Characteristics and Equations, Regenerative Braking, Plugging, Speed Transitions during Acceleration and Deceleration, Speed Control: Stator Voltage Control, V/f Control, Soft starting with V/f control. Synchronous Motor Drives: Introduction to Synchronous Motor Variable Speed Drives – V/f Control, Self Control. | |
| 6 | Advanced Control Techniques in Induction Motor Drives<br>Review of d-q Model of Induction Motor, Principle of Vector Control (also called as Field Oriented Control (FOC)), DC Motor Analogy, Block diagram and Phasor Diagram of Direct Vector Control Scheme, Comparison of Scalar and Vector control, Direct Torque and Flux Control using the Switching Table of Inverter Voltage Vectors (DTFC or DTC). | 07 |

Text Books:

1. Fundamentals of Electrical Drives by G. K. Dubey, Narosa Publication
2. First Course on Electrical Drives by S. K. Pillai, New Age International
3. Modern Power Electronics and AC Drives by B. K. Bose, Prentice Hall PTR
4. Electrical Drives: Concepts and Applications by Vedam Subramanyam, T.M.H

Reference Books:

1. Electric Motor Drives: Modeling, Analysis and Control by Krishnan.R, PHI.
2. Power Electronics by Joseph Vithayathil, Tata McGraw Hill
3. Power Electronics by Muhammad H. Rashid, Pearson

Web Reference /Video Courses

1. NPTEL Course: Fundamentals of Electric Drives By Prof. Shyama Prasad Das, IIT Kanpur
2. NPTEL Course: Advanced Electric Drives By Prof. Shyama Prasad Das, IIT Kanpur
3. NPTEL Course: Industrial Drives - Power Electronics, Prof. K. Gopakumar, IISC Bangalore

Assessment:
Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be randomly selected from all the modules.

| ELECTRICAL ENGINEERING - SEMESTER-VII | | | | | | |
|---|---|---|---|---|---|---|
| Course Code | Course Name | Teaching Scheme (Contact Hours) | | Credits assigned | | |
| **EEC702** | **Electrical Power System III** | Theory | Pract./Tut. | Theory | Pract /Tut. | Total |
| | | **3** | **--** | **3** | **--** | **3** |

| Course Code | Course Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory | | | | | Term work | Pract./ Oral | Total |
| | | Internal Assessment | | | End Sem. Exam. | Exam. Duration (in Hrs) | | | |
| | | Test 1 | Test 2 | Avg | | | | | |
| **EEC702** | **Electrical Power System III** | **20** | **20** | **20** | **80** | **03** | **--** | **-** | **100** |

| | |
|---|---|
| **Course Objectives** | Student shall be able<br>1. to understand concept of Generator operating cost, input-output, Heat rate and IFC curve, Constraints in operation, solve Load scheduling and unit commitment problem<br>2. to understand concept of out of step falling of synchronous generator, system stability and analysis<br>3. to apply different numerical techniques to study power system stability<br>4. to understand concept of load flow studies and solve it by using different numerical techniques<br>5. to understand concept of load frequency control and voltage control<br>6. to understand concept of interchange of power and energy |
| **Course outcomes** | **Upon successful completion of this course, the learner will be able to**<br>1. Solve Load scheduling and unit commitment problem<br>2. Define and classify power system stability<br>3. Determine critical clearing angle using techniques like equal area criterion<br>4. Formulate load flow problem and solve it by using different techniques<br>5. Model single area load frequency control and analyse its steady state and dynamic behavior<br>6. Understand concept of interchange of power and energy |

| Module | Contents | Hours |
|---|---|---|
| 1. | Economic Operation of Power System<br>Optimal operation of generators in thermal power station, heat rate curve, input-output curve, IFC curves, optimum generation scheduling neglecting Transmission losses (coordinate equation), optimum generation scheduling considering transmission losses (Exact coordinate equation), Transmission loss formula, Bmn coefficient, Inherent procedure of solving co-ordination equation, optimal unit commitment (Numerical) | 10 |
| 2. | Power System Stability I<br>Introduction to stability, types of stability, Power angle curve, dynamics of synchronous machine, power angle equation, steady state stability (Numerical) | 05 |
| 3. | Power System Stability II<br>Swing equation, transient stability, equal area criterion, application of equal area criterion, some techniques for improving transient stability (Numerical) | 05 |
| 4. | Load Flow Studies<br>Introduction, formation of Y bus using step by step method, Load flow problem, Load flow Equation and methods of solution, Gauss-Seidel method, Newton- Raphson method, Decoupled load flow method, Fast decoupled load flow method, comparison of load flow method (Numerical) | 08 |
| 5. | Automatic Generation and Voltage control<br>Introduction, Basic control loops in generator, AVR loop, Thermal control, speed governing system and transfer function, steam turbine, and power system transfer | 06 |

| | | |
|---|---|---|
| | function, Load frequency control (single area), steady state and dynamic response. | |
| 6. | Power system security and Interchange of power<br>Power system security: Introduction, System state classification, security analysis, contingency analysis.<br>Interchange of power: Interchange of power between interconnected utilities, types of interchange, capacity and diversity interchange, energy banking, power pools | 05 |

**Text Books:-**

1. Kothari D.P., Nagrath I.J., Modern power system Analysis, TMH publication, 4e, 2019.
2. Chakrabarti A, Halder S., Power System Analysis-Operation and Control, PHI
3. Allen Wood, Bruce F. Wollenberg, Power Generation operation and control, Willey India
4. B.R. Gupta, Power System Analysis and Design, S. Chand

**Reference Books:-**

1. Hadi Saadat, Power System Analysis, TMH publications, 2e
2. Soman S.A., Kharpade S.A., and Subha Pandit - Computer Methods for Large Power System Analysis, an object Oriented Approach, Kluwer Academic Publisher New York 2001.

**Website Reference/ Video Courses**:

1. NPTEL Course: Power System Analysis, Prof. A.K. Sinha, IIT Kharagpur
2. NPTEL Course: Power System Engineering, By Prof. Debapriya Das, IIT Kharagpur
3. NPTEL Course: Power System Protection, By Prof. Ashok Kumar Pradhan, IIT Kharagpur
4. NPTEL Course: Operation and Planning of Power Distribution Systems, By Prof. Sanjib Ganguly, IIT Guwahati
5. NPTEL Course: Power System Dynamics, Dr. M.L. Kothari, IIT Delhi

**Assessment:**

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

**Theory Examination**:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be randomly selected from all the modules.

| ELECTRICAL ENGINEERING - SEMESTER-VII | | | | | | |
|---|---|---|---|---|---|---|
| Course Code | Course Name | Teaching scheme (Contact Hours) | | Credits Assigned | | |
| **EEDO7011** | **Digital Control System** | Theory | Pract./Tut. | Theory | Pract./Tut. | Total |
| | | **3** | **--** | **3** | | **3** |

| Course Code | Course Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory | | | | | Term Work | Pract/ Oral | Total |
| | | Internal Assessment | | | End Sem. Exam | Exam Duration (in Hrs) | | | |
| | | Test 1 | Test 2 | Avg | | | | | |
| **EEDO7011** | **Digital Control System** | **20** | **20** | **20** | **80** | **3** | **-** | **-** | **100** |

| | |
|---|---|
| **Course Objectives** | 1. To familiarize the student with the concept of discretization<br>2. Introduction to discrete-time system representations and digital control<br>3. Learn to design controller for digital systems |
| **Course outcomes** | **Upon successful completion of this course, the learner will be able to:**<br>1. Obtain discrete representation of LTI systems.<br>2. Analyze stability of open loop and closed loop discrete-time systems.<br>3. Design and analyze digital controllers.<br>4. Design state feedback and output feedback controllers. |

| Module | Contents | Hours |
|---|---|---|
| 1. | Discrete Representation of Continuous Systems:<br>Basics of Digital Control Systems. Discrete representation of continuous systems. Sample and hold circuit. Mathematical Modelling of sample and hold circuit. Effects of Sampling and Quantization. Choice of sampling frequency. ZOH equivalent | 05 |
| 2. | Discrete System Analysis:<br>Z-Transform and Inverse Z Transform for analyzing discrete time systems. Pulse Transfer function. Pulse transfer function of closed loop systems. Mapping from s-plane to z plane. Solution of Discrete time systems. Time response of discrete time system. | 06 |
| 3. | Stability of Discrete Time System:<br>Stability analysis by Jury test. Stability analysis using bilinear transformation. Design of digital control system with dead beat response. Practical issues with dead beat response design. | 04 |
| 4. | State Space Approach for discrete time systems:<br>State space models of discrete systems, State space analysis. Lyapunov Stability. Controllability, reach-ability, Re-constructibility and observability analysis. Effect of pole zero cancellation on the controllability & observability. | 10 |
| 5. | Design of Digital Control System:<br>Design of Discrete PID Controller, Design of discrete state feedback controller. Design of set point tracker. Design of Discrete Observer for LTI System. Design of Discrete compensator. | 07 |
| 6. | Discrete output feedback control:<br>Design of discrete output feedback control. Fast output sampling (FOS) and periodic output feedback controller design for discrete time systems. | 07 |

Text Books:-


1. K. Ogata, Discrete-time Control Systems, Ed. 2, Prentice-Hall, 1995
2. G. F. Franklin, J. D. Powell and M. L. Workman, Digital Control of Dynamic Systems, Addison-Wesley, 1998.
3. B. C.Kuo, Digital Control Systems, Oxford University Press, 2/e, Indian Edition, 2007.
4. M. Gopal, Digital Control and State Variable Methods, Tata Mcgraw Hill, 2/e, 2003.

5. K. J. Astroms and B. Wittenmark, Computer Controlled Systems - Theory and Design, Prentice Hall, 3/e, 1997.

Web Reference /Video Courses

1. NPTEL Course: Digital Control System by Dr. Indrani Kar and Prof. S. Majhi IIT Guwahati
2. NPTEL Course: Control Systems By Prof. C.S. Shankar Ram, IIT Madras

Assessment:
Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be randomly selected from all the modules

| ELECTRICAL ENGINEERING - SEMESTER-VII | | | | | | |
|---|---|---|---|---|---|---|
| Course Code | Course Name | Teaching scheme (Contact Hours) | | Credits Assigned | | |
| **EEDO7012** | **HVDC Transmission Systems** | Theory | Pract./Tut. | Theory | Pract./Tut. | Total |
| | | **3** | **--** | **3** | | **3** |

| Course Code | Course Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory | | | | | Term Work | Pract/ Oral | Total |
| | | Internal Assessment | | | End Sem. Exam | Exam Duration (in Hrs) | | | |
| | | Test 1 | Test 2 | Avg | | | | | |
| **EEDO7012** | **HVDC Transmission Systems** | **20** | **20** | **20** | **80** | **3** | **-** | **-** | **100** |

| | |
|---|---|
| **Course Objectives** | To impart knowledge on HVDC system, its control, protection along with brief analysis of HVDC converters |
| **Course outcomes** | **Upon successful completion of this course, the learner will be able to:**<br>1. Identify significance of dc over ac transmission systems, types of HVDC link, Components of HVDC system and applications.<br>2. Analyze multi-pulse converters.<br>3. Illustrate the basic control of HVDC system and its limitation, features and implementation.<br>4. Describe the converter firing control schemes for starting and stopping of HVDC link.<br>5. Understand and analyze faults and protection of HVDC system.<br>6. Illustrate the harmonics, their causes, effects and use of different filters. |

| Module | Contents | Hours |
|---|---|---|
| 1 | **Introduction to HVDC transmission:**<br>Early discoveries and applications, Limitation and advantages of AC and DC transmission, Classification of HVDC links, Components HVDC Transmission system, Ground Return Advantages and Problems, Advances in HVDC transmission. HVDC system application in wind power generation | 05 |
| 2 | **Analysis of the Bridge rectifier:**<br>Analysis of six pulse converter with grid control but no overlap, Current and phase relations, Analysis of six pulse converter with grid control and overlap less than $60^o$, Relation between AC and DC quantities, Analysis with overlap greater than $60^o$, Rectifier operation output voltage, thyristor voltage waveforms with and without overlap, Inverter operation output voltage waveforms. Equivalent circuit of rectifier and inverter, Multi bridge converter, Numerical from converter circuits and multiple bridge converters. | 12 |
| 3 | **HVDC System Control:**<br>Basic means of control, Limitation of manual control, Constant current verses constant voltage control, Desired features of control, Actual control characteristics, Significance of current margin, Power reversal, Control implementation | 06 |
| 4 | **Converter Control:**<br>Converter Firing Control Schemes (EPC and IPC. Starting and shutting down the HVDC link | 04 |
| 5 | **Faults and protection:**<br>By pass valve, Causes and analysis of arc back, arc through, misfire, current extinction, single commutation failure, double commutation failure, short circuits in converter station Protection against over current, over voltage | 08 |

| | | |
|---|---|---|
| 6 | **Harmonics & Filters:**<br>Characteristics Harmonics and Un-Characteristics Harmonics, Causes, Consequences, Trouble Caused by Harmonics, Means of Reducing Harmonics, Filters, AC & DC Filters. | 04 |

Text Books:-


1. Edward Wilson Kimbark, Direct Current Transmission, Wiley publication Interscience
2. K R Padiyar, HVDC power transmission systems, second edition, New Age International Ltd
3. S. Kamkshaiah and V Kamraju, HVDC transmission, Tata McGraw Hill, New Delhi
4. S.N. Singh, Electric Power Generation, Transmission and Distribution, PHI, New Delhi, 2nd edition, 2008


Reference Books:-


1. S. Rao, EHVAC and HVDC Transmission Engineering and Practice, Khanna publication, 1990
2. J. Arrillaga, HVDC Transmission, Wiley publication Inter science
3. C.L. Wadhwa, Electrical Power System (2nd Edition)


Web Reference /Video Courses

1. NPTEL Course: High Voltage DC Transmission, by Dr. S.N. Singh, IIT Kanpur

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be randomly selected from all the modules

| ELECTRICAL ENGINEERING - SEMESTER-VII | | | | | | |
|---|---|---|---|---|---|---|
| Course Code | Course Name | Teaching scheme (Contact Hours) | | Credits Assigned | | |
| **EEDO7013** | **Internet of Things** | Theory | Pract./Tut. | Theory | Pract./Tut. | Total |
| | | **3** | **--** | **3** | | **3** |

| Course Code | Course Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory | | | | | Term Work | Pract/ Oral | Total |
| | | Internal Assessment | | | End Sem. Exam | Exam Duration (in Hrs) | | | |
| | | Test 1 | Test 2 | Avg | | | | | |
| **EEDO7013** | **Internet of Things** | **20** | **20** | **20** | **80** | **3** | **-** | **-** | **100** |

| | |
|---|---|
| **Course Objectives** | To provide overview of internet-of-things technologies, hardware, operating systems, networking, security and databases aspects. |
| **Course outcomes** | **Upon successful completion of this course, the learner will be able to:**<br>1. Understand the concept of IOT<br>2. Illustrate IOT architecture and applications in various fields<br>3. Demonstrate use Devices, Gateways and Data Management in IoT.<br>4. Describe the security and privacy issues in IOT.<br>5. Understand emerging technological options, platforms and case studies of IoT implementation in home & city automation. |

| Module | Contents | Hours |
|---|---|---|
| 1 | **Introduction to IoT:**<br>Defining IoT, Characteristics of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Sources of IoT; Sensing, Actuation, Basics of Networking; Software Architectures and Software Interoperability, Privacy and Security | 06 |
| 2 | **IoT Architecture:**<br>Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views. Real-World Design Constraints- Introduction, Technical Design constraints, Data representation and visualization, Interaction and remote control. | 06 |
| 3 | **Hardware Platforms:**<br>Operating Systems, Time Synchronization, Positioning and Localization, Medium Access Control, Topology and Coverage Control, Routing: Transport Protocols, Network Security, Middleware, Databases. IOT Physical Devices & Endpoints: | 06 |
| 4 | **Networking and Communication Protocols:**<br>Cloud based IoT platforms, Zigbee and Zwave, advantage of low power mesh networking. Long distance Zigbee; Bluetooth/BLE: Low power vs high power, speed of detection, class of BLE. Wireless protocols such as Piconet and packet structure for BLE and Zigbee.<br>Web Communication Protocols for connected devices, Web connectivity using Gateway, SOAP, REST, HTTP, RESTful and WebSockets (Publish –Subscribe),MQTT, AMQP, CoAP Protocols | 10 |
| 5 | **Introduction to Mobile App platform for IoT:**<br>Protocol stack of Mobile app for IoT, Mobile to server integration. | 04 |
| 6 | **IoT Applications:**<br>Fog Computing, eHealth, Smart Cities and Smart Homes, Connected Vehicles, Smart Grid; Industrial IoT: Case Study: Agriculture, Healthcare, Activity Monitoring. | 07 |

| | | |
|---|---|---|
| | Introduction to Programming and Integration of Sensors / Actuators with IoT platform using Arduino, Raspberry Pi. | |

**Text /Reference Books:-**


1. Vijay Madisetti and Arshdeep Bahga, "Internet of Things (A Hands-on-Approach)", 1st Edition, VPT, 2014.
2. S. Misra, A. Mukherjee, and A. Roy, Introduction to IoT. Cambridge University Press, 2020.
3. S. Misra, C. Roy, and A. Mukherjee, Introduction to Industrial Internet of Things and Industry 4.0. CRC Press. 2020.
4. Adrian McEwen, Hakim Cassimally Designing the Internet of Things , John Wiley, 2014
5. Francis daCosta, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", 1st Edition, Apress Publications, 2013.
6. CunoPfister, "Getting Started with the Internet of Things", OReilly Media, 2011
7. A. McEwen, H. Cassimally, "Designing the Internet of Things", Wiley, 2013.
8. Samuel Greenguard, "Internet of Things", MIT Press, 2015.
9. Mandler, B., Barja, J., Mitre Campista, M.E., Cagáová, D., Chaouchi, H., Zeadally, S., Badra, M., Giordano, S., Fazio, M., Somov, A., Vieriu, R.-L., Internet of Things. IoT Infrastructures, Springer International Publishing
10. Olivier Hersent, David Boswarthick, Omar Elloumi, The Internet of Things: Key Applications and Protocols, Wiley-Blackwell.
11. Internet of things (IoT): Technologies, Applications, Challenges, and Solutions Edited by B.K. Tripathy J. Anuradha, CRC Press, 2018


**Web Reference /Video Courses**

1. **NPTEL Course:** Introduction to Internet of Things By Prof. Sudip Misra, IIT Kharagpur

**Assessment:**

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

**Theory Examination**:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be randomly selected from all the modules

| ELECTRICAL ENGINEERING - SEMESTER-VII | | | | | | |
|---|---|---|---|---|---|---|
| Course Code | Course Name | Teaching scheme (Contact Hours) | | Credits Assigned | | |
| **EEDO7014** | **Digital Signal Processors and Applications** | Theory | Pract./Tut. | Theory | Pract./Tut. | Total |
| | | **3** | **--** | **3** | | **3** |

| Course Code | Course Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory | | | | | Term Work | Pract/ Oral | Total |
| | | Internal Assessment | | | End Sem. Exam | Exam Duration (in Hrs) | | | |
| | | Test 1 | Test 2 | Avg | | | | | |
| **EEDO7014** | **Digital Signal Processors and Applications** | **20** | **20** | **20** | **80** | **3** | **-** | **-** | **100** |

| | |
|---|---|
| **Course Objectives** | 1. To introduce digital signal processors (DSP) architecture, its specifications, functionalities and programming for simple applications.<br>2. To introduce the numerical integration techniques and its use in implementation of digital compensator<br>3. To introduce various applications of DSPs in power system and power electronics and their practical design aspects. |
| **Course outcomes** | **Upon successful completion of this course, the learner will be able to:**<br>1. To identify and describe DSP/DSC architecture and its features along with number representation used.<br>2. To write a program code for DSP for simple applications<br>3. To compare and evaluate various numerical integration methods used for digital control implementation.<br>4. To model, analyze and design various compensators for converter/ inverter control<br>5. To understand various applications of DSP in power electronics and power systems<br>6. To design solar PV systems for various modes of operation. |

| Module | Contents | Hours |
|---|---|---|
| 1 | Introduction<br>Digital signal processors (DSP) and digital signal controller (DSC) architectures; Fixed and floating-point processors, Fixed point and floating point number representations. Review of commonly used DSPs/DSCs in power and control applications, Introductions to TMS320C2000 processors | 05 |
| 2 | DSP/DSC Architecture, Peripherals and Programming:<br>DSP/DSC Architecture, peripherals Overview of TMS320C2000 DSC family – Features, Architecture, Memory map, Clock system- Digital I/O -CPU Timers, Analog to Digital Converter (ADC), Pulse Width Modulator (PWM) Capture Module, Quadrature Encoder Pulse Module and communication ports. Programming: assembler, linker processes, code structure, Code Composer Studio (CCS), Programming for: generation of PWM, Sine PWM, measurement of AC/ DC voltage/ currents, use of CPU timers and Digital I/Os | 08 |
| 3 | Mathematical tools for Real Time DSP implementation:<br>Review of numerical integration: Euler's implicit and explicit method, Heun's Method, Trapezoidal Method. Implementation of digital filters and transformations | 05 |
| 4 | Digital Controller Design:<br>Modeling buck, boost converter and 3 phase inverter with LC filter, Design of compensators voltage and current mode, control for their closed loop applications. Design of PI, Type II and Type III controllers. | 07 |

| | | |
|---|---|---|
| 5 | Applications in Power Systems and Power Electronics:<br>Implementation of Active filters in DSP/DSC under balanced and unbalanced condition, harmonic oscillator and 3 phase lock loop, Static VAR Compensator, Speed control of Induction motor. | 10 |
| 6 | DSP based System Design:<br>Design of a DSP controlled Solar PV based Converter/Inverter system for standalone and grid connected modes. | 04 |

Reference Books:-


1. Digital Signal Processing in Power Electronics Control Circuits By Krzysztof Sozanski, Springer
2. Digital Signal Processing in Power System Protection and Control By Waldemar Rebizant, Janusz Szafran, and Andrzej Wiszniewski, Springer.
3. Digital Power Electronics and Applications By Fang Lin Luo, Hong Ye and Muhammad Rashid, Elsevier Academic Press.
4. Digital Signal Processing in Power Electronics Control Circuits By Krzysztof Sozanski, Springer
5. Power Electronics, Converters, Applications & Design by N.Mohan, T.M.Undeland, W.P Robbins, Wiley India Pvt. Ltd.
6. Modern Power Electronics and AC Drives by B. K Bose, Pearson Education
7. DSP Based Electromechanical Motion Control by Hamid Toliyat and Steven Campbell, CRC Press


Web Reference /Video Courses

Texas Instruments Website:

1. https://www.ti.com/microcontrollers-mcus-processors/microcontrollers/c2000-real-time-control-mcus/overview.html
2. https://training.ti.com/c2000-workshops

