# NOIDA INTERNATIONAL UNIVERSITY