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be randomly selected from all the modules

| ELECTRICAL ENGINEERING - SEMESTER-VII | | | | | | |
|---|---|---|---|---|---|---|
| Course Code | Course Name | Teaching scheme (Contact Hours) | | Credits Assigned | | |
| **EEDO7021** | **Microgrid and Smart-grid** | Theory | Pract./Tut. | Theory | Pract./Tut. | Total |
| | | **3** | **--** | **3** | | **3** |

| Course Code | Course Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory | | | | | Term Work | Pract/ Oral | Total |
| | | Internal Assessment | | | End Sem. Exam | Exam Duration (in Hrs) | | | |
| | | Test 1 | Test 2 | Avg | | | | | |
| **EEDO7021** | **Microgrid and Smart-grid** | **20** | **20** | **20** | **80** | **3** | **-** | **-** | **100** |

| | |
|---|---|
| **Course Objectives** | 1. To introduce the fundamental concept, various power architectures and control of distributed generation and microgrids.<br>2. To review various regulatory standards and state of the art of microgrids<br>3. To understand the microgrid and Smart Grid deployments for large scale integration of clean energy sources, various technologies, automation and ICT infrastructure requirements. |
| **Course outcomes** | **Upon successful completion of this course, the learner will be able to:**<br>1. To identify and describe the impact of renewable energy integration for mitigating energy crises and sustainable future.<br>2. To identify and describe the concept of Microgrid and its various topologies, modes of operation control and communication architecture.<br>3. To identify and describe the concept of Smart Grid, its features and the state of the art.<br>4. To understand various Smart Grid technologies, automation, resiliency and its adoption in current power system**.** |

| Module | Contents | Hours |
|---|---|---|
| 1 | **Introduction:**<br>Energy crises and sustainable alternatives, review of conventional and non-conventional energy sources and power generation; Comparison of renewable technologies: Solar Photovoltaics, Wind Energy systems, Fuel Cells, micro-turbines, biomass, and tidal sources. Impact of grid integration of renewable energy resources on existing power system: reliability, stability and power quality issues | 05 |
| 2 | **Distributed Generations (DG) and Microgrids:** .<br>DG topologies, regulatory standards/ framework: IEEE 1547 series, Limits on operational parameters: voltage, frequency, THD, response to grid abnormal operating conditions, islanding issues; Concept of microgrid, review of sources of microgrids, typical structure and configuration of a microgrid, AC and DC Microgrids;<br>Control architectures of microgrids: Centralised, decentralised and hierarchical control. Local and system level control functionalities; basics of Power sharing and coordinated control of microgrids | 08 |
| 3 | **Power Conditioning Units (PCUs) for Microgrid Sources:**<br>PCUs in DC and AC microgrids, modes of operation and control of PCUs: Voltage mode control, current mode control. Microgrid functions: black-start and grid synchronisation. | 05 |
| 4 | **Microgrid operations and islanding:**<br>Grid connected and islanded mode, Active and reactive power control, protection issues, anti-islanding schemes: passive, active and communication based techniques. Role of energy Storage in Microgrid operations and stability | 07 |
| 5 | **Introduction to Smart-Grid:**<br>Concept of Smart-Grid, Definitions, Need of Smart-Grid, Functions of Smart-Grid, Opportunities & Barriers of Smart Grid, Concept of Resilient & Self-Healing Grid, Microgrids role in smart-grid scenario. | 07 |

| | | |
|---|---|---|
| | *Review of Smart Grid Technologies:* Introduction to Smart Meters, Real Time Prizing, Smart Appliances, Automatic Meter Reading(AMR), EV (Vehicle to Grid). | |
| 6 | **Smart Grid Operations and Automation:** Smart Substations, Substation Automation, Feeder Automation. Intelligent Electronic Devices(IED) & their application for monitoring & protection, Wide Area Measurement System(WAMS), Phase Measurement Unit(PMU) *Communication Network for Microgrids & Smart Grid:* Home Area Network (HAN), Wide Area Network (WAN), Bluetooth, ZigBee, , Wireless Mesh Network, Cyber Security for Smart Grid. | 07 |

**Text Books :**


1. Microgrids architectures and control Edited by Nikos Hatziargyriou, Wiley, IEEE Press, 2014
2. A. Keyhani, M. N. Marwali, M. Dai, Integration of Green and Renewable Energy in Electric Power Systems, Wiley, 2009
3. Antonio Carlos Zambroni de Souza, Miguel Castilla, Microgrids Design and Implementation, Springer 2019


Reference Books:-


1. Yezdani, and Reza Iravani, Voltage Source Converters in Power Systems: Modeling, Control and Applications, John Wiley Publications, 2010
2. Dorin Neacsu, Power Switching Converters: Medium and High Power, CRC Press, 2006
3. B. M. Buchholz and Z. Styczynski, Smart Grids – Fundamentals and Technologies in Electricity Networks, Springer, 2014
4. C. W. Gellings, The Smart Grid: Enabling Energy Efficiency and Demand Response, CRC Press, 2009
5. J. Ekanayake, N. Jenkins, K. Liyanage, J. Wu, A. Yokoyama, Smart Grid: Technology and Applications, Wiley, 2012
6. J. C. Sabonnadière and N. Hadjsaïd, Smart Grids, John Wiley & Sons and ISTE, 2012
7. IEEE standards —IEEE-1547-2003: IEEE Standard for Interconnecting Distributed Resources with Electric Power Systems IEEE standards 2003
8. IEEE standards —IEEE 1547-4-2011: IEEE Guide for Design Operation & Integration of Distributed Resources Island System with Electric Power System,
9. Consortium for Electric Reliability Technology Solutions (CERTS) white paper on Integration of Distributed Energy Resources: The CERTS Microgrid Concept' 2002


Web Reference /Video Courses

1. NPTEL Course: DC Microgrid and Control System, Prof. Avik Bhattacharya, IIT Roorkee
2. NPTEL Course: Introduction to Smart Grid, By Prof. N. P. Padhy & Prof. Premalata Jena, IIT Roorkee

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be randomly selected from all the modules

| ELECTRICAL ENGINEERING - SEMESTER-VII | | | | | | |
|---|---|---|---|---|---|---|
| Course Code | Course Name6 | Teaching scheme (Contact Hours) | | Credits Assigned | | |
| **EEDO7022** | **Power System Dynamics and Control** | Theory | Pract./Tut. | Theory | Pract./Tut. | Total |
| | | **3** | **--** | **3** | | **3** |

| Course Code | Course Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory | | | | | Term Work | Pract/ Oral | Total |
| | | Internal Assessment | | | End Sem. Exam | Exam Duration (in Hrs) | | | |
| | | Test 1 | Test 2 | Avg | | | | | |
| **EEDO7022** | **Power System Dynamics and Control** | **20** | **20** | **20** | **80** | **3** | **-** | **-** | **100** |

| | |
|---|---|
| **Course Objectives** | 1. To understand fundamental concepts & classification of power system stability.<br>2. To analyze theory and practice of modelling main power system components, such as synchronous machines, excitation systems.<br>3. Analyze the performance of the system with small signal analysis.<br>4. To explore voltage stability concepts in power stability studies. |
| **Course outcomes** | **Upon successful completion of this course, the learner will be able to:**<br>1. Explain the dynamic models of power system components.<br>2. Analyze the performance of the system with small signal analysis.<br>3. Choose the fundamental dynamic behavior and controls of power systems to perform basic stability analysis.<br>4. Select the appropriate model depending on the analysis to be done. |

| Module | Contents | Hours |
|---|---|---|
| 1 | **Introduction to Power System Stability Problem:**<br>Rotor angle stability, voltage stability, voltage collapse, Mid- term and Long- term stability, classification of stability | 03 |
| 2 | **Synchronous Machine Modeling and Representation:**<br>Basic equations of synchronous machine, dqo transformation, Per unit- voltage- flux- torque- power equations and reactance, Equivalent circuit d-q axis, Voltage current flux linkage relation- phasor representation- rotor angle-steady state equivalent circuit. Three phase short circuit, Magnetic saturation and representation Simplifications for large scale studies, Constant flux linkage model. | 12 |
| 3 | **Excitation System:**<br>Excitation system requirement, Elements of excitation system, Types of excitation system, Dynamic performance measures, Control and protective functions in modern excitation control system. | 04 |
| 4 | **Small Signal Stability:**<br>Fundamental concept of stability of dynamic system, Eigen properties of state matrix, SSS of single machine infinite bus system, Effect of AVR on synchronizing and damping torque, Power system stabilizer. | 12 |
| 5 | **Voltage Stability:**<br>Basic concepts, Voltage collapse, Voltage stability analysis, Prevention of voltage collapse. | 04 |
| 6 | **Method of Improving Stability:**<br>Transient system enhancement methods, Small signal stability enhancement method | 04 |

Text Books/ Reference Books:-

1. Prabha Kundur , Power System Stability and Control , TMH Publication,2008
2. K. R. PADIYAR," Power system dynamics "- B.S. Publications
3. P.M. Anderson and A. A. Fouad, "Power system control and stability", IEEE Press
4. Kimbark E W, Power System Stability, Volume I, III, Wiley publication.
5. Anderson P.M, Fouad A.A, Power System Control and Stability, Wiley Inter-Science, 2008 Edition

Web Reference /Video Courses

1. NPTEL Course: Power System Dynamics and Control, Dr. A.M. Kulkarni, IIT Bombay
2. NPTEL Course: Power System Dynamics, Control and Monitoring, By Prof. Debapriya Das, IIT Kharagpur
3. NPTEL Course: Power System Dynamics, Dr. M.L. Kothari, IIT Delhi

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be randomly selected from all the modules

| ELECTRICAL ENGINEERING - SEMESTER-VII | | | | | | |
|---|---|---|---|---|---|---|
| Course Code | Course Name | Teaching scheme (Contact Hours) | | Credits Assigned | | |
| **EEDO7023** | **Artificial Intelligence and Machine Learning** | Theory | Pract./Tut. | Theory | Pract./Tut. | Total |
| | | **3** | **--** | **3** | | **3** |

| Course Code | Course Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory | | | | | Term Work | Pract/ Oral | Total |
| | | Internal Assessment | | | End Sem. Exam | Exam Duration (in Hrs) | | | |
| | | Test 1 | Test 2 | Avg | | | | | |
| **EEDO7023** | **Artificial Intelligence and Machine Learning** | **20** | **20** | **20** | **80** | **3** | **-** | **-** | **100** |

| | |
|---|---|
| **Course Objectives** | 1. To learn the ability of selecting suitable artificial intelligence and machine learning techniques for data handling and to gain knowledge from it.<br>2. To evaluate the performance of algorithms and to provide solutions for various real-world applications. |
| **Course outcomes** | **Upon successful completion of this course, the learner will be able to:**<br>1. To develop a basic understanding of artificial intelligence building blocks and analyze whether a problem can be solved using artificial intelligence techniques<br>2. To understand the fundamental concepts of neural networks, different neural network architectures, algorithms, applications and their limitations.<br>3. To formulate and identify machine learning techniques suitable for a given problem<br>4. To develop and apply regression algorithms for finding relationships between data variables.<br>5. To develop and apply pattern classification algorithms to classify multivariate data and demonstrate the usefulness of reinforcement learning and deep learning for controlling complex systems.<br>6. To create solutions to real-world electrical engineering problems using artificial intelligence and machine learning. |

| Module | Contents | Hours |
|---|---|---|
| 1 | Introduction to Artificial Intelligence:<br>Introduction to artificial intelligence; Application areas of artificial intelligence; State space search: Depth first search, Breadth first search; Heuristic search: Best first search, Hill Climbing, Beam Search. | 4 |
| 2 | Artificial Neural Networks:<br>Biological Neurons and Biological Neural Networks, Artificial Neural Networks Models, Activation Functions, Perceptrons, Representation Power, Training Rule, Gradient Descent, and the Delta Rule, Multilayer networks and the Back Propagation algorithm, Convergence and Local Minima, Feedforward networks, Inductive Bias, Hidden Layer, Generalization, Overfitting, and Stopping Criterion | 8 |
| 3 | Introduction to Machine Learning:<br>Towards Intelligent Machines, Machine Learning Problems, Data Representation, Diversity of Data: Structured/Unstructured, Forms of Learning, Machine Learning and Data Mining, Basic Linear Algebra in Machine Learning Techniques | 3 |
| 4 | Supervised and Statistical Learning:<br>Bias and Variance, Metrics for Assessing Regression (Numeric Prediction) Accuracy, Metrics for Assessing Classification (Pattern Recognition) Accuracy, Descriptive Statistics in Learning Techniques, Bayesian Reasoning: A Probabilistic Approach to Inference, k-Nearest Neighbor | 10 |

| | | |
|---|---|---|
| | (k-NN) Classifier, Discriminant Functions and Regression Functions, Linear Regression with Least Square Error Criterion, Logistic Regression for Classification Tasks, Regression by Support Vector Machines, Decision Trees, Overfitting and Regularization | |
| 5 | Data Clustering and Data Transformations:<br>Unsupervised Learning, Overview of Basic Clustering Methods, K-Means Clustering, Data Cleansing, Derived Attributes, Discretizing Numeric Attributes, Attribute Reduction Techniques, Principal Components Analysis (PCA) for Attribute Reduction<br>Introduction to Advance Machine Learning: Introduction, Need and Model of Reinforcement Learning and Deep Learning | 8 |
| 6 | Application of Artificial Intelligence in Electrical Engineering:<br>Voltage control, Protection System, Static Security Assessment, Condition Monitoring, Schedule Maintenance of Electrical Power Transmission Networks<br>Application of Machine Learning in Electrical Engineering:<br>Load forecasting, Voltage stability assessment, Demand Side Management, Predicting User Preference, Load Pattern Classification, Wind speed forecasting. | 6 |

Text Books:


1. Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, 2nd Edition, Pearson Education
2. S. Rajasekaran and G. A. Vijayalakshmi Pai, Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis and Applications, PHI.
3. M. Gopal, Applied Machine Learning, McGraw Hill
4. Kevin Warwick, Arthur O. Ekwue, Raj Aggarwal, Artificial Intelligence Techniques in Power Systems, Institution of Electrical Engineers, 1997
5. Morteza, Somayeh, Mohammadi, Moloud, Milad, Application of Machine Learning and Deep Learning Methods to Power System Problems, Springer, 2022


Reference Books:


1. J. Zurada, Introduction to Artificial Neural Systems, Jaico Publishing House
2. Tom Mitchell, Machine Learning, TMH
3. Harrington, Peter. Machine learning in action. Simon and Schuster, 2012.
4. Bishop, Christopher M., and Nasser M. Nasrabadi. Pattern recognition and machine learning. Vol. 4, no. 4. New York: springer, 2006.
5. Athem Ealpaydin, Introduction to Machine Learning, PHI
6. C. Bishop, Neural Networks for Pattern Recognition, Oxford University Press.
7. Ajay Kumar Vyas, Harsh S. Dhiman, Kamal Kant Hiran, S. Balamurugan, Artificial Intelligence for Renewable Energy Systems, WIley, 2022


Web Reference /Video Courses

1. NPTEL Course: Artificial Intelligence: Search Methods for Problem Solving, Prof. Deepak Khemani, IIT Madras
2. NPTEL Course: Introduction to Machine Learning, Prof. S. Sarkar, IIT Kharagpur

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be randomly selected from all the modules

| ELECTRICAL ENGINEERING - SEMESTER-VII | | | | | | |
|---|---|---|---|---|---|---|
| Course Code | Course Name | Teaching scheme (Contact Hours) | | Credits Assigned | | |
| **EEDO7024** | **Electrical Machine Design** | Theory | Pract./Tut. | Theory | Pract./Tut. | Total |
| | | **3** | **--** | **3** | | **3** |

| Course Code | Course Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory | | | | | Term Work | Pract/ Oral | Total |
| | | Internal Assessment | | | End Sem. Exam | Exam Duration (in Hrs) | | | |
| | | Test 1 | Test 2 | Avg | | | | | |
| **EEDO7024** | **Electrical Machine Design** | **20** | **20** | **20** | **80** | **3** | **-** | **-** | **100** |

| | |
|---|---|
| **Course Objectives** | 1. To explore the design philosophies adopted in design of electrics machines and transformers<br>2. To introduce software tools used in design of electrics machines and transformers |
| **Course outcomes** | **Upon successful completion of this course, the learner will be able to:**<br>1. Understand the construction and performance characteristics of electrical machines.<br>2. Understand the various factors which influence the design: electrical, magnetic and thermal loading of electrical machines<br>3. Understand the principles of electrical machine design and carry out a basic design of an ac machine.<br>4. Use software tools to do electrical machine design calculations. |

| Module | Contents | Hours |
|---|---|---|
| 1 | Introduction:<br>Major considerations in electrical machine design, electrical engineering materials, space factor, choice of specific electrical and magnetic loadings, thermal considerations, heat flow, temperature rise, rating of machines. | 04 |
| 2 | Transformers:<br>Sizing of a transformer, main dimensions, kVA output for single- and three-phase transformers, window space factor, overall dimensions, operating characteristics, regulation, no load current, temperature rise in transformers, design of cooling tank, methods for cooling of transformers | 07 |
| 3 | Induction Motors:<br>Sizing of an induction motor, main dimensions, length of air gap, rules for selecting rotor slots of squirrel cage machines, design of rotor bars & slots, design of end rings, design of wound rotor, magnetic leakage calculations, leakage reactance of poly-phase machines, magnetizing current, short circuit current, circle diagram, operating characteristics | 10 |
| 4 | Synchronous Machines:<br>Sizing of a synchronous machine, main dimensions, design of salient pole machines, short circuit ratio, shape of pole face, armature design, armature parameters, estimation of air gap length, design of rotor, design of damper winding, determination of full load field mmf, design of field winding, design of turbo alternators, rotor design. | 10 |
| 5 | Machines for special Applications:<br>Introduction to structures of modern machines-PMSMs, BLDCs, SRM and claw-pole machines; Sizing of motors for Electric Vehicles, design of EV grade Induction motor. | 04 |
| 6 | Computer aided Design (CAD):<br>Limitations (assumptions) of traditional designs, need for CAD analysis, synthesis and hybrid methods, design optimization methods, variables, constraints and objective function, problem formulation. Introduction to FEM based machine design. | 04 |

Text/ Reference Books:-


1. A. K. Sawhney, A Course in Electrical Machine Design, Dhanpat Rai and Sons, 1970.
2. M.G. Say, Theory & Performance & Design of A.C. Machines, ELBS London.
3. S. K. Sen, Principles of Electrical Machine Design with computer programmes, Oxford and IBH Publishing, 2006.
4. K. L. Narang, A Text Book of Electrical Engineering Drawings, Satya Prakashan, 1969.
5. Shanmugasundaram, G. Gangadharan and R. Palani, Electrical Machine Design Data Book, New Age International, 1979.
6. K. M. V. Murthy, Computer Aided Design of Electrical Machines, B.S. Publications, 2008.
7. Electrical machines and equipment design exercise examples using Ansoft's Maxwell 2D machine design package.


Web Reference /Video Courses

1. NPTEL Course: Modelling and Analysis of Electric Machines, Dr. Krishna Vasudevan, IIT Madras
2. NPTEL Course: Electrical Equipment and Machines: Finite Element Analysis By Prof. S. V. Kulkarni, IIT Bombay

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be randomly selected from all the modules

| ELECTRICAL ENGINEERING - SEMESTER-VII | | | | | | |
|---|---|---|---|---|---|---|
| Course Code | Course Name | Teaching scheme (Contact Hours) | | Credits Assigned | | |
| **EEIO7011** | **Product Life Cycle Management** | Theory | Pract./Tut. | Theory | Pract./Tut. | Total |
| | | **3** | **--** | **3** | **--** | **3** |

| Course code | Course Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory | | | | | Term Work | Oral | Total |
| | | Internal Assessment | | | End Sem. Exam | Exam Duration (in Hrs) | | | |
| | | Test 1 | Test 2 | Avg | | | | | |
| **EEIO7011** | **Product Life Cycle Management** | **20** | **20** | **20** | **80** | 3 | **--** | **--** | **100** |

| | |
|---|---|
| **Course Objectives** | 1.To familiarize the students with the need, benefits and components of PLM<br>2.To acquaint students with Product Data Management & PLM strategies<br>3. To give insights into new product development program and guidelines for designing and developing a product<br>4. To familiarize the students with Virtual Product Development |
| **Course Outcomes** | Upon successful completion of this course, the learner will be able to:<br>1. Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.<br>2. Illustrate various approaches and techniques for designing and developing products.<br>3. Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc.<br>4. Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant |

| Module | Contents | Hours |
|---|---|---|
| 1 | **Introduction to Product Lifecycle Management (PLM):**<br>Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications<br>**PLM Strategies:** Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy, Change management for PLM | 10 |
| 2 | **Product Design:**<br>Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process | 09 |

| | | |
|---|---|---|
| 3 | **Product Data Management (PDM):**<br>Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation | 05 |
| 4 | **Virtual Product Development Tools:**<br>For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies | 05 |
| 5 | **Integration of Environmental Aspects in Product Design:**<br>Sustainable Development, Design for Environment, Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design | 05 |
| 6 | **Life Cycle Assessment and Life Cycle Cost Analysis:**<br>Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis | 05 |

**References:**


1. John Stark, "Product Lifecycle Management: Paradigm for 21st Century Product Realisation", Springer-Verlag, 2004. ISBN: 1852338105
2. Fabio Giudice, Guido La Rosa, Antonino Risitano, "Product Design for the environment-A life cycle approach", Taylor & Francis 2006, ISBN: 0849327229
3. Saaksvuori Antti, Immonen Anselmie, "Product Life Cycle Management", Springer, Dreamtech, ISBN: 3540257314
4. Michael Grieve, "Product Lifecycle Management: Driving the next generation of lean thinking", Tata McGraw Hill, 2006, ISBN: 0070636265


**Assessment:**

**Internal Assessment for 20 marks:** Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

**End Semester Examination:**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

| ELECTRICAL ENGINEERING - SEMESTER-VII | | | | | | |
|---|---|---|---|---|---|---|
| Course Code | Course Name | Teaching scheme (Contact Hours) | | Credits Assigned | | |
| **EEIO7012** | **Reliability Engineering** | Theory | Pract./Tut. | Theory | Pract./Tut. | Total |
| | | **3** | **--** | **3** | **--** | **3** |

| Course code | Course Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory | | | | | Term Work | Oral | Total |
| | | Internal Assessment | | | End Sem. Exam | Exam Duration (in Hrs) | | | |
| | | Test 1 | Test 2 | Avg | | | | | |
| **EEIO7012** | **Reliability Engineering** | **20** | **20** | **20** | **80** | **3** | **--** | **--** | **100** |

| | |
|---|---|
| **Course Objectives** | 1. To familiarize the students with various aspects of probability theory<br>2. To acquaint the students with reliability and its concepts<br>3. To introduce the students to methods of estimating the system reliability of simple and complex systems<br>4. To understand the various aspects of Maintainability, Availability and FMEA procedure |
| **Course Outcomes** | Upon successful completion of this course, the learner will be able to:<br>1. Understand and apply the concept of Probability to engineering problems<br>2. Apply various reliability concepts to calculate different reliability parameters<br>3. Estimate the system reliability of simple and complex systems<br>4. Carry out a Failure Mode Effect and Criticality Analysis |

| Module | Contents | Hours |
|---|---|---|
| 1 | **Probability theory:** Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem.<br>**Probability Distributions:** Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance.<br>**Measures of Dispersion:** Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis. | 08 |
| 2 | **Reliability Concepts:** Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve.<br>**Failure Data Analysis:** Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions.<br>**Reliability Hazard Models:** Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis. | 08 |
| 3 | **System Reliability:**<br>System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems. | 05 |
| 4 | **Reliability Improvement:**<br>Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis.<br>System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method. | 08 |
| 5 | **Maintainability and Availability:**<br>System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. Availability – qualitative aspects. | 05 |

| | | |
|---|---|---|
| 6 | **Failure Mode, Effects and Criticality Analysis:**<br>Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fau1t tree analysis and Event tree Analysis | 05 |

**References:**


1. L.S. Srinath, "Reliability Engineering", Affiliated East-Wast Press (P) Ltd., 1985.
2. Charles E. Ebeling, "Reliability and Maintainability Engineering", Tata McGraw Hill.
3. B.S. Dhillion, C. Singh, "Engineering Reliability", John Wiley & Sons, 1980.
4. P.D.T. Conor, "Practical Reliability Engg.", John Wiley & Sons, 1985.
5. K.C. Kapur, L.R. Lamberson, "Reliability in Engineering Design", John Wiley & Sons.
6. Murray R. Spiegel, "Probability and Statistics", Tata McGraw-Hill Publishing Co. Ltd


**Assessment:**

**Internal Assessment for 20 marks:**

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

**End Semester Examination:**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

| ELECTRICAL ENGINEERING - SEMESTER-VII | | | | | | |
|---|---|---|---|---|---|---|
| Course Code | Course Name | Teaching scheme (Contact Hours) | | Credits Assigned | | |
| **EEIO7013** | **Management Information System** | Theory | Pract./Tut. | Theory | Pract./Tut. | Total |
| | | **3** | **--** | **3** | **--** | **3** |

| Course code | Course Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory | | | | | Term Work | Oral | Total |
| | | Internal Assessment | | | End Sem. Exam | Exam Duration (in Hrs) | | | |
| | | Test 1 | Test 2 | Avg | | | | | |
| **EEIO7013** | **Management Information System** | **20** | **20** | **20** | **80** | **3** | **--** | **--** | **100** |

| | |
|---|---|
| **Course Objectives** | 1. The course is blend of Management and Technical field.<br>2. Discuss the roles played by information technology in today's business and define various technology architectures on which information systems are built<br>3. Define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage<br>4. Identify the basic steps in systems development |
| **Course Outcomes** | Upon successful completion of this course, the learner will be able to:<br>1. Explain how information systems Transform Business<br>2. Identify the impact information systems have on an organization<br>3. Describe IT infrastructure and its components and its current trends<br>4. Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making<br>5. Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses |

| Module | Contents | Hours |
|---|---|---|
| 1 | **IntroductiontTo Information Systems (IS):**<br>Computer Based Information Systems, Impact of IT on organizations, Importance of IS to Society. Organizational Strategy, Competitive Advantages and IS | 04 |
| 2 | **Data and Knowledge Management:** Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management<br>**Business intelligence (BI):** Managers and Decision Making, BI for Data analysis and Presenting Results | 07 |
| 3 | **Ethical issues and Privacy:**<br>Information Security. Threat to IS, and Security Controls | 07 |
| 4 | **Social Computing (SC):**<br>Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce – B2B B2C. Mobile commerce. | 07 |
| 5 | **Computer Networks** Wired and Wireless technology, Pervasive computing, Cloud computing model. | 06 |
| 6 | **Information System within Organization:**<br>Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process. | 08 |

| | | |
|---|---|---|
| | Acquiring Information Systems and Applications: Various System development life cycle models. | |

**References:**


1. Kelly Rainer, Brad Prince, Management Information Systems, Wiley
2. K.C. Laudon and J.P. Laudon, Management Information Systems: Managing the Digital Firm, 10th Ed., Prentice Hall, 2007.
3. D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization, Prentice Hall, 2008


**Assessment:**

**Internal Assessment for 20 marks:**

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

**End Semester Examination:**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

| ELECTRICAL ENGINEERING - SEMESTER-VII | | | | | | |
|---|---|---|---|---|---|---|
| Course Code | Course Name | Teaching scheme (Contact Hours) | | Credits Assigned | | |
| **EEIO7014** | **Design of Experiments** | Theory | Pract./Tut. | Theory | Pract./Tut. | Total |
| | | **3** | **--** | **3** | **--** | **3** |

| Course code | Course Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory | | | | | Term Work | Oral | Total |
| | | Internal Assessment | | | End Sem. Exam | Exam Duration (in Hrs) | | | |
| | | Test 1 | Test 2 | Avg | | | | | |
| **EEIO7014** | **Design of Experiments** | **20** | **20** | **20** | **80** | **3** | **--** | **--** | **100** |

| | |
|---|---|
| **Course Objectives** | 1. To understand the issues and principles of Design of Experiments (DOE)<br>2. To list the guidelines for designing experiments<br>3. To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization |
| **Course Outcomes** | Upon successful completion of this course, the learner will be able to:<br>1. Plan data collection, to turn data into information and to make decisions that lead to appropriate action<br>2. Apply the methods taught to real life situations<br>3. Plan, analyze, and interpret the results of experiments |

| Module | Contents | Hours |
|---|---|---|
| 1 | **Introduction**<br>1.1 Strategy of Experimentation<br>1.2 Typical Applications of Experimental Design<br>1.3 Guidelines for Designing Experiments<br>1.4 Response Surface Methodology | 06 |
| 2 | **Fitting Regression Models**<br>2.1 Linear Regression Models<br>2.2 Estimation of the Parameters in Linear Regression Models<br>2.3 Hypothesis Testing in Multiple Regression<br>2.4 Confidence Intervals in Multiple Regression<br>2.5 Prediction of new response observation<br>2.6 Regression model diagnostics<br>2.7 Testing for lack of fit | 08 |
| 3 | **Two-Level Factorial Designs**<br>3.1 The $2^2$ Design<br>3.2 The $2^3$ Design<br>3.3 The General$2^k$ Design<br>3.4 A Single Replicate of the $2^k$ Design<br>3.5 The Addition of Center Points to the $2^k$ Design,<br>3.6 Blocking in the $2^k$ Factorial Design<br>3.7 Split-Plot Designs | 07 |

| | | |
|---|---|---|
| 4 | **Two-Level Fractional Factorial Designs**<br>4.1 The One-Half Fraction of the $2^k$ Design<br>4.2 The One-Quarter Fraction of the $2^k$ Design<br>4.3 The General $2^{k-p}$ Fractional Factorial Design<br>4.4 Resolution III Designs<br>4.5 Resolution IV and V Designs<br>4.6 Fractional Factorial Split-Plot Designs | 07 |
| 05 | **Response Surface Methods and Designs**<br>5.1 Introduction to Response Surface Methodology<br>5.2 The Method of Steepest Ascent<br>5.3 Analysis of a Second-Order Response Surface<br>5.4 Experimental Designs for Fitting Response Surfaces | 07 |
| 06 | **Taguchi Approach**<br>6.1 Crossed Array Designs and Signal-to-Noise Ratios<br>6.2 Analysis Methods<br>6.3 Robust design examples | 04 |

**References:**


1. Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3rd edition, John Wiley & Sons, New York, 2001
2. D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York, 2001
3. George E P Box, J Stuart Hunter, William G Hunter, Statics for Experimenters: Design, Innovation and Discovery, 2nd Ed. Wiley
4. W J Dimond, Practical Experiment Designs for Engineers and Scientists, John Wiley and Sons Inc. ISBN: 0-471-39054-2
5. Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T. Voss


**Assessment:**

**Internal Assessment for 20 marks:**

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

**End Semester Examination:**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

| ELECTRICAL ENGINEERING - SEMESTER-VII | | | | | | |
|---|---|---|---|---|---|---|
| Course Code | Course Name | Teaching scheme (Contact Hours) | | Credits Assigned | | |
| **EEIO7015** | **Operations Research** | Theory | Pract./Tut. | Theory | Pract./Tut. | Total |
| | | **3** | **--** | **3** | **--** | **3** |

| Course code | Course Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory | | | | | Term Work | Oral | Total |
| | | Internal Assessment | | | End Sem. Exam | Exam Duration (in Hrs) | | | |
| | | Test 1 | Test 2 | Avg | | | | | |
| **EEIO7015** | **Operations Research** | **20** | **20** | **20** | **80** | **3** | **--** | **--** | **100** |

| | |
|---|---|
| **Course Objectives** | 1. Formulate a real-world problem as a mathematical programming model.<br>2. Understand the mathematical tools that are needed to solve optimization problems.<br>3. Use mathematical software to solve the proposed models. |
| **Course Outcomes** | Upon successful completion of this course, the learner will be able to:<br>1. Understand the theoretical workings of the simplex method, the relationship between a linear program and its dual, including strong duality and complementary slackness.<br>2. Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change.<br>3. Solve specialized linear programming problems like the transportation and assignment problems, solve network models like the shortest path, minimum spanning tree, and maximum flow problems.<br>4. Understand the applications of integer programming and a queuing model and compute important performance measures |

| Module | Contents | Hours |
|---|---|---|
| 1 | **Introduction to Operations Research**: Introduction, Structure of the Mathematical Model, Limitations of Operations Research<br>**Linear Programming**: Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, Simplex Method Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, **Duality**, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis<br>**Transportation Problem**: Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method.<br>**Assignment Problem**: Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem<br>**Integer Programming Problem**: Introduction, Types of Integer Programming Problems, | 14 |

| | | |
|---|---|---|
| | Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms. | |
| 2 | **Queuing models**: queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population | 05 |
| 3 | **Simulation**: Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation | 05 |
| 4 | **Dynamic programming**. Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems. | 05 |
| 5 | **Game Theory**. Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games. | 05 |
| 6 | **Inventory Models**: Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model, | 05 |

**REFERENCES:**


1. Taha, H.A. "Operations Research - An Introduction", Prentice Hall, (7th Edition), 2002.
2. Ravindran, A, Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", John Willey and Sons, 2nd Edition, 2009
3. Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", Tata McGraw Hill, 2002.
4. Operations Research, S. D. Sharma, KedarNath Ram Nath-Meerut
5. Operations Research, KantiSwarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons


**Assessment:**

**Internal Assessment for 20 marks:**

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

**End Semester Examination:**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then, part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

| ELECTRICAL ENGINEERING - SEMESTER-VII | | | | | | |
|---|---|---|---|---|---|---|
| Course Code | Course Name | Teaching scheme (Contact Hours) | | Credits Assigned | | |
| **EEIO7016** | **Cyber Security and Laws** | Theory | Pract./Tut. | Theory | Pract./Tut. | Total |
| | | **3** | **--** | **3** | **--** | **3** |

| Course code | Course Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory | | | | | Term Work | Oral | Total |
| | | Internal Assessment | | | End Sem. Exam | Exam Duration (in Hrs) | | | |
| | | Test 1 | Test 2 | Avg | | | | | |
| **EEIO7016** | **Cyber Security and Laws** | **20** | **20** | **20** | **80** | **3** | **--** | **--** | **100** |

| | |
|---|---|
| **Course Objectives** | 1. To understand and identify different types cybercrime and cyber law<br>2. To recognized Indian IT Act 2008 and its latest amendments<br>3. To learn various types of security standards compliances |
| **Course Outcomes** | Upon successful completion of this course, the learner will be able to:<br>1. Understand the concept of cybercrime and its effect on outside world<br>2. Interpret and apply IT law in various legal issues<br>3. Distinguish different aspects of cyber law<br>4. Apply Information Security Standards compliance during software design and development |

| Module | Contents | Hours |
|---|---|---|
| 1 | **Introduction to Cybercrime:**<br>Cybercrime definition and origins of the world, Cybercrime and information security, Classifications of cybercrime, Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes. | 04 |
| 2 | **Cyber offenses & Cybercrime:**<br>How criminal plan the attacks, Social Engg, Cyber stalking, Cyber café and Cybercrimes, Botnets, Attack vector, Cloud computing, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Devices-Related Security Issues, Organizational Security Policies and Measures in Mobile Computing Era, Laptops | 09 |
| 3 | **Tools and Methods Used in Cyberline:**<br>Phishing, Password Cracking, Key loggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft) | 06 |
| 4 | **The Concept of Cyberspace** :<br>E-Commerce, The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law, The Intellectual Property Aspect in Cyber Law, The Evidence Aspect in Cyber Law , The Criminal Aspect in Cyber Law, Global Trends in Cyber Law , Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking , The Need for an Indian Cyber Law | 08 |
| 5 | **Indian IT Act:**<br>Cyber Crime and Criminal Justice: Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments | 06 |

| | | |
|---|---|---|
| 6 | **Information Security Standard compliances**<br>SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI. | 06 |

**REFERENCES:**


1. Nina Godbole, Sunit Belapure, *Cyber Security*, Wiley India, New Delhi
2. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi
3. The Information Technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi.
4. Cyber Law & Cyber Crimes by Advocate Prashant Mali; Snow White Publications, Mumbai
5. Nina Godbole, *Information Systems Security,* Wiley India, New Delhi
6. Kennetch J. Knapp, *Cyber Security* &*Global Information Assurance* Information Science Publishing.
7. William Stallings*, Cryptography and Network Security,* Pearson Publication
8. Websites for more information is available on: The Information Technology ACT, 2008- TIFR: https://www.tifrh.res.in
9. Website for more information: A Compliance Primer for IT professional: https://www.sans.org/reading-room/whitepapers/compliance/compliance-primerprofessionals-33538


**Assessment:**

**Internal Assessment for 20 marks:**

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

**End Semester Examination:**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then, part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

| ELECTRICAL ENGINEERING - SEMESTER-VII | | | | | | |
|---|---|---|---|---|---|---|
| Course Code | Course Name | Teaching scheme (Contact Hours) | | Credits Assigned | | |
| **EEIO7017** | **Disaster Management and Mitigation Measures** | Theory | Pract./Tut. | Theory | Pract./Tut. | Total |
| | | **3** | **--** | **3** | **--** | **3** |

| Course code | Course Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory | | | | | Term Work | Oral | Total |
| | | Internal Assessment | | | End Sem. Exam | Exam Duration (in Hrs) | | | |
| | | Test 1 | Test 2 | Avg | | | | | |
| **EEIO7017** | **Disaster Management and Mitigation Measures** | **20** | **20** | **20** | **80** | **3** | **--** | **--** | **100** |

| | |
|---|---|
| **Course Objectives** | 1. To understand physics and various types of disaster occurring around the world<br>2. To identify extent and damaging capacity of a disaster<br>3. To study and understand the means of losses and methods to overcome /minimize it.<br>4. To understand role of individual and various organization during and after disaster<br>5. To understand application of GIS in the field of disaster management<br>6. To understand the emergency government response structures before, during and after disaster |
| **Course Outcomes** | Upon successful completion of this course, the learner will be able to:<br>1 Get to know natural as well as manmade disaster and their extent and possible effects on the economy.<br>2 Plan of national importance structures based upon the previous history.<br>3 Get acquainted with government policies, acts and various organizational structure associated with an emergency.<br>4 Get to know the simple do's and don'ts in such extreme events and act accordingly. |

| Module | Contents | Hours |
|---|---|---|
| 1 | **Introduction**<br>1.1 Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change. | 03 |
| 2 | **Natural Disaster and Manmade disasters:**<br>2.1 Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion<br>2.2 Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of manmade disasters. | 09 |
| 3 | **Disaster Management, Policy and Administration**<br>3.1 Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management.<br>3.2 Policy and administration:<br>Importance and principles of disaster management policies, command and coordination of in disaster management, rescue operations-how to start with and | 06 |

| | | |
|---|---|---|
| | how to proceed in due course of time, study of flowchart showing the entire process. | |
| 4 | **Institutional Framework for Disaster Management in India:**<br>4.1 Importance of public awareness, Preparation and execution of emergency management program. Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India. Methods and measures to avoid disasters, Management of casualties, set up of emergency facilities, importance of effective communication amongst different agencies in such situations.<br>4.2 Use of Internet and softwares for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard. | 06 |
| 5 | **Financing Relief Measures:**<br>5.1 Ways to raise finance for relief expenditure, role of government agencies and NGO's in this process, Legal aspects related to finance raising as well as overall management of disasters. Various NGO's and the works they have carried out in the past on the occurrence of various disasters, Ways to approach these teams.<br>5.2 International relief aid agencies and their role in extreme events. | 09 |
| 6 | **Preventive and Mitigation Measures:**<br>6.1 Pre-disaster, during disaster and post-disaster measures in some events in general<br>6.2 Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication<br>6.3 Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans.<br>6.4 Do's and don'ts in case of disasters and effective implementation of relief aids. | 06 |

**References:**


1. 'Disaster Management' by Harsh K. Gupta, Universities Press Publications.
2. 'Disaster Management: An Appraisal of Institutional Mechanisms in India' by O.S. Dagur, published by Centre for land warfare studies, New Delhi, 2011.
3. 'Introduction to International Disaster Management' by Damon Copolla, Butterworth Heinemann Elsevier Publications.
4. 'Disaster Management Handbook' by Jack Pinkowski, CRC Press Taylor and Francis group.
5. 'Disaster management & rehabilitation' by Rajdeep Dasgupta, Mittal Publications, New Delhi.
6. 'Natural Hazards and Disaster Management, Vulnerability and Mitigation – R B Singh, Rawat Publications
7. Concepts and Techniques of GIS –C.P.Lo Albert, K.W. Yonng – Prentice Hall (India) Publications. (Learners are expected to refer reports published at national and International level and updated information available on authentic web sites)


**Assessment:**

**Internal Assessment for 20 marks:** Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

**End Semester Examination:**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then, part (b) will be from any module other than module 3)

4. Only **Four questions need to be solved**.

| ELECTRICAL ENGINEERING - SEMESTER-VII | | | | | | |
|---|---|---|---|---|---|---|
| Course Code | Course Name | Teaching scheme (Contact Hours) | | Credits Assigned | | |
| **EEIO7018** | **Energy Audit and Management** | Theory | Pract./Tut. | Theory | Pract./Tut. | Total |
| | | **3** | **--** | **3** | **--** | **3** |

| Course code | Course Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory | | | | | Term Work | Oral | Total |
| | | Internal Assessment | | | End Sem. Exam | Exam Duration (in Hrs) | | | |
| | | Test 1 | Test 2 | Avg | | | | | |
| **EEIO7018** | **Energy Audit and Management** | **20** | **20** | **20** | **80** | **3** | **--** | **--** | **100** |

| | |
|---|---|
| **Course Objectives** | 1. To understand the importance energy security for sustainable development and the fundamentals of energy conservation.<br>2. To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management<br>3. To relate the data collected during performance evaluation of systems for identification of energy saving opportunities. |
| **Course Outcomes** | Upon successful completion of this course, the learner will be able to:<br>1. To identify and describe present state of energy security and its importance.<br>2. To identify and describe the basic principles and methodologies adopted in energy audit of a utility.<br>3. To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.<br>4. To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities<br>5. To analyze the data collected during performance evaluation and recommend energy saving measures |

| Module | Contents | Hours |
|---|---|---|
| 1 | **Energy Scenario:**<br>Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance | 04 |
| 2 | **Energy Audit Principles:**<br>Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring& targeting; Energy audit Instruments; Data and information-analysis.<br>Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR) | 08 |
| 3 | **Energy Management and Energy Conservation in Electrical System:**<br>Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipments and appliances, star ratings.<br>**Energy efficiency measures in lighting system, lighting control:** Occupancy sensors, daylight integration, and use of intelligent controllers.<br>Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives. | 10 |

| | | |
|---|---|---|
| 4 | **Energy Management and Energy Conservation in Thermal Systems:**<br>Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system.<br>General fuel economy measures in Boilers and furnaces, Waste heat recovery, use of insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities. | 10 |
| 5 | **Energy Performance Assessment:**<br>On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis. | 04 |
| 6 | **Energy conservation in Buildings:**<br>Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources | 03 |

**References:**


1. Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science
2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System
3. Energy Management Handbook, By W.C. Turner, John Wiley and Sons
4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
5. Energy Management Principles, C.B.Smith, Pergamon Press
6. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
7. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press
8. www.energymanagertraining.com
9. www.bee-india.nic.in


**Assessment:**

**Internal Assessment for 20 marks:**

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

**End Semester Examination:**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then, part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

| ELECTRICAL ENGINEERING - SEMESTER-VII | | | | | | |
|---|---|---|---|---|---|---|
| Course Code | Course Name | Teaching scheme (Contact Hours) | | Credits Assigned | | |
| **EEIO7019** | **Development Engineering** | Theory | Pract./Tut. | Theory | Pract./Tut. | Total |
| | | **3** | **--** | **3** | **--** | **3** |

| Course code | Course Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory | | | | | Term Work | Oral | Total |
| | | Internal Assessment | | | End Sem. Exam | Exam Duration (in Hrs) | | | |
| | | Test 1 | Test 2 | Avg | | | | | |
| **EEIO7019** | **Development Engineering** | **20** | **20** | **20** | **80** | **3** | **--** | **--** | **100** |

| | |
|---|---|
| **Course Objectives** | 1. To understand the characteristics of rural Society and the Scope, Nature and Constraints of rural Development<br>2. To study Implications of 73rd CAA on Planning, Development and Governance of Rural Areas<br>3. An exploration of human values, which go into making a 'good' human being, a 'good' professional, a 'good' society and a 'good life' in the context of work life and the personal life of modern Indian professionals<br>4. To understand the Nature and Type of Human Values relevant to Planning Institutions |
| **Course Outcomes** | Upon successful completion of this course, the learner will be able to:<br>1. Apply knowledge for Rural Development.<br>2. Apply knowledge for Management Issues.<br>3. Apply knowledge for Initiatives and Strategies<br>4. Develop acumen for higher education and research.<br>5. Master the art of working in group of different nature.<br>6. Develop confidence to take up rural project activities independently |

| Module | Contents | Hours |
|---|---|---|
| 1 | **Introduction to Rural Development:**<br>Meaning, nature and scope of development; Nature of rural society in India; Hierarchy of settlements; Social, economic and ecological constraints for rural development, Roots of Rural Development in India Rural reconstruction and Sarvodaya programme before independence; Impact of voluntary effort and Sarvodaya Movement on rural development; Constitutional direction, directive principles; Panchayati Raj - beginning of planning and community development; National extension services. | 08 |
| 2 | **Post-Independence Rural Development:**<br>Balwant Rai Mehta Committee - three tier system of rural local Government; Need and scope for people's participation and Panchayati Raj; Ashok Mehta Committee - linkage between Panchayati Raj, participation and rural development. | 04 |
| 3 | **Rural Development Initiatives in Five Year Plans:**<br>Five Year Plans and Rural Development; Planning process at National, State, Regional and District levels; Planning, development, implementing and monitoring organizations and agencies; Urban and rural interface - integrated approach and local plans; Development initiatives and their convergence; Special component plan and sub-plan for the weaker section; Micro-eco zones; Data base for local planning; Need for decentralized planning; Sustainable rural development. | 06 |

| | | |
|---|---|---|
| 4 | **Post 73rd Amendment Scenario:**<br>73rd Constitution Amendment Act, including - XI schedule, devolution of powers, functions and finance; Panchayati Raj institutions - organizational linkages; Recent changes in rural local planning; Gram Sabha - revitalized Panchayati Raj; Institutionalization; resource mapping, resource mobilization including social mobilization; Information Technology and rural planning; Need for further amendments. | 04 |
| 5 | **Values and Science and Technology:** Material development and its values; the challenge of science and technology; Values in planning profession, research and education.<br>Types of Values Psychological values — integrated personality; mental health; Societal values — the modern search for a good society; justice, democracy, rule of law, values in the Indian constitution; Aesthetic values — perception and enjoyment of beauty; Moral and ethical values; nature of moral judgment; Spiritual values; different concepts; secular spirituality; Relative and absolute values; Human values— humanism and human values; human rights; human values as freedom, creativity, love and wisdom. | 10 |
| 6 | **Ethics:** Canons of ethics; ethics of virtue; ethics of duty; ethics of responsibility; Work ethics; Professional ethics; Ethics in planning profession, research and education | 04 |

**References:**


1. ITPI, Village Planning and Rural Development, ITPI, New Delhi
2. Thooyavan, K.R. Human Settlements: A 2005 MA Publication, Chennai
3. GoI, Constitution (73rd GoI, New Delhi Amendment) Act, GoI, New Delhi
4. Planning Commission, Five Year Plans, Planning Commission
5. Planning Commission, Manual of Integrated District Planning, 2006, Planning Commission New Delhi
6. Planning Guide to Beginners
7. Weaver, R.C., The Urban Complex, Doubleday.
8. Farmer, W.P. et al, Ethics in Planning, American Planning Association, Washington.
9. How, E., Normative Ethics in Planning, Journal of Planning Literature, Vol.5, No.2, pp. 123-150.
10. Watson, V., Conflicting Rationalities: -Implications for Planning Theory and Ethics, Planning Theory and Practice, Vol. 4, No.4, pp.395 – 407


**Assessment:**

**Internal Assessment for 20 marks:** Consisting **Two Compulsory Class Tests**
First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

**End Semester Examination:**
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then, part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

| ELECTRICAL ENGINEERING - SEMESTER-VII | | | | | | |
|---|---|---|---|---|---|---|
| Course Code | Course Name | Teaching scheme (Contact Hours) | | Credits Assigned | | |
| **EEL701** | **Electrical Drives and Control Lab** | Theory | Pract./Tut. | Theory | Pract./Tut. | Total |
| | | -- | **2** | | **1** | **1** |

| Course Code | Course Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory | | | | | Term Work | Pract & Oral | Total |
| | | Internal Assessment | | | End Sem. Exam | Exam Duration (in Hrs) | | | |
| | | Test 1 | Test 2 | Avg | | | | | |
| **EEL701** | **Electrical Drives and Control Lab** | --- | --- | --- | --- | -- | **25** | **25** | **50** |

| | |
|---|---|
| **Course Objectives** | 1. To impart practical knowledge on electrical drives and its control |
| **Course outcomes** | Upon successful completion of this course, the learner will be able :<br>2. To analyze the dynamic performance of ac and dc drives.<br>3. To analyze the dynamics of electrical braking in ac and dc drives<br>4. To analyze the control aspects and the performance of power electronic drives.<br>5. To use simulation tools to evaluate the performance of ac and dc drive |

**Syllabus:**

Same as that of Course Drives and Control (EEC701) with the following additions: - Starting of DC/AC motors, Speed Control of DC Motor with Half Controlled Converter, Dual Converter, Speed Control of Wound Rotor Induction Motor, Control of Special Machines like Brushless DC (BLDC) Motor, Permanent Magnet Synchronous Motor (PMSM), Stepper Motor, Switched Reluctance Motor (SRM), Synchronous Reluctance Motor (SyRM).

**Suggested List of Laboratory Experiments:**

1. Measurement of Moment of Inertia by Retardation Test
2. Study of Different Speed Sensing, Current Sensing and Voltage Sensing devices used for closed loop controlled drive.
3. Developing Sensor/interfacing Circuits required for the drive.
4. Single phase fully-controlled rectifier fed DC drive/Single phase half controlled rectifier fed DC drive / Three phase fully controlled rectifier fed DC drive/ Three phase half controlled rectifier fed DC drive/Dual Converter controlled fed DC drive. (Simulation/ Hardware)
5. Chopper Controlled DC drive. (Simulation/ Hardware)
6. Closed loop Control of DC drive (Simulation/ Hardware).
7. Simulation of Starting of DC motor (Conventional resistance start and any one Soft-start scheme)
8. Dynamic braking, Plugging of DC motor.
9. Plugging of three phase Induction Motor.
10. V control and V/f control of Induction Motor using PWM Inverter.
11. Rotor resistance control of IM
12. Slip Power Recovery Scheme (Static Scherbius Drive).
13. Hands on Experience in Programming a general purpose three phase Induction Motor Industrial Drive.
14. Vector Control of three phase Induction Motor (Simulation/Hardware).
15. DTC of three phase Induction Motor (Simulation/Hardware).
16. Control of Special Machines like Brushless DC (BLDC) Motor, Permanent Magnet Synchronous Motor (PMSM), Stepper Motor, Switched Reluctance Motor (SRM), Synchronous Reluctance Motor (SyRM)

Any other experiment based on the syllabus which will help students to understand the topic/concept.

Term work:
Term work shall consist of minimum eight experiments with minimum six hardware experiments.

The distribution of marks shall be as follows:

| | |
|---|---|
| Experiments Performance | : 10 marks |
| Journal | : 10 marks |
| Attendance | : 05 marks |

The final certification and acceptance of term work ensures the minimum passing in the term work.

Practical and Oral Examination:
Practical and Oral examination shall be based on entire syllabus of experiments conducted in **'EEL701: Electrical Drives and Control Lab'** and '**EEC701: Electrical Drives & Control**' syllabus

| ELECTRICAL ENGINEERING - SEMESTER-VII | | | | | | |
|---|---|---|---|---|---|---|
| Course code | Course Name | Teaching scheme (Contact Hours) | | Credits Assigned | | |
| **EEL702** | **Simulation Lab-III** | Theory | Pract./Tut. | Theory | Pract./Tut. | Total |
| | | -- | **2** | | **1** | **1** |

| Course code | Course Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory | | | | | Term Work | Oral | Total |
| | | Internal Assessment | | | End Sem. Exam | Exam Duration (in Hrs) | | | |
| | | Test 1 | Test 2 | Avg | | | | | |
| **EEL702** | **Simulation Lab-III** | --- | --- | --- | --- | -- | **25** | **25** | **50** |

| | |
|---|---|
| **Course Objectives** | The course is aimed:<br>1. To understand basic block sets of different simulation platform used in electrical /electronic circuit design.<br>2. To understand use and coding in different software tools used in electrical/ electronic circuit design |
| **Course outcomes** | Upon successful completion of this course, the learner will be able to<br>1. Develop the skill to use the software packages to model and program electrical and electronics systems<br>2. Model different electrical and electronic systems and analyze the results<br>3. Articulate importance of software packages used for simulation in laboratory experimentation /research/industry by analyzing the simulation results.<br>4. Simulate circuits for performance analysis. |

**Suggested Software Tools to be Used for Simulation Lab-III:**

1. Students should be encouraged to use open source softwares such as SCILAB, LTSPICE, Texas Instrument's 'Webbench', Ngspice, Solve Elec etc. for carrying out the lab simulation listed below.
2. Use of Professional Licensed versions of softwares like MATLAB, Proteus, LabVIEW, NI Multisim, PSpice, PSim, PSCAD, TINA etc. is also allowed.
3. Use of 'Python' platform for simulating components/ circuit behaviour should also be emphasized
4. Many of the following suggested experimentation can be carried out on Virtual lab platform

Suggested List of Laboratory Experiment: Minimum eight experiments need to be performed from various subjects domain. Some of the simulation experiments can also be selected based on the department elective offered

*Power Electronics Design and Control*

1. Simulation of a Buck or Boost or Buck-Boost DC-DC converter for switched mode power supplies (any one converter)
2. Simulation of feed-back compensator for closed- loop control of Buck or Boost or Buck-Boost DC-DC converter for extraction of energy from renewable energy sources (any one converter)
3. Simulation single phase or three phase SPWM technique for control of bridge inverter for an AC load
4. Simulation of a single-phase bridge inverter for an AC load
5. Simulation a feed-back compensator for a single-phase bridge inverter
6. Simulation of a feedback compensator for a flyback converter for Laptop charger /for LED lighting system /mobile phone charger or any other application.
7. Simulation of digital control of a DC-DC converter

*EPS-III: (Virtual Power Lab experiments @https://www.vlab.co.in/broad-area-electrical-engineeringor any other simulation tools to be used)*

1. To study the Synchronization of alternator with infinite bus bar.

2. To determine the direct axis reactance (Xd) and quadrature axis reactance (Xq) of synchronous machine.
3. To determine positive sequence, negative sequence and zero sequence reactances of an alternator.
4. To Study the over-current relay and the effect of PSM and TSM.
5. To determine the sub-transient (xd″), transient (xd′) and steady state reactance (xd) of a synchronous machine.
6. To Study the Ferranti Effect of a transmission line/cable.
7. To study the differential Protection of a three phase delta-delta connected transformer.
8. To study the Protection of a three phase Induction Motor using Numerical Relay.

*Microgrid/ Smart-grid:*

1. Simulation of DC-DC Converters (unidirectional /Bidirectional) with Voltage mode control / current mode control for DC Microgrid application.
2. Simulation of DC-AC Converter (Inverter) with Voltage mode control / current mode control for AC Microgrid application.
3. Simulation of DC-AC Converter (Inverter) with grid connected mode operation for AC Microgrid application.
4. Simulation of power sharing between two (or more) DC-DC Converters in DC Microgrid scenario
5. Simulation of power sharing between two Inverters in AC Microgrid scenario
6. Simulation/Emulation of smart grid technologies

*High voltage Engineering: (Virtual Power Lab experiments @https://www.vlab.co.in/broad-area-electrical-engineeringor any other simulation tools to be used)*

1. Study of Impulse Voltage Generator
2. Parametric Analysis of Impulse Voltage Waveform
3. Study of Impulse Current Generator
4. Parametric Analysis of Impulse Current Waveform
5. Critical Flashover of a Sphere Gap using IVG
6. Study of Rectangular Pulse Current Generator
7. Functioning of Voltage Doubler
8. 3-Stage Cockroft Walton Voltage Multiplier
9. Application of High Voltage D.C. Test Source

Any other simulations / algorithms based on semester VII syllabus, which will help students to understand topic / concept.

Note: Students and teachers are encouraged to use the virtual labs whose links are as given below The remote-access to Labs in various disciplines of Science and Engineering is available. Students can conduct online experiments which would help them in learning basic and advanced concepts through remote experimentation.

Virtual Lab Website Reference

1. http://vlab.co.in/broad-area-electrical-engineering
2. http://vlab.co.in/broad-area-electronics-and-communications

Term work:

Term work shall consist of minimum eight experiments. The distribution of marks shall be as follows:

| | |
|---|---|
| Experiments Performance | : 10 marks |
| Journal | : 10 marks |
| Attendance | : 05 marks |

The final certification and acceptance of term work ensures the minimum passing in the term work.

Oral Examination:

Oral examination will be based on all the laboratory experiments carried out in **EEL702- Simulation Lab-III**

| ELECTRICAL ENGINEERING - SEMESTER-VII | | | | | | |
|---|---|---|---|---|---|---|
| Course code | Course Name | Teaching scheme (Contact Hours) | | Credits Assigned | | |
| **EEL703** | **Power Electronics Design Lab** | Theory | Pract./Tut. | Theory | Pract./Tut. | Total |
| | | -- | **2** | | **1** | **1** |

| Course code | Course Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory | | | | | Term Work | Oral | Total |
| | | Internal Assessment | | | End Sem. Exam | Exam Duration (in Hrs) | | | |
| | | Test 1 | Test 2 | Avg | | | | | |
| **EEL703** | **Power Electronics Design Lab** | --- | --- | --- | --- | -- | **25** | **25** | **50** |

| | |
|---|---|
| **Course Objectives** | 1. To provide hands on / skill-sets to model / design and implement the power electronics systems/ subsystems<br>2. To impart knowledge on practical aspects of power electronics converters design |
| **Course outcomes** | Upon successful completion of this course, the learner will be able to<br>1. Illustrate design of auxiliary circuits for Power Electronic systems.<br>2. Analyse the requirements, model and design a compensator for a power electronic converter.<br>3. Create a power electronic converter for a particular application.<br>4. Implement control algorithm for a power electronic converter in hardware / simulation platform |

**Suggested Power Electronics (PE) Design Lab exercises:**

**Group 1: PE Converter Hardware**

1. Implementation of a Buck or Boost or Buck-Boost DC-DC converter for switched mode power supplies (any one converter)
2. Model and design of feed-back compensator for closed- loop control of Buck or Boost or Buck-Boost DC-DC converter for extraction of energy from renewable energy sources (any one converter)
3. Implement a single-phase bridge inverter for an AC load
4. Model and design a feed-back compensator for a single-phase bridge inverter
5. Model and design a feedback compensator for a flyback converter for Laptop charger /for LED lighting system /mobile phone charger or any other application.
6. Implement any power electronic converter for a specific application.

**Group 2: PE Converter Control – Coding (programming)**

1. Implement single phase or three phase SPWM technique for control of bridge inverter for an AC load
2. Implementation of microcontroller / DSP code for voltage mode control (VMC) of DC-DC converter
3. Implementation of microcontroller / DSP code for current mode control (CMC) of DC-DC converter
4. Implementation of microcontroller / DSP code for VMC/ CMC of an inverter
5. Implementation of microcontroller / DSP code for v/f control of induction motor / any other drive application
6. Implementation of any control coding for any PE Converter.

**Group 3: Aux System / Protection / Heatsink**

1. Design of Gate driver circuits for different power semi-conductor switches (Si devices or Wide band gap devices like SiC or GaN etc.)
2. Design of Snubber circuit and analysing its impact on the operation of switch used in PE converter or inverter
3. Design of heat sink for a PE converter and verify its thermal performance

4. Design AC/DC voltage and Current Sensing (isolated/ or non-isolated) circuit for feedback control of a PE converter
5. Design of over current / short circuit protection system for any PE converter
6. Design of any specific auxiliary systems commonly used in Power Electronic systems.

Term work Requirements:

a. Design / Modelling and Implementation of minimum one exercise from each group mentioned above (total three at least).
b. Detailed report including all the details of design / modelling and implementation (with photographs) shall be submitted as a part of term-work.
c. Institute shall arrange a visit to a Power Electronic industry or seminar (by students) based on survey of power electronic converters or power electronic systems for specific applications. Report for the same shall be submitted as a part of the term-work.

References Books:

1. Mohan, Ned. et.al, "Power Electronics Converters, Applications and Design", Wiley India Pvt. Ltd., New Delhi.
2. L. Umanand, Bhatt, "Design of Magnetic Components for Switched Mode Power Converters", John Wiley & Sons

Web Courses:

1. NPTEL course: Design of Power Electronic Converters, Prof. Shabari Nath, IIT Guwahati.
2. NPTEL course: Advanced Power Electronics and Control, Prof. Avik Bhattacharya, IIT Roorkee

Term work:

Term work shall consist of minimum three exercises with detailed reports as mention in requirements. The distribution of marks shall be as follows:

Lab Performance (design/ modelling/ implementation) :15 marks
Industry Visit / Seminar Report :05 marks
Attendance :05 marks

The final certification and acceptance of term work ensures the minimum passing in the term work.

Oral Examination:

Oral examination will be based on experiments carried out in EEL703

| ELECTRICAL ENGINEERING - SEMESTER-VII | | | | | | |
|---|---|---|---|---|---|---|
| Course Code | Course Name | Teaching scheme (Contact Hours) | | Credits Assigned | | |
| **EEP701** | **Major Project - I** | Theory | Pract./Tut. | Theory | Pract./Tut. | Total |
| | | -- | **6$** | **--** | **3** | **3** |

| Course code | Course Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory | | | | | Term Work | Oral | Total |
| | | Internal Assessment | | | End Sem. Exam | Exam Duration (in Hrs) | | | |
| | | Test 1 | Test 2 | Avg | | | | | |
| **EEP701** | **Major Project - I** | -- | -- | -- | -- | -- | 50 | - | 50 |

$ indicates work load of Learner (Not Faculty)

| | |
|---|---|
| **Course Objectives** | 1. To design and develop a complex electrical/electronic/digital circuit/ interdisciplinary problem with practical relevance<br>2. To understand basic concepts of circuit/ system design while developing the project.<br>3. To enable the students to gain hands-on experience independently proposing and implementing the project and thus acquire the necessary confidence to deal with complex electrical/electronic/digital systems.<br>4. To acquaint with the process of applying basic engineering fundamental in the domain of practical applications |
| **Course Outcomes** | Upon successful completion of this course, the learner will be able to:<br>1. Identify problems based on societal /research needs.<br>2. Apply Knowledge and skill to solve societal problems in a group.<br>3. Develop interpersonal skills to work as member of a group or leader.<br>4. Draw the proper inferences from available results through theoretical/ experimental/ simulations.<br>5. Analyse the impact of solutions in societal and environmental context for sustainable development.<br>6. Use standard norms of engineering practices<br>7. Excel in written and oral communication.<br>8. Demonstrate capabilities of self-learning in a group, which leads to life-long learning.<br>9. Demonstrate project management principles during project work |

**Major Project -Topic Selection and Approval Guidelines**

1. The group may be of maximum FOUR (04) students.
2. Students should propose project ideas & finalize the project idea in consultation with guide/ HOD. Students should select a problem which addresses some real life applications.
3. Students should identify different components/ devices, instruments, simulation/emulations software tools required for the project.
4. Students should submit implementation plan in the form of Gantt/ PERT/ CPM chart, which will cover weekly activity of project.
5. A log-book to be prepared by each group to record the work progress in terms of milestones per week by students. Weekly comment, remarks to be put by guiding faculty.

**Application Domains:**

List of key application domains from where students are encouraged to derive Major Projects topics (but not limited to):

1) Smart Agriculture solutions

2) Power converter applications in various Applications
3) IoT based applications in power systems
4) AI/ML applications in disaster management
5) Renewable Energy
6) Energy Conservation
7) Energy Storage
8) Battery Charging and Protection
9) Fire Safety
10) Electrical System Protection
11) Lighting Control
12) Wireless Power Transfer
13) Electrical Components Testing
14) Electrical Parameters Measurement
15) Non-conventional Electricity Generation
16) Laboratory Equipment
17) E-Mobility / Electric Vehicles
18) Video Surveillance Systems
19) Robotics for Hazardous applications
20) Waste Management System
21) Smart City Solutions
22) Smart Classrooms and learning Solutions
23) Design of Electrical Equipment
24) PLC based automation system
25) Power system Monitoring System

Students can identify the Major project topic either from above suggested domains or any other relevant electrical engineering domains. The inter-disciplinary nature of the project is also desirable.

Guidelines for Assessment of Major Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of major project to be evaluated on continuous basis, minimum two reviews in each semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of Term work marks for Major Project- I shall be as below;
  - Marks awarded by guide/supervisor based on log book : 20
  - Marks awarded by review committee 20
  - Quality of Project report 10

Review/progress monitoring committee may consider following points for assessment as mentioned in general guidelines. Two reviews shall be conducted based on presentation given by students group based on the following criteria:

Assessment criteria of Major Project-I.

Major Project shall be assessed based on following criteria;

1. Quality of literature survey/ need identification
2. Clarity of Problem definition based on need.
3. Innovativeness in solutions
4. Feasibility of proposed problem solutions and selection of best solution
5. Cost effectiveness

6. Societal impact
7. Innovativeness
8. Cost effectiveness
9. Effective use of skill sets
10. Effective use of standard engineering norms
11. Contribution of an individual's as member or leader
12. Clarity in written and oral communication

Project Report has to be prepared strictly as per University of Mumbai report writing guidelines.

| ELECTRICAL ENGINEERING - SEMESTER-VIII | | | | | | |
|---|---|---|---|---|---|---|
| Course Code | Course Name | Teaching Scheme (Contact Hours) | | Credits assigned | | |
| **EEC801** | **Electrical System Design, Management and Auditing** | Theory | Pract./Tut. | Theory | Pract /Tut. | Total |
| | | **4** | **--** | **4** | **--** | **4** |

| Course Code | Course Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory | | | | | Term work | Pract./ Oral | Total |
| | | Internal Assessment | | | End Sem. Exam. | Exam. Duration (in Hrs) | | | |
| | | Test 1 | Test 2 | Avg | | | | | |
| **EEC801** | **Electrical System Design, Management and Auditing** | **20** | **20** | **20** | **80** | **03** | **-** | **-** | **100** |

| | |
|---|---|
| **Course Objectives** | To impart knowledge of<br>1. Designing electrical distribution network<br>2. Electrical energy audit in the distribution system |
| **Course Outcomes** | Upon successful completion of this course, the learner will be able:<br>1. To do sizing, selecting transformer, switchgear and cable as required for distribution system<br>2. To illustrate Engineering knowledge in energy audit and energy efficient technologies to improve energy efficiency<br>3. Describe the energy conservation through energy monitoring and targeting<br>4. Analyse and Evaluate the energy audit data for targeting possible opportunities of energy saving |

| Module | Contents | Hours |
|---|---|---|
| 1 | Introduction:<br>Types of electrical Projects, Types of electrical system, review of components of electrical system, different plans/ drawings in electrical system design, single line diagram in detail, Tendering, Estimation | 05 |
| 2 | Design of Power Distribution System:<br>Different types of distribution systems and selection criteria, Electrical Earthing, Electrical load size, L.F, D.F, future estimates, substation equipment options, design considerations in transformer selection, sizing and specifications; Selection of HT/LT switchgears, metering, switchboards and MCC, protection systems, coordination and discrimination. IS standards applicable in above design | 10 |
| 3 | Selection / Sizing of Cable and Auxiliary system:<br>Cables selection and sizing, cable installation and management systems, bus bars design; Basics of selection of emergency/backup supplies, UPS, DG Set, Batteries; Preliminary design of interior lighting system. IS standards applicable in above designs | 07 |
| 4 | Energy Monitoring and Targeting:<br>Defining monitoring and targeting. Elements of monitoring and Targeting. Analysis techniques for energy optimization, Cumulative Sum of Differences (CUSUM), Electricity billing. Energy Management of Electrical Systems: Electrical load management and maximum demand control, Power factor improvement and its benefit, selection and location of capacitors, distribution and transformer losses. | 10 |
| 5 | Energy Audit:<br>Introduction to Energy Conservation Act 2001, Energy Audit: Definition-need, Types of energy audit, Energy Management (audit) approach understanding energy costs, Bench marking, Maximizing system efficiencies, optimizing input energy requirement, fuel and energy substitution. Energy Audit instruments. Electrical Energy Performance Assessment: Motors and | 10 |

| | | |
|---|---|---|
| | Variable Speed Drives, Lighting Systems. Basics of HVAC system assessment for electrical energy usage. | |
| 6 | Energy Efficient Technologies:<br>Energy efficient BLDC Fans, Smart lighting system for indoor and outdoor applications, Maximum Demand controllers, Automatic Power Factor Controllers, Energy Efficient Motors, Soft starters, Variable Frequency Drives, Energy Efficient Transformer. Energy saving potential of each technology. Use of Energy Management system (EMS) and Building Management System (BMS). | 10 |

Text Books:


1. Handbook of Electrical Installation Practice, Fourth Edition, by Geofry Stokes, Blackwell Science
2. Energy-Efficient Electric Motor, Third Edition, By Ali Emadi, New Marcel Dekker, Inc., 2005.
3. Electrical Energy Efficiency: Technologies and Applications by Andreas Sumper and Angelo Baggini, John Wiley & Sons, Ltd., 2012
4. Electrical Calculations and Guidelines for Generating Stations and Industrial Plants by Thomas E. Baker, CRC Publications, 2012
5. Electrical Installations Handbook, Third Edition, by Gunter Seip, MCD Verilag, 2000
6. Electrical Installation Designs, Fourth Edition by Bill Atkinson, Roger Lovegrove and Gary Gundry, John Wiley & Sons, Ltd, 2013.
7. Handbook of International Electrical Safety Practices, by Princeton Energy Resources International, Scrivener Publishing, 2010.
8. Designing with Light: Lighting Handbook, by Anil Valia, Lighting System
9. Energy Management Handbook||, by W.C. Turner, John Wiley and sons
10. Handbook on Energy Audits and Management||, by Amit Kumar Tyagi, TERI
11. Introduction to Efficient Electrical System Design, by Stephen Ayraud and Albert Thumann, The Fairmount Press


Reference Books:


1. Energy Auditing Made Simple||, by P. Balasubramanian, Seperation Engineers (P) Ltd
2. University of Mumbai, Electrical Engineering, Rev. 2016-17 Page 51
3. Electrical Installation Calculations: for Compliance with BS 7671:200, Fourth Edition, by Mark Coates, Brian Jenkins, John Wiley & Sons, Ltd, 2010
4. Energy Management Principles, by C.B. Smith, Peragamon Press
5. Energy Conservation Guidebook, by Dale R.Patrick, Stephon Fadro, E. Richardson, Fairmont Press
6. Handbook of Energy Audits||, by Albert Thumann, William J. Younger, Terry Niehus, CRC Press


Web Reference /Video Courses

1. http://www.energymanagertraining.com/
2. http://www.bee-india.nic.in/

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be randomly selected from all the modules.

| ELECTRICAL ENGINEERING - SEMESTER-VIII | | | | | | |
|---|---|---|---|---|---|---|
| Course Code | Course Name | Teaching Scheme (Contact Hours) | | Credits assigned | | |
| **EEDO8011** | **Power Quality and FACTs** | **Theory** | **Pract./Tut.** | **Theory** | **Pract /Tut.** | **Total** |
| | | **3** | **--** | **3** | **--** | **3** |

| Course Code | Course Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory | | | | | Term work | Pract./ Oral | Total |
| | | Internal Assessment | | | End Sem. Exam. | Exam. Duration (in Hrs) | | | |
| | | Test 1 | Test 2 | Avg | | | | | |
| **EEDO8011** | **Power Quality and FACTs** | **20** | **20** | **20** | **80** | **03** | **--** | **-** | **100** |

| | |
|---|---|
| **Course Objectives** | 1. To get awareness about non-linear loads in power system.<br>2. To understand the concept of Flexible AC Transmission System<br>3. To introduce the operation of various FACTS controllers. |
| **Course outcomes** | **Upon successful completion of this course, the learner will be able to:**<br>1. Analyze the problems due to non-linear loads<br>2. Suggest the solution to improve power quality.<br>3. Illustrate the aspects of flexible ac transmission system over conventional ac transmission system and analyze the concept of load compensation.<br>4. Categorize the static shunt and series compensation for transmission line.<br>5. Outline the concept of voltage and phase angle regulators |

| Module | Contents | Hours |
|---|---|---|
| 1. | Power Quality Introduction:<br>Disturbances, Unbalance, Distortion, Voltage Fluctuations, Flicker, Quality Assessment | 03 |
| 2. | Harmonics and its effects :<br>Definition of harmonics, odd and even harmonics, Harmonic phase rotation and phase angle relationship, Causes of voltage and current harmonics, individual and total harmonic distortion with problems, Power assessment under waveform distortion with numerical. Effects of harmonics on rotating Machines, Transformers and Cables, Overloading of Neutral conductor | 07 |
| 3. | Power quality improvement:<br>Power factor when both voltage and current are sinusoidal, Power factor compensation using capacitor (vector diagram and numerical included), power factor when voltage is sinusoidal and current is non-sinusoidal (numerical included), Effect of capacitor compensation in power factor improvement under non-sinusoidal condition. Mitigation of harmonics- Passive filters- Advantages and disadvantages of passive filters- Active filters- shunt connection, series connection and hybrid connection, Instantaneous PQ theory. | 10 |
| 4. | General concept of FACTS and Load Compensation:<br>Transmission Interconnections, Flow of Power in AC system, What Limits the Loading Capability, Power Flow and Dynamic Stability Considerations of a Transmission Interconnection, Relative Importance of controllable Parameters, Basic Types of FACTS Controllers, Benefits from FACTS Technology, Objectives in load compensation, ideal compensator, Practical considerations, Power factor correction and Voltage Regulation in single phase systems | 08 |
| 5. | Static shunt and series compensators:<br>Objectives of shunt compensation, Methods of controllable VAR generation, Variable impedance type static Var generator (TCR, TSR, TSC, FC-TCR), Switching converter type Var | 08 |

| | | |
|---|---|---|
| | generators, basic operating principle. Objectives of series compensation, Variable impedance type series compensation (only GCSC, TSSC and TCSC), Switching converter type series compensation (only SSSC) | |
| 6. | Static voltage and phase angle regulators- Objectives of voltage and phase angle regulators- TCVR and TCPAR | 03 |

**Text Books:-**


1. "Power System Harmonics" Jos Arrillaga, Neville R Watson
2. "Electric Power Quality" , G.T.Heydt
3. "Electric Power Systems and Quality" , Roger C. Dugan,Mark F. McGranaghan, H.Wayne Beatyd
4. "IEEE-519 Standard
5. 'Hingorani N.G.. & Gyugi L., —Understanding FACTS : Concepts and Technology of Flexible AC Transmission Systems,|| Wiley-1EEE Press.
6. Timothy J. E. Miller —Reactive power control in Electric Systems,|| Wiley India Edition.


**Reference Books:-**


1. "Power System Quality Assessment", J. Arrillaga, N.R.Watson, S.Chen
2. "Power Quality" , C. Shankaran, CRC press
3. "Reactive power control in electric systems" by Timothy J. E. Miller
4. "Power Quality Enhancement Using Custom Devices" Arindam Ghosh, Gerard Ledwich
5. "Power Electronics" Ned Mohan, Undeland, Robbins, John Wiley Publication
6. "Power System Analysis- Short Circuit Load Flow and Harmonics" J.C.Das.
7. "Flexible AC transmission system" by Yong Hua Song Institution of Electrical Engineers, London


**Website Reference/ Video Courses**:

**Assessment:**

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

**Theory Examination**:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be randomly selected from all the modules.

| ELECTRICAL ENGINEERING - SEMESTER-VIII | | | | | | |
|---|---|---|---|---|---|---|
| Course Code | Course Name | Teaching Scheme (Contact Hours) | | Credits assigned | | |
| **EEDO8012** | **Automation and Control** | **Theory** | **Pract./Tut.** | **Theory** | **Pract /Tut.** | **Total** |
| | | **3** | **--** | **3** | **--** | **3** |

| Course Code | Course Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory | | | | | Term work | Pract./ Oral | Total |
| | | Internal Assessment | | | End Sem. Exam. | Exam. Duration (in Hrs) | | | |
| | | Test 1 | Test 2 | Avg | | | | | |
| **EEDO8012** | **Automation and Control** | **20** | **20** | **20** | **80** | **03** | **--** | **-** | **100** |

| | |
|---|---|
| **Course Objectives** | To impart the fundamentals knowledge in the field of Automation and Control |
| **Course outcomes** | **Upon successful completion of this course, the learner will be able to**<br>1. Understand basic terminologies and concepts associated with Automation and Control<br>2. Demonstrate comprehension of various Robotic sub-systems<br>3. Understand kinematics and dynamics to explain exact working pattern of robots |

| Module | Contents | Hours |
|---|---|---|
| 1. | **Introduction:**<br>Basic concepts of Automation: Definition, three laws, DOF; Elements of Robotic Systems: Robot anatomy, Classification, Associated parameters i.e. resolution, accuracy, repeatability, dexterity, compliance.<br>Automation: Need, Automation in Production System, Principles and Strategies of Automation, Basic Elements of an Automated System, Levels of Automations | 06 |
| 2. | **Robot Grippers and Sensors:**<br>Types of Grippers, Design aspects for gripper, Force analysis for various basic gripper system.<br>Sensors for Robots: Characteristics of sensing devices, Selections of sensors, Classification and applications of sensors. Types of Sensors, Need for sensors and vision system in the working and control of a robot. | 08 |
| 3. | **Drives and Control Systems:**<br>Types of Drives, Actuators and its selection while designing a robot system. Types of transmission systems, Control Systems -Types of Controllers.<br>Control Technologies in Automation:- Industrial Control Systems, Process Industries Verses Discrete-Manufacturing Industries, Continuous Verses Discrete Control, Control System Components such as Sensors, Actuators and others. | 06 |
| 4. | **Kinematics:**<br>Transformation matrices and their arithmetic, link and joint description, Denavit - Hartenberg parameters, direct kinematics, kinematics redundancy, kinematics calibration, inverse kinematics, solvability, algebraic and geometrical methods.<br>Velocities and Static forces in manipulators:-Jacobians, singularities, static forces, Jacobian in force domain. Dynamics:- Introduction to Dynamics, Trajectory generations | 08 |
| 5. | **Machine Vision System:**<br>Vision System Devices, Image acquisition, Masking, Sampling and quantization, Image Processing Techniques, Noise reduction methods, Edge detection, Segmentation.<br>Robot Programming :- Methods of robot programming, lead through programming, motion interpolation, branching capabilities, WAIT, SIGNAL and DELAY commands, | 06 |

| | | |
|---|---|---|
| | subroutines. | |
| 6. | **Modeling and Simulation for manufacturing Plant Automation:** Introduction, need for system Modeling, Building Mathematical Model of a manufacturing Plant, Modern Tools- Artificial neural networks in manufacturing automation, AI in manufacturing, Fuzzy decision and control, robots and application of robots for automation. | 05 |

**Text Books:-**


1. John J. Craig, Introduction to Robotics (Mechanics and Control), Addison-Wesley, 2nd Edition, 04
2. Mikell P. Groover et. Al., Industrial Robotics: Technology, Programming and Applications, McGraw – Hill International, 1986.
3. Shimon Y. Nof, Handbook of Industrial Robotics, John Wiley Co, 01.
4. Automation, Production Systems and Computer Integrated Manufacturing, M.P. Groover, Pearson Education.
5. Industrial Automation: W.P. David, John Wiley and Sons


**Reference Books:-**


1. Richard D. Klafter , Thomas A. Chemielewski, Michael Negin, Robotic Engineering : An Integrated Approach , Prentice Hall India, 02.
2. Handbook of design, manufacturing & Automation: R.C. Dorf, John Wiley and Sons.


**Assessment:**

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

**Theory Examination**:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be randomly selected from all the modules.

| ELECTRICAL ENGINEERING - SEMESTER-VIII | | | | | | |
|---|---|---|---|---|---|---|
| Course Code | Course Name | Teaching Scheme (Contact Hours) | | Credits assigned | | |
| **EEDO8013** | **Advanced Electric Drives** | **Theory** | **Pract./Tut.** | **Theory** | **Pract /Tut.** | **Total** |
| | | **3** | **--** | **3** | **--** | **3** |

| Course Code | Course Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory | | | | | Term work | Pract./ Oral | Total |
| | | Internal Assessment | | | End Sem. Exam. | Exam. Duration (in Hrs) | | | |
| | | Test 1 | Test 2 | Avg | | | | | |
| **EEDO8013** | **Advanced Electric Drives** | **20** | **20** | **20** | **80** | **03** | **--** | **-** | **100** |

| | |
|---|---|
| **Course Objectives** | To impart the knowledge of<br>1. The advanced control techniques used in induction motor (IM) drives<br>2. The control of Sinusoidal Surface Permanent Magnet (SPM) synchronous machine (PMSM) drives |
| **Course outcomes** | **Upon successful completion of this course, the learner will be able to:**<br>1. To select suitable V/f control scheme of IM based on the application.<br>2. To illustrate vector control and indirect vector control of IM.<br>3. To explain how to achieve sensorless vector control of IM.<br>4. To discuss various adaptive control schemes used in IM drives<br>5. To analyze direct torque control (DTC) used in induction motor drives.<br>6. To describe the speed control schemes used in PMSM drives |

| Module | Contents | Hours |
|---|---|---|
| 1. | Introduction: Variable frequency operation of three phase symmetrical induction machine, Scalar control methods – Voltage fed inverter control: Open loop V/f control; Closed loop V/f control with slip regulation; Closed loop V/f control with torque and flux control, Current controlled voltage fed inverter drive, Current fed inverter drive with speed and flux control, Efficiency optimization control by flux program. | 08 |
| 2. | Vector control of Induction Motor (IM): Introduction, Direct or feedback vector control, Flux vector estimation – Voltage model and current model, Indirect or feed forward vector control, Slip gain tuning, Stator flux oriented vector control. | 10 |
| 3. | Sensorless vector control of IM: Slip calculation, Direct synthesis from state equations, Model Referencing Adaptive System (MRAS), Speed adaptive flux observer, Extended Kalman filter. | 05 |
| 4. | Adaptive control of IM: Self tuning control, MRAC, Sliding mode control, Fuzzy control, Neural control. | 05 |
| 5. | Direct Torque and Flux Control of IM: Conventional Direct torque and flux control (direct torque control (DTC)) of IM using switching table of inverter voltage vectors. | 05 |
| 6. | Synchronous Motor Drives: Sinusoidal SPM Machine Drives: V/Hz control, self-control, Vector control. | 06 |

**Text Books:-**


1. Modern Power Electronics and A.C. Drive||, B. K. Bose, PHI.
2. Electric Motor Drives: Modeling, Analysis and Control||, R.Krishnan,.PHI
3. Control of Electrical drives||, W. Leonhard, Springer-Verlag,


**Reference Books:-**


1. Power Semiconductor Controlled Drives||, G. K. Dubey, Prentice-Hall International.

2. Fundamentals of Electrical Drives||, G. K. Dubey, Narosa Publishing House.
3. Analysis of Electric Machinery||, P.C. Krause, McGraw Hill, New York

**Website Reference/ Video Courses**:

**Assessment:**
Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

**Theory Examination**:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be randomly selected from all the modules.

| ELECTRICAL ENGINEERING - SEMESTER-VIII | | | | | | |
|---|---|---|---|---|---|---|
| Course Code | Course Name | Teaching Scheme (Contact Hours) | | Credits assigned | | |
| **EEDO8014** | **High Power Switching Converters** | **Theory** | **Pract./Tut.** | **Theory** | **Pract /Tut.** | **Total** |
| | | **3** | **--** | **3** | **--** | **3** |

| Course Code | Course Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory | | | | | Term work | Pract./ Oral | Total |
| | | Internal Assessment | | | End Sem. Exam. | Exam. Duration (in Hrs) | | | |
| | | Test 1 | Test 2 | Avg | | | | | |
| **EEDO8014** | **High Power Switching Converters** | **20** | **20** | **20** | **80** | **03** | **--** | **-** | **100** |

| | |
|---|---|
| **Course Objectives** | 1. To understand and select high power devices, gain knowledge about power modules, suitable packaging and latest market trends.<br>2. To understand and analyse high power converters and the protection needed for the converters.<br>3. To keep abreast with the latest technologies and research going on in different areas related to high power converters.<br>4. To enhance the knowledge of practical aspects in the design of Power Converters.<br>5. To deliver technological solution in the field of power electronics. |
| **Course outcomes** | **Upon successful completion of this course, the learner will be able to**<br>1. Analyze and understand high power devices and practical issues in implementing high power converters.<br>2. Understand protection aspects and design considerations to build proper power electronics systems.<br>3. Design closed loop control and discretize controllers for using digital control methods.<br>4. Analyze and design converters in the fields of drives, power generation and energy conversion, industrial applications, extraction of energy from renewable sources |

| Module | Contents | Hours |
|---|---|---|
| 1. | High power switching devices:<br>Review of high power devices - diodes, SCRs, GTOs and IGBTs-ratings and switching characteristics, view of power device market trend, series connected devices, voltage equalization techniques-static and dynamic, constraints in paralleling IGBTs, intelligent power modules, packages for high power devices, wide band gap devices. | 04 |
| 2. | High power converters and Protection:<br>Multi pulse controlled rectifiers-12 pulse, introduction to higher pulse controlled rectifiers, Cascaded H bridge multilevel inverters, Modular Multi level converters, Practical Aspects in Building Three-Phase Power Converters- Motor drives, Grid applications, Protection aspects-Over current, Over voltage, temperature, snubber design-component selection, basics of resonant snubber and regenerative snubber, numerical. | 10 |
| 3. | Design considerations:<br>Electrical specifications, Mechanical specifications, Environmental specifications, EMI/EMC specifications, Hardware specifications, Thermal Management, Selection of switching frequency, Selection of switching device and topology, control and isolation, cost. | 06 |

| | | |
|---|---|---|
| 4. | Closed-Loop control:<br>Analog PWM controllers, Digital control-advantages, Signal conditioning and sampling, digital implementation of PWM modulator-single update and double update mode, PI & PR controller discretization, effect of computational delay, Processors in converter control, Grid synchronization techniques, introduction to non-linear control methods. | 08 |
| 5. | High power AC drives:<br>Line side requirements, motor side challenges, switching device constraints, converter configurations, control aspects, case studies of drive application. | 05 |
| 6. | Grid interfaced converters:<br>Requirements and challenges, high power grid interfaced converters, current control, voltage control, grid synchronization, filter design, dc link voltage control, case studies on grid interfacing of renewable energy sources. | 06 |

**Text Books:-**


1. Dorin O. Neacsu, "Switching Power Converters, Medium and High Power", CRC press, Taylor & Francis group, second edition, 2017.
2. Bin Wu, "High Power Converters and AC drives", IEEE press, John Wiley & Sons.
3. N. Mohan and T. M. Undeland, "Power Electronics: Converters, Applications and Design", John Wiley & Sons, 2007.
4. Simon Ang, Alejandro Oliva, "Power-Switching Converters", Taylor and Francis group.
5. A Yazdani, R. Iravani, "Voltage- Sourced Converters in Power Systems", Wiley, IEEE press.
6. B. Jayant Baliga, "Silicon Carbide Power Devices", World Scientific, 2005.


**Reference Books:-**


1. R. Teodoresco, M. Liserrie,P. Rodr´ıguez "Grid Converters for Photovoltaic and Wind Power Systems", John Wiley and Sons.
2. L. Umanad, "Power Electronics: Essentials & Applications", Wiley.
3. V. Ramanarayanan, "Course Material on Switched Mode Power Conversion", 2007.
4. M. Jamil, M. Rizwan, D.P Kothari, "Grid Integration of Solar Photovoltaic Systems", CRC press, Taylor & Francis.
5. Peter Friedrichs, T. Kimoto, L. Ley and G. Pensl, "Silicon Carbide, Volume 2: Power Devices and Sensors", Wiley Publications, 2011.


**Assessment:**

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

**Theory Examination**:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be randomly selected from all the modules.

| ELECTRICAL ENGINEERING - SEMESTER-VIII | | | | | | |
|---|---|---|---|---|---|---|
| Course Code | Course Name | Teaching Scheme (Contact Hours) | | Credits assigned | | |
| **EEDO8021** | **Power System Planning and Reliability** | **Theory** | **Pract./Tut.** | **Theory** | **Pract /Tut.** | **Total** |
| | | **3** | **--** | **3** | **--** | **3** |

| Course Code | Course Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory | | | | | Term work | Pract/ Oral | Total |
| | | Internal Assessment | | | End Sem. Exam | Exam. Duration (in Hrs) | | | |
| | | Test 1 | Test 2 | Avg | | | | | |
| **EEDO8021** | **Power System Planning and Reliability** | **20** | **20** | **20** | **80** | **03** | **--** | **-** | **100** |

| | |
|---|---|
| **Course Objectives** | Student shall be able<br>1. To use reliability theory as a tool for decision support for design, operation and planning of electric power system.<br>2. To familiarize the students with various aspects of probability theory.<br>3. To acquaint the students with reliability and its concepts.<br>4. To introduce the students to methods of estimating the system reliability of simple and complex systems. |
| **Course outcomes** | **Upon successful completion of this course, the learner will be able to**<br>1. To explain the basic modelling of power system components for reliability evaluation and planning.<br>2. To describe load forecasting models for short-term and long-term power system planning.<br>3. To describe the methodologies to solve generation system reliability calculation and generation planning.<br>4. To describe how to calculate reliability indices for combined generation and transmission systems.<br>5. To carry out planning and reliability for distribution system. |

| Module | Contents | Hours |
|---|---|---|
| 1. | Power System Planning and Load Forecasting:<br>Objectives of power system planning, Short term, medium term and long term planning; Classification and characteristics of loads, Load forecasting methods: Extrapolation, Co-Relation Techniques; Energy forecasting, Weather load model, Peak load forecasting | 08 |
| 2. | Basic Concepts of Reliabilit:y<br>Failure analysis and Reliability parameters, Hazard models and Bath-tub curve, Series and Parallel Systems, Continuous Markov process, Frequency and Duration approach | 08 |
| 3. | Generation Planning and Reliability:<br>Generation system model, Capacity Outage Probability Table, Recursive algorithm for systems including derated states, Evaluation of Loss of Load Expectation, Evaluation of Loss of Energy Expectation | 08 |
| 4. | Composite Generation and Transmission Systems:<br>Radial configurations, Conditional probability approach, Network configurations<br>System and load point indices, Application to practical systems | 06 |
| 5. | Distribution Planning and Reliability:<br>Evaluation techniques, Additional interruption indices, Application to radial systems | 06 |
| 6. | Impact of Renewable Energy penetration:<br>Impact analysis of high renewable energy penetration on stability and reliability of power system. Case studies based on Solar PV and Wind generation loss. | 05 |

**Text / Reference Books:-**


1. Power System Planning - R.N. Sullivan, Tata McGraw Hill Publishing Company Ltd.
2. Modern Power System Planning - X. Wang & J.R. McDonald, McGraw Hill Book Company.
3. Electrical Power Distribution A.S. Pabla Tata McGraw Hill Publishing Company Ltd.
4. Reliability Evaluation of Engineering System - Roy Billinton & Ronald N. Allan, Springer Publication.
5. Reliability Evaluation of Power System - Roy Billinton & Ronald N. Allan, Springer Publication.
6. Electrical Power Distribution Engineering - T. Gonen, McGraw Hill Book Company.


**Website Reference/ Video Courses**:

1. **NPTEL Course:** Operation and Planning of Power Distribution Systems By Prof. Sanjib Ganguly, IIT Guwahati

**Assessment:**

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

**Theory Examination**:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be randomly selected from all the modules.

| ELECTRICAL ENGINEERING - SEMESTER-VIII | | | | | | |
|---|---|---|---|---|---|---|
| Course Code | Course Name | Teaching Scheme (Contact Hours) | | Credits assigned | | |
| **EEDO8022** | **Lighting System Design** | Theory | Pract./Tut. | Theory | Pract /Tut. | Total |
| | | **3** | **--** | **3** | **--** | **3** |

| Course Code | Course Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory | | | | | Term work | Pract./ Oral | Total |
| | | Internal Assessment | | | End Sem. Exam. | Exam. Duration (in Hrs) | | | |
| | | Test 1 | Test 2 | Avg | | | | | |
| **EEDO8022** | **Lighting System Design** | **20** | **20** | **20** | **80** | **03** | **--** | **-** | **100** |

| | |
|---|---|
| **Course Objectives** | 1. To introduce various laws of illumination, lighting parameters, light sources, luminaries and their characteristics to be used for lighting design.<br>2. To introduce lighting design considerations for interior and exterior applications.<br>3. To adapt to the LED based solid state lighting with different lighting control technologies and standards. |
| **Course outcomes** | **Upon successful completion of this course, the learner will be able to:**<br>1. Identify and describe the various laws of illumination, lighting parameters, light sources, luminaries and their Photometric characteristics.<br>2. Identify and describe various LED lighting components / subsystems, thermal management and lifetime studies.<br>3. Formulate and design an Interior Lighting system through standards, design considerations and calculation for different application areas.<br>4. Formulate and design an Exterior Lighting system through standards, design considerations and calculation for different application areas.<br>5. Identify and describe different Lighting Control schemes.<br>6. Identify and describe Solid-State Lighting technology, it's applications in Lighting for health and safety and solar powered schemes. |

| Module | Contents | Hours |
|---|---|---|
| 1. | Introduction:<br>Review of Light, Color and Photometry: Laws of illumination, illumination entities. Radiometric and photometric standards, Photometric measurement procedure-assessment of lamp efficacy, Color temperature, Colorimetry- Measurement of CRI, Glare, Solid-State Lighting: Drivers for LED lamps, standards and regulations, LED luminaries, LED Light Distributions, | 04 |
| 2. | Lamps and Luminaries:<br>Lamp: Review of development, construction and characteristics: Incandescent lamp, Discharge lamps, induction lamp, and LED lamp; LED Lighting Components and Subsystems, OLEDs, light-emitting polymers (LEPs) Thermal Management and Lifetime Studies; Luminaire: optical control, Control gear: ballast, standard and electronic, Luminaries photometry, Luminaire testing procedures | 08 |
| 3. | Interior Lighting Design & Calculation:<br>Objectives, quality and quantity of lighting. Lamp /Luminaire selection and placement, design considerations and calculation. Glare Consideration and control. Indoor lighting design by lumen method, by point by point method. Applications: residential, educational institute, industries, sports centers, commercial premises: retail stores, offices etc. Applicable standards. | 12 |
| 4. | Exterior Lighting Design & Calculation:<br>Exterior lighting system- Road lighting system, Utility area lighting, Sports lighting, Decorative flood lighting. Applicable standards | 06 |

| | | |
|---|---|---|
| 5. | Lighting Control:<br>Introduction to Lighting Control, Controls, Selection of Lighting Controls, Design of Lighting Control Scheme, Lighting and LEED, Daylighting control, Controlling LED Lighting Systems, Smart Lighting Fixtures, Digital Lighting Networks, DMX control. | 04 |
| 6. | Recent trends in Lighting:<br>Smart Street Lighting with Remote Monitoring and Control System, Solar Powered LED Lighting, Tunable White Lighting and RGB LED based Colored Lighting. Lighting for health and safety, Circadian Rhythm and Human Centric Lighting. DC Microgrid based Lighting System | 05 |

**Text Books:-**


1. Anil Valia, Designing with Light – A Lighting Handbook, International Lighting Academy
2. M. Nisa Khan, Understanding LED Illumination, CRC Press 2013
3. Anil Valia, LED LIGHTING SYSTEMS All you need to know, International Lighting Academy
4. National Lighting Code- 2011
5. Kao Chen, Energy Management in Illumination Systems, CRC Press.
6. John L. Fetters, The Hand Book of Lighting Surveys and Audits, CRC Press.


**Reference Books:-**


1. Illuminating Engineering Society, —The IES Lighting Handbook, 10th Edition
2. J. L. Lindsey and S. C. Dunning, —Applied Illumination Engineering, Third Edition, Fairmont Press, 2016
3. Lamps and Lighting – Edited by J.R. Coaton and A.M. Marsden, 4th Edition
4. Lighting for health and safety – N.A. Smith, Butterworth-Heimann.
5. Human Factors in Lighting – Peter R. Boyce, Taylor & Francis.


**Website Reference/ Video Courses**:

1. **NPTEL Course:** Illumination Engineering, Prof. N.K. Kishore**,** IIT Kharagpur

**Assessment:**

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

**Theory Examination**:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be randomly selected from all the modules.

| ELECTRICAL ENGINEERING - SEMESTER-VIII | | | | | | |
|---|---|---|---|---|---|---|
| Course Code | Course Name | Teaching Scheme (Contact Hours) | | Credits assigned | | |
| **EEDO8023** | **Cyber Physical Systems** | Theory | Pract./Tut. | Theory | Pract /Tut. | Total |
| | | **3** | **--** | **3** | **--** | **3** |

| Course Code | Course Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory | | | | | Term work | Pract./ Oral | Total |
| | | Internal Assessment | | | End Sem. Exam. | Exam. Duration (in Hrs) | | | |
| | | Test 1 | Test 2 | Avg | | | | | |
| **EEDO8023** | **Cyber Physical Systems** | **20** | **20** | **20** | **80** | **03** | **--** | **-** | **100** |

| | |
|---|---|
| **Course Objectives** | 1. To understand design, and analysis of cyber-physical systems - the tight integration of computing, control, and communication.<br>2. To explore various applications for CPS like in smart-grids, smart buildings, electric vehicle systems etc. |
| **Course outcomes** | **Upon successful completion of this course, the learner will be able to:**<br>1. Understand the Cyber-Physical Systems in the real world with hardware and software platforms.<br>2. Illustrate various automated control design aspects<br>3. Describe various methods of safety assurance in CPS<br>4. Correlate the safety aspects and attack related issues in CPS<br>5. Illustrate the impact of attack and defense against on CPS deployment in the fields like smartgrid, vehicular systems etc. |

| Module | Contents | Hours |
|---|---|---|
| 1. | Introduction:<br>Cyber-Physical Systems (CPS) in the real world, Basic principles of design and validation of CPS; CPS HW platforms: Processors, Sensors, Actuators, CPS Network, CPS SW stack RTOS, Scheduling Real Time control tasks. | 06 |
| 2. | CPS Hardware platforms:<br>Embedded systems, Hybrid systems, Control theory and systems, Computer-aided verification and synthesis, Complex networks, Programming models, Application areas: Transportation, medical devices, aerospace | 08 |
| 3. | CPS software components:<br>Mapping software components to ECUs, CPS Performance Analysis: effect of scheduling, bus latency, sense and actuation faults on control performance, network congestion | 06 |
| 4. | Principles of Automated Control Design:<br>Dynamical Systems and Stability, Controller Design Techniques. Stability Analysis: CLFs, MLFs, stability under slow switching, Performance under Packet drop and Noise. | 06 |
| 5. | Methods for Safety Assurance of Cyber-Physical Systems:<br>Advanced Automata based modelling and analysis: Basic introduction and examples, Timed and Hybrid Automata, Definition of trajectories, zenoness, Formal Analysis: Flow pipe construction, reachability analysis, Analysis of CPS Software, Weakest Pre-conditions, Bounded Model checking | 08 |
| 6. | Secure Deployment of CPS:<br>Attack models, Secure Task mapping and Partitioning, State estimation for attack detection; Case study: Vehicle ABS hacking, Power Distribution; Case study: Attacks on Smart grid. | 05 |

**Text Books:-**

1. Lee, Edward Ashford, and Sanjit Arunkumar Seshia, Introduction to embedded systems: A Cyber-physical systems Approach, Lee & Seshia, 2011.
2. Alur, Rajeev, Principles of Cyber-Physical Systems, MIT Press, 2015.\
3. Raj Rajkumar, Dionisio de Niz and Mark Klein, Cyber-Physical Systems, Addison Wisley, 2017
4. Wolf, Marilyn. High-Performance Embedded Computing: Applications in Cyber-Physical Systems and Mobile Computing. Elsevier, 2014**.**
5. T. D. Lewis "Network Science: Theory and Applications", Wiley, 2009.
6. P. Tabuada, "Verification and control of hybrid systems: a symbolic approach", Springer-Verlag 2009.
7. C. Cassandras, S. Lafortune, "Introduction to Discrete Event Systems", Springer 2007.
8. Constance Heitmeyer and Dino Mandrioli, "Formal methods for real-time computing", Wiley publisher, 1996

**Assessment:**
Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

**Theory Examination**:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be randomly selected from all the modules.

| ELECTRICAL ENGINEERING - SEMESTER-VIII | | | | | | |
|---|---|---|---|---|---|---|
| Course Code | Course Name | Teaching Scheme (Contact Hours) | | Credits assigned | | |
| **EEDO8024** | **Electric Vehicle System Design** | Theory | Pract./Tut. | Theory | Pract /Tut. | Total |
| | | **3** | **--** | **3** | **--** | **3** |

| Course Code | Course Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory | | | | | Term work | Pract./ Oral | Total |
| | | Internal Assessment | | | End Sem. Exam. | Exam. Duration (in Hrs) | | | |
| | | Test 1 | Test 2 | Avg | | | | | |
| **EEDO8024** | **Electric Vehicle System Design** | **20** | **20** | **20** | **80** | **03** | **--** | **-** | **100** |

| | |
|---|---|
| **Course Objectives** | 1. To illustrate the design philosophies used in the EV domain.<br>2. To explore the selection of power and control architecture of EV drives<br>3. To study the design aspects of EV battery packs and other auxiliary systems |
| **Course outcomes** | **Upon successful completion of this course, the learner will be able to**<br>1. To select and size the electric motor for a particular EV application and performance criteria<br>2. To select and size the battery pack to meet desired EV performance and<br>3. To design the EV drive system with functional safety considerations.<br>4. To illustrate the use of hybrid energy source for EV performance improvement<br>5. To illustrate the design aspects of Automotive Subsystem<br>6. To design the EV chargers and charging infrastructure |

| Module | Contents | Hours |
|---|---|---|
| 1. | **Selection and Sizing of EV Electric Motors:**<br>Electric Vehicle modelling, Tractive force calculations, Design considerations for 2Wand 4W EVs; Torque, power and Speed requirement, Traction Limit, Maximum Acceleration Limit, Maximum Grade Limit. Vehicle Power Demand during Driving Cycles. Application Examples of EV /HEV motors with vehicles and motor specifications. | 07 |
| 2. | **Selection and Sizing of Energy Storage for EV:**<br>Selection of type of Battery pack for 2W and 4W EVs; Battery pack sizing: Design considerations: Range per charge, range anxiety, EV motor power requirement; Impact of road conditions, environmental conditions and traffic conditions.<br>Selection and sizing of Fuel cell for FCEV, design considerations; Battery-ultra-capacitor hybrid combination sizing, performance analysis. | 08 |
| 3. | **Automotive Subsystem Design:**<br>Electronic Control Unit (ECU) and its Control Features, Communications between ECUs. Acceleration and braking control, regenerative braking; Automotive Steering Systems. Design considerations of HVAC controller | 06 |
| 4. | **EV System integration:**<br>EMC design on ECU level, EMC design on system level and in special subsystems, Radiated emissions and Conducted emissions, EMI EMC measurements. | 04 |
| 5. | **Design of EV Chargers:**<br>Design considerations for AC charger: vehicle interface and charging protocol design. applicable charging standards<br>Design of On-Board Charger (OBC)-Schematic, power topology and control, Power capacities.<br>Design considerations of DC fast charger: vehicle interface and charging protocol design. Connectivity and applicable charging standards | 08 |
| 6. | **Functional Safety of Automotive Electronics:** | 06 |

| | | |
|---|---|---|
| | Functional Safety requirements of Automotive Electronics; ASIL identification and safety goal finalization, ISO 26262.<br>Energy Storage integrity / protection: rupture and toxic gas management; low energy stranding, Unintended vehicle movement, shock protection, and Elimination of potential thermal/ explosive event. | |

**Text / Reference Books:-**


1. Design and Control of Automotive Propulsion Systems by Zongxuan Sun and Guoming Zhu, CRC Press, 2015
2. Electric Vehicle Machines and Drives Design, Analysis and Application by K. T. Chau, IEEE Press and Wiley, 2015
3. I. Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
4. M. Ehsani, Y. Gao, S.E. Gay and Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press. 2005
5. Sheldon Williamsom, Energy Management Strategies for Electric and Plug-in Hybrid Vehicles, Springer 2013
6. J. Larminie and J. Lowry, Electric Vehicle Technology Explained, Wiley, 2003
7. EMC and Functional Safety of Automotive Electronics by Kai Borgeest, IET, 2018


**Website Reference/ Video Courses**:

1. NPTEL Web Course: Electric Vehicles - Part 1 by Prof. Amit Kumar Jain D IIT Delhi
2. NPTEL Web Course: Fundamentals of Electric vehicles: Technology & Economics, by Prof. Ashok Jhunjhunwala, Prof. Prabhjot Kaur, Prof. Kaushal Kumar Jha and Prof. L Kannan, IIT Madras,
3. NPTEL Web Course: Introduction to Hybrid and Electric Vehicles by Dr. Praveen Kumar and Prof. S. Majhi, IIT Guwahati
4. Infineon's IGBT Simulation Tools: https://www.infineon.com/cms/en/tools/landing/igbt.html
5. Semikron Semisel: https://www.semikron.com/service-support/semisel-simulation.html

**Assessment:**

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

**Theory Examination**:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be randomly selected from all the modules.

| ELECTRICAL ENGINEERING - SEMESTER-VIII | | | | | | |
|---|---|---|---|---|---|---|
| Course Code | Course Name | Teaching scheme (Contact Hours) | | Credits Assigned | | |
| **EEIO8021** | **Project Management** | Theory | Pract./Tut. | Theory | Pract./Tut. | Total |
| | | **3** | **--** | **3** | **--** | **3** |

| Course code | Course Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory | | | | | Term Work | Oral | Total |
| | | Internal Assessment | | | End Sem. Exam | Exam Duration (in Hrs) | | | |
| | | Test 1 | Test 2 | Avg | | | | | |
| **EEIO8021** | **Project Management** | **20** | **20** | **20** | **80** | **3** | **--** | **--** | **100** |

| | |
|---|---|
| Course Objectives | 1. To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques.<br>2. To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure. |
| Course Outcomes | Upon successful completion of this course, the learner will be able to:<br>1. Apply selection criteria and select an appropriate project from different options.<br>2. Write work break down structure for a project and develop a schedule based on it.<br>3. Identify opportunities and threats to the project and decide an approach to deal with them strategically.<br>4. Use Earned value technique and determine & predict status of the project.<br>5. Capture lessons learned during project phases and document them for future reference |

| Module | Contents | Hours |
|---|---|---|
| 1 | **Project Management Foundation:**<br>Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager, Negotiations and resolving conflicts, Project management in various organization structures, PM knowledge areas as per Project Management Institute (PMI) | 05 |
| 2 | **Initiating Projects:**<br>How to get a project started, selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming &performing), team dynamics. | 06 |
| 3 | **Project Planning and Scheduling:**<br>Work Breakdown structure (WBS) and linear responsibility chart, Interface; Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart, Introduction to Project Management Information System (PMIS). | 08 |
| 4 | **Planning Projects:**<br>Crashing project time, Resource loading and levelling, Goldratt's critical chain, Project Stakeholders and Communication plan<br>Risk Management in projects: Risk management planning, Risk identification and risk register, Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks | 06 |

| | | |
|---|---|---|
| 5 | **5.1 Executing Projects:**<br>Planning monitoring and controlling cycle, Information needs and reporting, engaging with all stakeholders of the projects, Team management, communication and project meetings<br>**5.2 Monitoring and Controlling Projects:**<br>Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep, Project audit<br>**5.3 Project Contracting**<br>Project procurement management, contracting and outsourcing, | 08 |
| 6 | **6.1 Project Leadership and Ethics:**<br>Introduction to project leadership, ethics in projects, Multicultural and virtual projects<br>**6.2 Closing the Project:**<br>Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study. | 06 |

**References:**


1. Project Management: A managerial approach, Jack Meredith & Samuel Mantel, 7th Edition, Wiley India
2. A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 5th Ed, Project Management Institute PA, USA
3. Project Management, Gido Clements, Cengage Learning
4. Project Management, Gopalan, Wiley India
5. Project Management, Dennis Lock, 9th Edition, Gower Publishing England


**Assessment:**

**Internal Assessment for 20 marks:**

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

**End Semester Examination:**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then, part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

| ELECTRICAL ENGINEERING - SEMESTER-VIII | | | | | | |
|---|---|---|---|---|---|---|
| Course Code | Course Name | Teaching scheme (Contact Hours) | | Credits Assigned | | |
| **EEIO8022** | **Finance Management** | Theory | Pract./Tut. | Theory | Pract./Tut. | Total |
| | | **3** | **--** | **3** | **--** | **3** |

| Course code | Course Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory | | | | | Term Work | Oral | Total |
| | | Internal Assessment | | | End Sem. Exam | Exam Duration (in Hrs) | | | |
| | | Test 1 | Test 2 | Avg | | | | | |
| **EEIO8022** | **Finance Management** | **20** | **20** | **20** | **80** | **3** | **--** | **--** | **100** |

| | |
|---|---|
| Course Objectives | 1. To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques.<br>2. To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure. |
| Course Outcomes | Upon successful completion of this course, the learner will be able to:<br>1 Understand Indian finance system and corporate finance<br>2 Take investment, finance as well as dividend decisions |

| Module | Contents | Hours |
|---|---|---|
| 1 | **Overview of Indian Financial System:** Characteristics, Components and Functions of Financial System.<br>**Financial Instruments:** Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills.<br>**Financial Markets:** Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market<br>**Financial Institutions:** Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges | 06 |
| 2 | **Concepts of Returns and Risks:** Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio.<br>**Time Value of Money:** Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting. | 06 |
| 3 | **Overview of Corporate Finance:** Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision.<br>**Financial Ratio Analysis:** Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis. | 09 |

| | | |
|---|---|---|
| 4 | **Capital Budgeting:** Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR)<br>**Working Capital Management:** Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities. | 10 |
| 5 | **Sources of Finance:** Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance.<br>**Capital Structure:** Factors Affecting an Entity's Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure | 05 |
| 6 | **Dividend Policy:** Meaning and Importance of Dividend Policy; Factors Affecting an Entity's Dividend Decision; Overview of Dividend Policy Theories and Approaches—Gordon's Approach, Walter's Approach, and Modigliani-Miller Approach | 03 |

**References:**


1. Fundamentals of Financial Management, 13th Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.
2. Analysis for Financial Management, 10th Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi.
3. Indian Financial System, 9th Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.
4. Financial Management, 11th Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) & Company Limited, New Delhi.


**Assessment:**

**Internal Assessment for 20 marks:**

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

**End Semester Examination:**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then, part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

| ELECTRICAL ENGINEERING - SEMESTER-VIII | | | | | | |
|---|---|---|---|---|---|---|
| Course Code | Course Name | Teaching scheme (Contact Hours) | | Credits Assigned | | |
| **EEIO8023** | **Entrepreneurship Development and Management** | Theory | Pract./Tut. | Theory | Pract./Tut. | Total |
| | | **3** | **--** | **3** | **--** | **3** |

| Course code | Course Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory | | | | | Term Work | Oral | Total |
| | | Internal Assessment | | | End Sem. Exam | Exam Duration (in Hrs) | | | |
| | | Test 1 | Test 2 | Avg | | | | | |
| **EEIO8023** | **Entrepreneurship Development and Management** | **20** | **20** | **20** | **80** | **3** | **--** | **--** | **100** |

| | |
|---|---|
| Course Objectives | 1 To acquaint with entrepreneurship and management of business<br>2 Understand Indian environment for entrepreneurship<br>3 Idea of EDP, MSME |
| Course Outcomes | Upon successful completion of this course, the learner will be able to:<br>1 Understand the concept of business plan and ownerships<br>2 Interpret key regulations and legal aspects of entrepreneurship in India<br>3 Understand government policies for entrepreneurs |

| Module | Contents | Hours |
|---|---|---|
| 1 | **Overview of Entrepreneurship:** Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership<br>Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship | 04 |
| 2 | **Business Plans and Importance of Capital to Entrepreneurship:** Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur<br>**Entrepreneurship and Business Development:** Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations | 09 |
| 3 | Women's Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises | 05 |
| 4 | **Indian Environment for Entrepreneurship:** key regulations and legal aspects, MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc.,<br>Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc. | 08 |
| 5 | **Effective Management of Business:** Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing | 08 |

| | | |
|---|---|---|
| 6 | **Achieving Success In The Small Business:** Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business | 05 |

**References:**


1. Poornima Charantimath, Entrepreneurship development- Small Business Enterprise, Pearson
2. Education Robert D Hisrich, Michael P Peters, Dean A Shapherd, Entrepreneurship, latest edition, The McGrawHill Company
3. Dr TN Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
4. Dr CN Prasad, Small and Medium Enterprises in Global Perspective, New century Publications, New Delhi
5. Vasant Desai, Entrepreneurial development and management, Himalaya Publishing House
6. Maddhurima Lall, Shikah Sahai, Entrepreneurship, Excel Books
7. Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad
8. Law and Practice relating to Micro, Small and Medium enterprises, Taxmann Publication Ltd.
9. Kurakto, Entrepreneurship- Principles and Practices, Thomson Publication
10. Laghu Udyog Samachar
11. www.msme.gov.in
12. www.dcmesme.gov.in
13. www.msmetraining.gov.in


**Assessment:**

**Internal Assessment for 20 marks:**

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

**End Semester Examination:**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then, part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

| ELECTRICAL ENGINEERING - SEMESTER-VIII | | | | | | |
|---|---|---|---|---|---|---|
| Course Code | Course Name | Teaching scheme (Contact Hours) | | Credits Assigned | | |
| **EEIO8024** | **Human Resource Management** | Theory | Pract./Tut. | Theory | Pract./Tut. | Total |
| | | **3** | **--** | **3** | **--** | **3** |

| Course code | Course Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory | | | | | Term Work | Oral | Total |
| | | Internal Assessment | | | End Sem. Exam | Exam Duration (in Hrs) | | | |
| | | Test 1 | Test 2 | Avg | | | | | |
| **EEIO8024** | **Human Resource Management** | **20** | **20** | **20** | **80** | **3** | **--** | **--** | **100** |

| | |
|---|---|
| Course Objectives | 1 To introduce the students with basic concepts, techniques and practices of the human resource management<br>2 To provide opportunity of learning Human resource management (HRM) processes, related with the functions, and challenges in the emerging perspective of today's organizations<br>3 To familiarize the students about the latest developments, trends & different aspects of HRM<br>4 To acquaint the student with the importance of inter-personal & inter-group behavioural skills in an organizational setting required for future stable engineers, leaders and managers |
| Course Outcomes | Upon successful completion of this course, the learner will be able to:<br>1 Understand the concepts, aspects, techniques and practices of the human resource management.<br>2 Understand the Human resource management (HRM) processes, functions, changes and challenges in today's emerging organizational perspective.<br>3 Gain knowledge about the latest developments and trends in HRM.<br>4 Apply the knowledge of behavioural skills learnt and integrate it with in inter personal and intergroup environment emerging as future stable engineers and managers. |

| Module | Contents | Hours |
|---|---|---|
| 1 | **Introduction to HR**<br>• Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions<br>• Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues | 05 |
| 2 | **Organizational Behaviour (OB)**<br>• Introduction to OB Origin, Nature and Scope of Organizational Behaviour, Relevance to Organizational Effectiveness and Contemporary issues<br>• Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness<br>• Perception: Attitude and Value, Effect of perception on Individual Decision-making, Attitude and Behaviour<br>• Motivation: Theories of Motivation and their Applications for Behavioural Change (Maslow, Herzberg, McGregor);<br>• Group Behaviour and Group Dynamics: Work groups formal and informal groups and stages of group development, Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team.<br>Case study | 07 |

| | | |
|---|---|---|
| 3 | **Organizational Structure &Design**<br>• Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and stress.<br>• Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership.<br>• Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies. | 06 |
| 4 | **Human resource Planning**<br>• Recruitment and Selection process, Job-enrichment, Empowerment – Job Satisfaction, employee morale<br>• Performance Appraisal Systems: Traditional & modern methods, Performance Counselling, Career Planning<br>Training & Development: Identification of Training Needs, Training Methods | 05 |
| 5 | **Emerging Trends in HR**<br>• Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development, managing processes & transformation in HR. Organizational Change, Culture, Environment<br>• Cross Cultural Leadership and Decision Making**:** Cross Cultural Communication and diversity at work**,** Causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation | 06 |
| 6 | **HR & MIS:** Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and service industries<br>**Strategic HRM:** Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals<br>**Labor Laws & Industrial Relations:** Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act | 10 |

**References:**


1. Stephen Robbins, Organizational Behavior, 16th Ed, 2013
2. V S P Rao, Human Resource Management, 3rd Ed, 2010, Excel publishing
3. Aswathapa, Human resource management: Text & cases, 6th edition, 2011
4. C. B. Mamoria and S V Gankar, Dynamics of Industrial Relations in India, 15th Ed, 2015, Himalaya Publishing, 15thedition, 2015
5. P. Subba Rao, Essentials of Human Resource management and Industrial relations, 5th Ed, 2013, Himalaya Publishing
6. Laurie Mullins, Management & Organizational Behavior, 2016, Pearson Publications


**Assessment:**

**Internal Assessment for 20 marks:**

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

**End Semester Examination:**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3, then part (b) will, be from any module other than module 3)

4. Only **Four questions need to be solved**.

| ELECTRICAL ENGINEERING - SEMESTER-VIII | | | | | | |
|---|---|---|---|---|---|---|
| Course Code | Course Name | Teaching scheme (Contact Hours) | | Credits Assigned | | |
| **EEIO8025** | **Professional Ethics and Corporate Social Responsibility (CSR)** | Theory | Pract./Tut. | Theory | Pract./Tut. | Total |
| | | **3** | **--** | **3** | **--** | **3** |

| Course code | Course Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory | | | | | Term Work | Oral | Total |
| | | Internal Assessment | | | End Sem. Exam | Exam Duration (in Hrs) | | | |
| | | Test 1 | Test 2 | Avg | | | | | |
| **EEIO8025** | **Professional Ethics and Corporate Social Responsibility (CSR)** | **20** | **20** | **20** | **80** | **3** | **--** | **--** | **100** |

| | |
|---|---|
| **Course Objectives** | 1 To understand professional ethics in business<br>2 To recognized corporate social responsibility |
| **Course Outcomes** | Upon successful completion of this course, the learner will be able to:<br>1 Understand rights and duties of business<br>2 Distinguish different aspects of corporate social responsibility<br>3 Demonstrate professional ethics<br>4 Understand legal aspects of corporate social responsibility |

| Module | Contents | Hours |
|---|---|---|
| 1 | **Professional Ethics and Business:** The Nature of Business Ethics; Ethical Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business | 04 |
| 2 | **Professional Ethics in the Marketplace:** Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy<br>**Professional Ethics and the Environment:** Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources | 08 |
| 3 | **Professional Ethics of Consumer Protection:** Markets and Consumer Protection; Contract View of Business Firm's Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy<br>**Professional Ethics of Job Discrimination:** Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs. | 06 |
| 4 | **Introduction to Corporate Social Responsibility:** Potential Business Benefits—Triple bottom line, Human resources, Risk management, Supplier relations; Criticisms and concerns—Nature of business; Motives; Misdirection. Trajectory of Corporate Social Responsibility in India | 05 |
| 5 | **Corporate Social Responsibility:** Articulation of Gandhian Trusteeship<br>Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP) in India | 08 |
| 6 | **Corporate Social Responsibility in Globalizing India:** Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility—Companies Act, 2013. | 08 |

**References:**


1. Business Ethics: Texts and Cases from the Indian Perspective (2013) by Ananda Das Gupta; Publisher: Springer.
2. Corporate Social Responsibility: Readings and Cases in a Global Context (2007) by Andrew Crane, Dirk Matten, Laura Spence; Publisher: Routledge.
3. Business Ethics: Concepts and Cases, 7th Edition (2011) by Manuel G. Velasquez; Pearson, New Delhi.
4. Corporate Social Responsibility in India (2015) by Bidyut Chakrabarty, Routledge, New Delhi.


**Assessment:**

**Internal Assessment for 20 marks:**

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

**End Semester Examination:**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then, part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

| ELECTRICAL ENGINEERING - SEMESTER-VIII | | | | | | |
|---|---|---|---|---|---|---|
| Course Code | Course Name | Teaching scheme (Contact Hours) | | Credits Assigned | | |
| **EEIO8026** | **Research Methodology** | Theory | Pract./Tut. | Theory | Pract./Tut. | Total |
| | | **3** | **--** | **3** | **--** | **3** |

| Course code | Course Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory | | | | | Term Work | Oral | Total |
| | | Internal Assessment | | | End Sem. Exam | Exam Duration (in Hrs) | | | |
| | | Test 1 | Test 2 | Avg | | | | | |
| **EEIO8026** | **Research Methodology** | **20** | **20** | **20** | **80** | **3** | **--** | **--** | **100** |

| | |
|---|---|
| **Course Objectives** | 1 To understand Research and Research Process<br>2 To acquaint students with identifying problems for research and develop research strategies<br>3 To familiarize students with the techniques of data collection, analysis of data and interpretation |
| **Course Outcomes** | Upon successful completion of this course, the learner will be able to:<br>1 Prepare a preliminary research design for projects in their subject matter areas<br>2 Accurately collect, analyze and report data<br>3 Present complex data or situations clearly<br>4 Review and analyze research findings |

| Module | Contents | Hours |
|---|---|---|
| 1 | **Introduction and Basic Research Concepts**<br>**1.1** Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Research methods vs Methodology<br>**1.2** Need of Research in Business and Social Sciences<br>**1.3** Objectives of Research<br>**1.4 Issues** and Problems in Research<br>**1.5** Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical | 09 |
| 2 | **Types of Research**<br>**2.1.** Basic Research<br>**2.2.** Applied Research<br>**2.3.** Descriptive Research<br>**2.4.** Analytical Research<br>**2.5.** Empirical Research<br>**2.6** Qualitative and Quantitative Approaches | 07 |
| 3 | **Research Design and Sample Design**<br>**3.1** Research Design – Meaning, Types and Significance<br>**3.2** Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors | 07 |

| | | |
|---|---|---|
| 4 | **Research Methodology**<br>**4.1** Meaning of Research Methodology **4.2**.<br>Stages in Scientific Research Process:<br>**a.** Identification and Selection of Research Problem<br>**b.** Formulation of Research Problem<br>**c.** Review of Literature<br>**d.** Formulation of Hypothesis<br>**e.** Formulation of research Design<br>**f.** Sample Design<br>**g.** Data Collection<br>**h.** Data Analysis<br>**i.** Hypothesis testing and Interpretation of Data<br>**j.** Preparation of Research Report | 08 |
| 5 | **Formulating Research Problem**<br>**5.1** Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis | 04 |
| 6 | **Outcome of Research**<br>**6.1** Preparation of the report on conclusion reached<br>**6.2** Validity Testing & Ethical Issues<br>**6.3** Suggestions and Recommendation | 04 |

**References:**


1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers Distributors.
2. Kothari, C.R.,1985, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2nded), Singapore, Pearson Education


**Assessment:**

**Internal Assessment for 20 marks:**

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

**End Semester Examination:**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

| ELECTRICAL ENGINEERING - SEMESTER-VIII | | | | | | |
|---|---|---|---|---|---|---|
| Course Code | Course Name | Teaching scheme (Contact Hours) | | Credits Assigned | | |
| **EEIO8027** | **IPR and Patenting** | Theory | Pract./Tut. | Theory | Pract./Tut. | Total |
| | | **3** | **--** | **3** | **--** | **3** |

| Course code | Course Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory | | | | | Term Work | Oral | Total |
| | | Internal Assessment | | | End Sem. Exam | Exam Duration (in Hrs) | | | |
| | | Test 1 | Test 2 | Avg | | | | | |
| **EEIO8027** | **IPR and Patenting** | **20** | **20** | **20** | **80** | **3** | **--** | **--** | **100** |

| | |
|---|---|
| Course Objectives | 1 To understand intellectual property rights protection system<br>2 To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures<br>3 To get acquaintance with Patent search and patent filing procedure and applications |
| Course Outcomes | Upon successful completion of this course, the learner will be able to:<br>1 understand Intellectual Property assets<br>2 assist individuals and organizations in capacity building<br>3 work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting |

| Module | Contents | Hours |
|---|---|---|
| 01 | **Introduction to Intellectual Property Rights (IPR)**: Meaning of IPR, Different category of IPR instruments - Patents, Trademarks, Copyrights, Industrial Designs, Plant variety protection, Geographical indications, Transfer of technology etc.<br>**Importance of IPR in Modern Global Economic Environment:** Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development | 05 |
| 02 | **Enforcement of Intellectual Property Rights:** Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) active in IPR enforcement<br>**Indian Scenario of IPR:** Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc. | 07 |
| 03 | **Emerging Issues in IPR:** Challenges for IP in digital economy, e-commerce, human genome, biodiversity and traditional knowledge etc. | 05 |
| 04 | **Basics of Patents:** Definition of Patents, Conditions of patentability, Patentable and non-patentable inventions, Types of patent applications (e.g. Patent of addition etc.), Process Patent and Product Patent, Precautions while patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method of getting a patent | 07 |
| 05 | **Patent Rules:** Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.) | 08 |

| | | |
|---|---|---|
| 06 | **Procedure for Filing a Patent (National and International):** Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publication, Time frame and cost, Patent Licensing, Patent Infringement<br>**Patent databases:** Important websites, Searching international databases | 07 |

**REFERENCE BOOKS:**


1. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants of India
2. Keayla B K, Patent system and related issues at a glance, Published by National Working Group on Patent Laws
3. T Sengupta, 2011, Intellectual Property Law in India, Kluwer Law International
4. Tzen Wong and Graham Dutfield, 2010, Intellectual Property and Human Development: Current Trends and Future Scenario, Cambridge University Press
5. Cornish, William Rodolph & Llewelyn, David. 2010, Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right, 7th Edition, Sweet & Maxwell
6. Lous Harns, 2012, The enforcement of Intellectual Property Rights: A Case Book, 3rd Edition, WIPO
7. Prabhuddha Ganguli, 2012, Intellectual Property Rights, 1st Edition, TMH
8. R Radha Krishnan & S Balasubramanian, 2012, Intellectual Property Rights, 1st Edition, Excel Books
9. M Ashok Kumar and mohd Iqbal Ali, 2-11, Intellectual Property Rights, 2nd Edition, Serial Publications
10. Kompal Bansal and Praishit Bansal, 2012, Fundamentals of IPR for Engineers, 1st Edition, BS Publications
11. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, A Manual on Intellectual Property Rights,
12. Mathew Y Maa, 2009, Fundamentals of Patenting and Licensing for Scientists and Engineers, World Scientific Publishing Company
13. N S Rathore, S M Mathur, Priti Mathur, Anshul Rathi**,** IPR: Drafting, Interpretation of Patent Specifications and Claims**,** New India Publishing Agency
14. Vivien Irish, 2005, Intellectual Property Rights for Engineers, IET
15. Howard B Rockman, 2004, Intellectual Property Law for Engineers and scientists, Wiley-IEEE Press


**Assessment:**

**Internal Assessment for 20 marks:**

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

**End Semester Examination:**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then, part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

| ELECTRICAL ENGINEERING - SEMESTER-VIII | | | | | | |
|---|---|---|---|---|---|---|
| Course Code | Course Name | Teaching scheme (Contact Hours) | | Credits Assigned | | |
| **EEIO8028** | **Digital Business Management** | Theory | Pract./Tut. | Theory | Pract./Tut. | Total |
| | | **3** | **--** | **3** | **--** | **3** |

| Course code | Course Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory | | | | | Term Work | Oral | Total |
| | | Internal Assessment | | | End Sem. Exam | Exam Duration (in Hrs) | | | |
| | | Test 1 | Test 2 | Avg | | | | | |
| **EEIO8028** | **Digital Business Management** | **20** | **20** | **20** | **80** | **3** | **--** | **--** | **100** |

| | |
|---|---|
| Course Objectives | 1 To familiarize with digital business concept<br>2 To acquaint with E-commerce<br>3 To give insights into E-business and its strategies |
| Course Outcomes | Upon successful completion of this course, the learner will be able to:<br>1 Identify drivers of digital business<br>2 Illustrate various approaches and techniques for E-business and management<br>3 Prepare E-business plan |

| Module | Content | Hours |
|---|---|---|
| 1 | **Introduction to Digital Business-**<br>Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts, Difference between physical economy and digital economy.<br>**Drivers of digital business**- Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things (digitally intelligent machines/services), Opportunities and Challenges in Digital Business | 09 |
| 2 | **Overview of E-Commerce**<br>**E-Commerce-** Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement<br>B2B-E-commerce-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, Intra business EC and Corporate portals<br>Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing<br>EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e-commerce business, Launching a successful online business and EC project, Legal, Ethics and Societal impacts of EC | 06 |
| 3 | **Digital Business Support services**: ERP as e –business backbone, knowledge Tope Apps, Information and referral system<br>**Application Development:** Building Digital business Applications and infrastructure | 06 |
| 4 | **Managing E-Business**-Managing Knowledge, Management skills for e-business, managing Risks in e –business, Security Threats to e-business -Security Overview, Electronic Commerce Threats, Encryption, Cryptography, Public Key and Private Key Cryptography, Digital Signatures, Digital Certificates, Security Protocols over Public Networks: HTTP, SSL, Firewall as Security Control, Public Key Infrastructure (PKI) for Security, Prominent Cryptographic Applications | 06 |

| | | |
|---|---|---|
| 5 | **E-Business Strategy**-E-business Strategic formulation- Analysis of Company's Internal and external environment, Selection of strategy, E-business strategy into Action, challenges and E-Transition (Process of Digital Transformation) | 04 |
| 6 | **Materializing e-business:** From Idea to Realization-Business plan preparation Case Studies and presentations | 08 |

**References:**


1. A textbook on E-commerce**,** Er Arunrajan Mishra, Dr W K Sarwade, Neha Publishers & Distributors, 2011
2. E-commerce from vision to fulfilment, Elias M. Awad, PHI-Restricted, 2002
3. Digital Business and E-Commerce Management, 6th Ed, Dave Chaffey, Pearson, August 2014
4. Introduction to E-business-Management and Strategy, Colin Combe, ELSVIER, 2006
5. Digital Business Concepts and Strategy, Eloise Coupey, 2nd Edition, Pearson
6. Trend and Challenges in Digital Business Innovation, Vinocenzo Morabito, Springer
7. Digital Business Discourse Erika Darics, April 2015, Palgrave Macmillan
8. E-Governance-Challenges and Opportunities in Proceedings in 2nd International Conference theory and practice of Electronic Governance
9. Perspectives the Digital Enterprise –A framework for Transformation, TCS consulting journal Vol.5
10. Measuring Digital Economy-A new perspective- DoI:10.1787/9789264221796-enOECD Publishing


**Assessment:**

**Internal Assessment for 20 marks:**

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

**End Semester Examination:**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then, part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

| ELECTRICAL ENGINEERING - SEMESTER-VIII | | | | | | |
|---|---|---|---|---|---|---|
| Course Code | Course Name | Teaching scheme (Contact Hours) | | Credits Assigned | | |
| **EEIO8029** | **Environmental Management** | Theory | Pract./Tut. | Theory | Pract./Tut. | Total |
| | | **3** | **--** | **3** | **--** | **3** |

| Course code | Course Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory | | | | | Term Work | Oral | Total |
| | | Internal Assessment | | | End Sem. Exam | Exam Duration (in Hrs) | | | |
| | | Test 1 | Test 2 | Avg | | | | | |
| **EEIO8029** | **Environmental Management** | **20** | **20** | **20** | **80** | **3** | **--** | **--** | **100** |

| | |
|---|---|
| Course Objectives | 1 Understand and identify environmental issues relevant to India and global concerns<br>2 Learn concepts of ecology<br>3 Familiarise environment related legislations |
| Course Outcomes | Upon successful completion of this course, the learner will be able to:<br>1 Understand the concept of environmental management<br>2 Understand ecosystem and interdependence, food chain etc.<br>3 Understand and interpret environment related legislations |

| Module | Contents | Hours |
|---|---|---|
| 1 | Introduction and Definition of Environment: Significance of Environment Management for contemporary managers, Career opportunities, Environmental issues relevant to India, Sustainable Development, the Energy scenario | 10 |
| 2 | Global Environmental concerns : Global Warming, Acid Rain, Ozone Depletion, Hazardous Wastes, Endangered life-species, Loss of Biodiversity, Industrial/Man-made disasters, Atomic/Biomedical hazards, etc. | 06 |
| 3 | Concepts of Ecology: Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc. | 05 |
| 4 | Scope of Environment Management, Role and functions of Government as a planning and regulating agency<br>Environment Quality Management and Corporate Environmental Responsibility | 10 |
| 5 | Total Quality Environmental Management, ISO-14000, EMS certification. | 05 |
| 6 | General overview of major legislations like Environment Protection Act, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act, etc. | 03 |

**References:**


1. Environmental Management: Principles and Practice, C J Barrow, Routledge Publishers London, 1999
2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G. Ockwell, Edward Elgar Publishing
3. Environmental Management, **T V Ramachandra and Vijay Kulkarni, TERI Press**
4. Indian Standard Environmental Management Systems — Requirements With Guidance For Use, Bureau Of Indian Standards, February 2005
5. Environmental Management: An Indian Perspective, S N Chary and Vinod Vyasulu, Maclillan India, 2000

6. Introduction to Environmental Management, Mary K Theodore and Louise Theodore, CRC Press
Environment and Ecology, Majid Hussain, 3rd Ed. Access Publishing.2015

**Assessment:**

**Internal Assessment for 20 marks:**

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

**End Semester Examination:**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

| ELECTRICAL ENGINEERING - SEMESTER-VIII | | | | | | |
|---|---|---|---|---|---|---|
| Course Code | Course Name | Teaching scheme (Contact Hours) | | Credits Assigned | | |
| **EEL801** | **Electrical System Design and Audit Lab** | Theory | Pract./Tut. | Theory | Pract./Tut. | Total |
| | | -- | **2** | | **1** | **1** |

| Course Code | Course Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory | | | | | Term Work | Oral | Total |
| | | Internal Assessment | | | End Sem. Exam | Exam Duration (in Hrs) | | | |
| | | Test 1 | Test 2 | Avg | | | | | |
| **EEL801** | **Electrical System Design and Audit Lab** | --- | --- | --- | --- | -- | **25** | **25** | **50** |

| | |
|---|---|
| **Course Objectives** | To explore the effectiveness of various energy efficient technologies from design and utilization perspective. |
| **Course outcomes** | Upon successful completion of this course, the learner will be able:<br>1. Prepare the SLD for electrical system<br>2. Evaluate the energy efficiency of the electrical systems<br>3. Size and select the cable for electrical distribution network<br>4. Analyse the impact of various energy efficient technologies<br>5. Illustrate the impact of fuel substitution on energy consumption<br>6. Design energy efficient electrical system |

Syllabus: Same as that of Courses of Sem-VIII EEC801: Electrical System Design, Management and Auditing

Suggested List of Tutorials/Case Studies/ Experiments

1) Tutorial on developing of Single line diagram of your own house
2) Tutorial on illumination system for the given installation
3) Tutorial on EELD (Energy Efficient Lighting Design) in comparison to Standard lighting design in terms of LPD
4) Tutorial on designing of power distribution network for a given installation
5) Tutorial on sizing and selection of Cables for electrical distribution network
6) Tutorial Motor retrofitting by Energy Efficient Motor
7) Tutorial on CUSUM analysis of a given installation
8) Case Study on analysing the effectiveness of power factor improvement towards improving energy efficiency
9) Case Study on analysing effectiveness of VFD in comparison to Damper control
10) Case study on fuel substitution
11) Experimentation to analyse energy efficiency of VFD based Pumping System
12) Experimentation to analyse energy efficiency of different lamps (T5, T8, CFL, and LED lamp)
13) Experimentation to analyse the effectiveness of power factor improvement based installation
14) Conduction of preliminary audit of any section / facility/ department of engineering institute or nearby industry
15) Conduction of detailed audit of any section / facility/ department of engineering institute or nearby industry

Any other experiment/ case study / tutorial based on the syllabus which will help students to understand the topic/concept.

Term work:
Term work shall consist of minimum eight tutorials /case studies/ experiments.

The distribution of marks shall be as follows:

| | |
|---|---|
| Experiments Performance | : 10 marks |
| Journal | : 10 marks |
| Attendance | : 05 marks |

The final certification and acceptance of term work ensures the minimum passing in the term work.

Oral Examination:
Oral examination will be based on entire syllabus of 'EEC801: Electrical System Design, Management and Auditing' and EEL801

| ELECTRICAL ENGINEERING - SEMESTER-VII | | | | | | |
|---|---|---|---|---|---|---|
| Course code | Course Name | Teaching scheme (Contact Hours) | | Credits Assigned | | |
| **EEL802** | **Measurement and Instrumentation Lab** | Theory | Pract./Tut. | Theory | Pract./Tut. | Total |
| | | -- | **2** | | **1** | **1** |

| Course code | Course Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory | | | | | Term Work | Oral | Total |
| | | Internal Assessment | | | End Sem. Exam | Exam Duration (in Hrs) | | | |
| | | Test 1 | Test 2 | Avg | | | | | |
| **EEL802** | **Measurement and Instrumentation Lab** | --- | --- | --- | --- | -- | **25** | **25** | **50** |

| | |
|---|---|
| **Course Objectives** | 1. To get acquainted with analog and digital measurement and instrumentation<br>2. To illustrate the challenges in real time measurements |
| **Course outcomes** | Upon successful completion of this course, the learner will be able to<br>5. Understand the construction, principle and characteristics of different types of digital measuring instruments<br>6. Apply the knowledge about different instruments and can identify the best suitable instrument for a required typical measurement.<br>7. Learn about the digital programming of different types of circuits.<br>8. Understand the conversion of digital to analog signal and vice versa. |

**Suggested list of experiments:**

1. Experiment demonstrating concepts relating to Measurements: True value, Accuracy, Precision, Resolution, Drift, Hysteresis, Dead-band, Sensitivity.
2. Experiment demonstrating errors in measurements.
3. Measurements of R, L and C using bridge or LCR meter
4. Measurement of very low and high resistance
5. Experiment with Sensors and Transducers for physical parameters: temperature, pressure, torque, flow. Speed and Position Sensors.
6. Measurement of Current and Voltage Measurements. Shunts, Potential Dividers. Instrument Transformers, Hall Sensors.
7. Measurement of high voltage /current
8. Isolated and un-isolated measurement
9. Use of Digital Multi-meter, True RMS meters, Clamp-on meters, Meggers.
10. Use of DSO to capture transients like a step change in R-L-C circuit.
11. Usage of DSO for steady state periodic waveforms produced by a function generator. Selection of trigger source and trigger level, selection of time-scale and voltage scale. Bandwidth of measurement and sampling rate.
12. Download of one-cycle data of a periodic waveform from a DSO and use values to compute the RMS values using a C program.
13. Analog Signal processing and Digital Signal Processing
14. Measurement and instrumentation using microcontroller boards like Aurdino/pic18F/ MSP430

Any other experiment related to measurement and instrumentation can be conducted.

Note: Students and teachers are encouraged to use the virtual labs whose links are as given below The remote-access to Labs in various disciplines of Science and Engineering is available. Students can conduct online experiments which would help them in learning basic and advanced concepts through remote experimentation.

| Virtual Lab Website Reference |
| --- |
| 1. http://vlab.co.in/broad-area-electrical-engineering |
| 2. http://vlab.co.in/broad-area-electronics-and-communications |

Reference books:


1. Alan S Morris (2001), Measurement and Instrumentation Principles, 3rd/e, Butterworth Hienemann
2. David A. Bell (2007), Electronic Instrumentation and Measurements 2nd/e, Oxford Press
3. S. Tumanski (2006), Principle of Electrical Measurement, Taylor & Francis
4. Ilya Gertsbakh (2010), Measurement Theory for Engineers, Springer


Term work:

Term work shall consist of minimum eight experiments. The distribution of marks shall be as follows:

| | |
| --- | --- |
| Experiments Performance | : 10 marks |
| Journal | : 10 marks |
| Attendance | : 05 marks |

The final certification and acceptance of term work ensures the minimum passing in the term work.

Oral Examination:

Oral examination will be based on all the laboratory experiments carried out in **EEL802- Measurement and Instrumentation Lab**

| ELECTRICAL ENGINEERING - SEMESTER-VIII | | | | | | |
|---|---|---|---|---|---|---|
| Course Code | Course Name | Teaching scheme (Contact Hours) | | Credits Assigned | | |
| **EEP801** | **Major Project - II** | Theory | Pract./Tut. | Theory | Pract./Tut. | Total |
| | | -- | $12^{\$}$ | -- | 6 | 6 |

| Course code | Course Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory | | | | | Term Work | Oral | Total |
| | | Internal Assessment | | | End Sem. Exam | Exam Duration (in Hrs) | | | |
| | | Test 1 | Test 2 | Avg | | | | | |
| **EEP801** | **Major Project - II** | -- | -- | -- | -- | -- | **100** | **50** | **150** |

$ indicates work load of Learner (Not Faculty)

| | |
|---|---|
| **Course Objectives** | 5. To design and develop a moderately complex electrical/electronic/digital circuit with practical applications.<br>6. To understand basic concepts of circuit design while developing the project.<br>7. To enable the students to gain hands-on experience independently proposing and implementing the project and thus acquire the necessary confidence to deal with complex electrical/electronic/digital systems. |
| **Course Outcomes** | Upon successful completion of this course, the learner will be able to:<br>10. Identify problems based on societal /research needs.<br>11. Apply Knowledge and skill to solve societal problems in a group.<br>12. Develop interpersonal skills to work as member of a group or leader.<br>13. Draw the proper inferences from available results through theoretical/ experimental/ simulations.<br>14. Analyse the impact of solutions in societal and environmental context for sustainable development.<br>15. Use standard norms of engineering practices<br>16. Excel in written and oral communication.<br>17. Demonstrate capabilities of self-learning in a group, which leads to life-long learning.<br>18. Demonstrate project management principles during project work |

Guidelines for Assessment of Major Project- II:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of major project to be evaluated on continuous basis, minimum two reviews in each semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of Term work marks for Major Project- I shall be as below;
  - Marks awarded by guide/supervisor based on log book : 40
  - Marks awarded by review committee 40
  - Quality of Project report 20

Review/progress monitoring committee may consider following points for assessment as mentioned in general guidelines. Two reviews shall be conducted based on presentation given by students group based on the following criteria:

Assessment criteria of Major Project-II.

Major Project shall be assessed based on following criteria;

13. Quality of literature survey/ need identification
14. Clarity of Problem definition based on need.
15. Innovativeness in solutions
16. Feasibility of proposed problem solutions and selection of best solution
17. Cost effectiveness
18. Societal impact
19. Innovativeness
20. Cost effectiveness
21. Effective use of skill sets
22. Effective use of standard engineering norms
23. Contribution of an individual's as member or leader
24. Clarity in written communication

Project Report has to be prepared strictly as per University of Mumbai report writing guidelines.

Oral Examination:

Project II should be assessed through a presentation by the student project group to a panel of Internal and External Examiner approved by the University of Mumbai. Students should be motivated to publish a paper in Conferences/students competitions based on the
work.

Major Project II shall be assessed based on following points:

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Full functioning of working model as per stated requirements
5. Effective use of skill sets
6. Effective use of standard engineering norms
7. Contribution of an individual's as member or leader
8. Clarity in written and oral communication

**University of Mumbai**
**Bachelor of Electrical Engineering**
**(With effect from 2022-23)**

## Honours* in Electric Vehicles

| Year & Sem | Course Code and Course Title | Teaching Scheme Hours / Week | | | Examination Scheme and Marks | | | | | Credit Scheme |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Theory | Seminar/ Tutorial | Pract | Internal Assessment | End Sem Exam | Term Work | Oral/ Pract | Total | Credits |
| TE Sem V | **HCEV501: Vehicular Systems and Dynamics** | 04 | -- | -- | 20 | 80 | -- | -- | 100 | 04 |
| | **Total** | **04** | **-** | **--** | **100** | | **-** | **-** | **100** | **04** |
| | | | | | | | | | **Total Credits =** | **04** |
| TE Sem. VI | **HCEV601: EV Drive and Energy Sources** | 04 | -- | -- | 20 | 80 | -- | -- | 100 | 04 |
| | **Total** | **04** | **-** | **-** | **100** | | **-** | **-** | **100** | **04** |
| | | | | | | | | | **Total Credits =** | **04** |
| BE Sem. VII | **HCEV701: Automotive Controllers and Auxiliary Systems** | 04 | -- | -- | 20 | 80 | -- | -- | 100 | 04 |
| | **HSEVBL701: Electric Vehicles Lab** | -- | -- | 04 | -- | -- | 50 | 50 | 100 | 02 |
| | **Total** | **04** | **-** | **04** | **100** | | **50** | **50** | **200** | **06** |
| | | | | | | | | | **Total Credits =** | **06** |
| BE Sem. VIII | **HCEV801: Electric Vehicle System Design** | 04 | - | -- | 20 | 80 | -- | -- | 100 | 04 |
| | **Total** | **04** | **-** | **-** | **100** | | **-** | **-** | **100** | **04** |
| | | | | | | | | | **Total Credits =** | **04** |
| | | | | | | | | | **Total Credits for Semesters V,VI, VII &VIII = 04+04+06+04 = 18** | |

*** To be offered as Honours for Major Disciplines as–**

**1. Electrical Engineering**

**2. Mechanical Engineering**

**For any other Major Disciplines which is not mentioned above, it may be offered as Minor Degree.**

Reference: https://www.aicte-india.org/sites/default/files/APH%202020_21.pdf (page 99-101)

| Honours Program In 'Electric Vehicle' - SEM-VII | | | | | | |
|---|---|---|---|---|---|---|
| Course Code | Course Name | Teaching Scheme (Contact Hours) | | Credits Assigned | | |
| | | Theory | Tutorial | Theory | Tutorial | Total |
| **HCEV701** | **Automotive Controllers and Auxiliary Systems** | 04 | - | 04 | - | 04 |

| Course code | Course Name | Examination Scheme | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | | | | | Term Work | Total |
| | | Internal Assessment | | | End Sem. Exam | Exam Duration (Hrs.) | | |
| | | Test 1 | Test 2 | Avg. | | | | |
| **HCEV701** | **Automotive Controllers and Auxiliary Systems** | 20 | 20 | 20 | 80 | 03 | - | 100 |

| | |
|---|---|
| Course Objectives | 1. To Identify functionalities of various automotive controllers and auxiliary systems<br>2. To study various automotive sensors and actuators<br>3. To explore details of energy sources management system, thermal management system and overall system integration in EVs/ HEVs |
| Course Outcomes | Upon successful completion of this course, the learner will be able:<br>1. To illustrate functionality of various auxiliary subsystems used EVs<br>2. To demonstrate the use of VCUS and ECUS in automobile<br>3. To describe the need and functionality of automotive sensors / actuators and networking<br>4. To illustrate the design and management aspects of EV energy sources<br>5. To describe the various heat losses, and thermal management systems incorporated in EVs<br>6. To elaborate on System Integration and resource optimization in EVs |

| Module | Contents | Hours |
|---|---|---|
| 1. | **Introduction:**<br>Review of Automotive electrical, electronic, communication and thermal subsystems; Review of Energy Storage (Power Plant) system, Main Traction Inverter, On-Board Charger (OBC), LV Auxiliary Power Source, HV Battery Disconnect; Vehicle Control Unit (VCU) and ECUs.<br>Braking Systems: Energy Consumption in Braking, Braking Power and Energy on Front and Rear Wheels, Brake System of EVs and HEVs, Series Brake-Optimal Feel, Series Brake-Optimal Energy Recovery; Parallel Brake; Antilock Brake System (ABS); Fundamentals of Regenerative Braking.<br>Steering System: In-car system networking, Steering ratio characteristic, Steering Stabilization, Over-steer, understeer, Electric-Power-Assisted Steering (EPAS); Autonomous vehicles, Principle of object detection. | 12 |
| 2. | **Vehicle Control Unit and Electronic Control Unit:**<br>VCU functionality: Inverter control, battery management, charging control, vehicle functions in transmission and engine control; Advanced Driver Assistance System (ADAS);<br>Electronic control units (ECUs): Various Section ECUs and their networking; Body and Lighting ECU (Key-less Entry, Sonar, HID, LED Lamps), Body ECU (Airbag). | 08 |
| 3. | **Automotive sensors / actuators and networking:**<br>Radar Sensor Detectors for Vehicle Safety Systems; Airborne Ultrasonic Imaging: SONAR Based Image Generation for Autonomous Vehicles, Motor angle sensor, Steering angle sensor, Tyre Pressure Monitoring Systems (TPMS); | 10 |

| | | |
|---|---|---|
| | In Vehicle communication system: CAN, LIN, Ethernet, Flexray | |
| 4. | **Energy Storage (Power Plant) Management system:**<br>Battery cell packaging, Battery Management System (BMS), Design of battery pack and safety considerations; High voltage cabling and cut-outs; Battery pack installation. Use of Battery-UC Hybrid source; Fuel Cell (FC): FC management and Hydrogen storage in EV. | 10 |
| 5. | **Thermal Management System:**<br>Heat Calculation in various subsystems; HVAC system: HVAC compressor drive; Liquid cooling system for Battery, Electric drive and On board charger. Design considerations for thermal management system | 06 |
| 6. | **System Integration and Implementation:**<br>Vehicular Power Control Strategy and Energy Management: A Generic Framework, Definition, and Needs, Methodologies for Optimization, Cost Function Optimization, Benefits of Energy Management. | 06 |

Text/Reference Books:-


1. Electric Powertrain Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles by John G. Hayes and G. Abas Goodarzi, Wiley, 2018.
2. Handbook of Automotive Power Electronics and Motor Drive Edited by Ali Emadi, CRC Press, 2005
3. Encyclopaedia of Automotive Engineering edited by David Crolla *et al.*, Wiley, 2014
4. Electric and Hybrid Vehicles Technologies, Modeling and Control: A Mechatronic Approach by Amir Khajepour, Saber Fallah and Avesta Goodarzi, Wiley, 2014.
5. Hybrid Electric Vehicles Principles and Applications with Practical Perspectives, Second Edition Chris Mi and M. Abul Masrur, Wiley 2018.
6. Autonomous Vehicles Intelligent Transport Systems And Smart Technologies edited by Nicu Bizon, Lucian Dascalescu and Naser Mahdavi Tabatabaei, Nova Publishers, 2014
7. Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles by Sheldon S. Williamson, Springer, 2013
8. Electric and Hybrid Buses for Urban Transport Energy Efficiency Strategies, by Bogdan Ovidiu Varga, Calin Iclodean and Florin Mariasiu, Springer, 2016


Website Reference / Video Courses:

1. NPTEL Web Course: Electric Vehicles - Part 1 by PROF. AMIT KUMAR JAIN Department of Electrical Engineering IIT Delhi; https://nptel.ac.in/courses/108/102/108102121/
2. NPTEL Web Course: by Fundamentals of Electric vehicles: Technology & Economics: Prof. Ashok Jhunjhunwala, Prof. Prabhjot Kaur,Prof. Kaushal Kumar Jha andProf. L Kannan, IIT Madras, https://nptel.ac.in/courses/108/106/108106170/
3. NPTEL Web Course: Introduction to Hybrid and Electric Vehicles by Dr. Praveen Kumar and Prof. S. Majhi, IIT Guwahati, https://nptel.ac.in/courses/108/103/108103009/

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.

4. Remaining question will be randomly selected from all the modules.

| Honours Program In 'Electric Vehicle' - SEM-VII | | | | | | |
|---|---|---|---|---|---|---|
| Course Code | Course Name | Teaching Scheme (Contact Hours) | | Credits Assigned | | |
| | | Theory | Practical/ Tutorial | Theory | Practical/ Tutorial | Total |
| HCEVSBL701 | **Electric Vehicles Lab** | | 04 | -- | 04 | 04 |

| Course code | Course Name | | | | Examination Scheme | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory | | | | | Term Work | Oral | Total |
| | | Internal Assessment | | | End Sem. Exam | Exam Duration (Hrs.) | | | |
| | | Test 1 | Test 2 | Avg. | | | | | |
| HCEVSBL701 | **Electric Vehicles Lab** | - | - | - | - | - | 50 | 50 | 100 |

| | |
|---|---|
| Course Objectives | 1. To provide hands-on with various major components used in EV/HEVs<br>2. To explore EV drives & control implementation along with analysis using simulation tool or with hardware.<br>3. To study various auxiliary systems commonly used in EV. |
| Course Outcomes | Upon successful completion of this course, the learner will be able to:<br>1. Compare and contrast conventional vehicles and EV/HEVs.<br>2. Illustrate operations and features of Conventional, hybrid electric vehicle and electrical vehicle Powertrains.<br>3. Describe the working of EV drives used for different kinds of electric motors.<br>4. Illustrate battery characteristics and working of BMS.<br>5. Describe the operation of On-board and Off-board EV chargers<br>6. Demonstrate the use of simulations tools along with hardware implementation for evaluation of EV subsystems. |

**Contents**

Electric Vehicles Lab: Experimental study based on the following topics

1. Conventional and electrical vehicle sub-systems and components
2. Conventional, hybrid electric vehicle and electrical vehicle Powertrains
3. Motor performance test - for BLDC /PMSM/ IM/SRM motors;
4. EV drive for BLDC/PMSM/IM /SRM motors
5. Battery cell and module- characterization
6. Battery Management System (BMS)
7. On-board and Off-board charger for EV
8. Study of Automotive Electronics-HVAC control, Steering Control, VCU; 2/3 or 4 Wheeler EV.

(or any other experiments based on EV/HEV related systems/ subsystems)

Use of software tools:

Use of tools like ADVISOR, MATLAB, SEMIKRON SEMISEL, Python, C, Java platforms (or similar) etc. for the following

1. Simulation/ Emulation of Vehicle performance analysis for Conventional and Electrical Vehicle
2. Design simulation of a battery pack with given specifications and constraints.
3. Simulation/ Emulation of BLDC motor drive for performance analysis

4. Simulation/ Emulation of PMSM motor drive for performance analysis
5. Simulation/ Emulation of IM motor drive for performance analysis
6. Simulation/ Emulation of SRM motor drive for performance analysis
7. Simulation/ Emulation of On board and Off board charger.
8. Simulation/ Emulation of regenerative breaking.

(or any other simulation based on EV/HEV related systems/ subsystems)

Visit to industrial/ manufacturing facility:

a. Visit to EV manufacturing facility.
b. Visit to Battery pack /BMS design facility
c. Visit to battery Charger facility
d. Visit to Automotive Research Association of India (ARAI), Pune EV COE

(or a visit to any facility / industry / research institute carrying out work in the domain of EV)

Course Project

Course project to be carried out to design /fabricate/ program one of the vehicular sub-systems used in EV

**Note:** Students and teachers are encouraged to use the virtual labs whose links are as given below. The remote-access to Labs in various disciplines of Science and Engineering is available. Students can conduct online experiments which would help them in learning basic and advanced concepts through remote experimentation.

**Virtual Lab Website Reference**

1. http://vlab.co.in/broad-area-electrical-engineering
2. https://www.vlab.co.in/broad-area-mechanical-engineering - Energy Storage Labs, Solar Energy lab, Wind Energy Lab

Term work:

Term work shall consist of minimum eight experiments, at least one plant visit, and one course project. The distribution of marks shall be as follows:

| | |
|---|---|
| Experiments Performance | : 20 marks |
| Attendance | : 05 marks |
| Plant Visit report | : 10 marks |
| Course Project report | : 10 Marks |
| Journal & Attendance | : 10 marks |

The final certification and acceptance of term work ensures the minimum passing in the term work.

Oral Examination:

Oral examination will be based on entire lab work of HCEVSBL701-Electric Vehicles Lab

| Honours Program In 'Electric Vehicle' - SEM-V | | | | | | |
|---|---|---|---|---|---|---|
| Course Code | Course Name | Teaching Scheme (Contact Hours) | | Credits Assigned | | |
| | | Theory | Tutorial | Theory | Tutorial | Total |
| **HCEV801** | **Electric Vehicle System Design** | 04 | - | 04 | - | 04 |

| Course code | Course Name | Examination Scheme | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | | | | | Term Work | Total |
| | | Internal Assessment | | | End Sem. Exam | Exam Duration (Hrs.) | | |
| | | Test 1 | Test 2 | Avg. | | | | |
| **HCEV801** | **Electric Vehicle System Design** | 20 | 20 | 20 | 80 | 03 | - | 100 |

| | |
|---|---|
| Course Objectives | 1. To illustrate the design philosophies used in the EV domain.<br>2. To explore the selection of power and control architecture of EV drives<br>3. To study the design aspects of EV battery packs and other auxiliary systems |
| Course Outcomes | Upon successful completion of this course, the learner will be able to:<br>1. To select and size the electric motor for a particular EV application and performance criteria<br>2. To select and size the battery pack to meet desired EV performance and<br>3. To design the EV drive system with functional safety considerations.<br>4. To illustrate the use of hybrid energy source for EV performance improvement<br>5. To illustrate the design aspects of Automotive Subsystem<br>6. To design the EV chargers and charging infrastructure |

| Module | Contents | Hours |
|---|---|---|
| 1. | **Selection/ Sizing of EV Electric Motors:**<br>Electric Vehicle modelling, Tractive force calculations, Design considerations for 2W, 3W and 4W EVs; Torque, power and Speed requirement, Traction Limit, Maximum Acceleration Limit, Maximum Grade Limit, Vehicle Power Demand Vehicle Performance Envelope, and Vehicle Power Envelope; Vehicle Power Demand during Driving Cycles.<br>Design considerations for EV motors and their cooling system. Application Examples of EV /HEV motors with vehicles and motor specifications. | 08 |
| 2. | **Selection/ Sizing of Battery pack and other Energy Resource:**<br>Selection of type of Battery pack for 2W, 3W and 4W EVs; Battery pack sizing: Design considerations: Range per charge, range anxiety, EV motor power requirement; Impact of road conditions, environmental conditions and traffic conditions.<br>High-Voltage Cabling and Disconnects, Safety in Battery Design, Testing for safety. Accelerated Reliability Testing of Electric Vehicles, Battery Cycle Life versus Peak Power and Rest Period.<br>Selection and sizing of Fuel cell for FCEV, design considerations; Battery-ultra-capacitor hybrid combination sizing, performance analysis.<br>Design considerations for Ultra-capacitor based EV, requirement of charging infra.<br>Flywheel selection and sizing for EV/HEV applications. | 12 |
| 3. | **Automotive Subsystem Design:**<br>Electronic Control Unit (ECU) and its Control Features, Communications between ECUs, Control Software Development: Software-in-the-Loop (SIL) Simulation and Hardware-in-the-Loop (HIL) Simulation.<br>Acceleration and braking control, regenerative braking; Automotive Steering Systems. | 06 |

| | | |
|---|---|---|
| | Design considerations of HVAC controller | |
| 4. | **EV System integration:**<br>EMC design on ECU level, EMC design on system level and in special subsystems, Radiated emissions and Conducted emissions, EMI EMC measurements. | 06 |
| 5. | **Design of Charging Infrastructure:**<br>Design considerations for AC charger: vehicle interface and charging protocol design. applicable charging standards<br>Design of On-Board Charger (OBC)-Schematic, power topology and control, Power capacities, regenerative braking control.<br>Design considerations of DC fast charger: vehicle interface and charging protocol design. Connectivity and applicable charging standards<br>Installation guidelines and grid requirement for charger installations. | 12 |
| 6. | **Design with Functional Safety of Automotive Electronics:**<br>Functional Safety requirements of Automotive Electronics; ASIL identification and safety goal finalization, ISO 26262.<br>Energy Storage integrity / protection: rupture and toxic gas management; low energy stranding, Unintended vehicle movement, shock protection, and Elimination of potential thermal/ explosive event.<br>Hazard and Risk Analysis (HARA) for different situations, Testing of vehicles for compliance of safety norms | 08 |

Text/Reference Books:-


1. Design and Control of Automotive Propulsion Systems by Zongxuan Sun and Guoming Zhu, CRC Press, 2015
2. Electric Vehicle Machines And Drives Design, Analysis and Application by K. T. Chau, IEEE Press, and Wiley, 2015
3. EMC and Functional Safety of Automotive Electronics by Kai Borgeest, IET, 2018


Website Reference / Video Courses:

1. NPTEL Web Course: Electric Vehicles - Part 1 by PROF. AMIT KUMAR JAIN Department of Electrical Engineering IIT Delhi; https://nptel.ac.in/courses/108/102/108102121/
2. NPTEL Web Course: Fundamentals of Electric vehicles: Technology & Economics, by Prof. Ashok Jhunjhunwala, Prof. Prabhjot Kaur, Prof. Kaushal Kumar Jha and Prof. L Kannan, IIT Madras, https://nptel.ac.in/courses/108/106/108106170/
3. NPTEL Web Course: Introduction to Hybrid and Electric Vehicles by Dr. Praveen Kumar and Prof. S. Majhi, IIT Guwahati, https://nptel.ac.in/courses/108/103/108103009/

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining question will be randomly selected from all the modules.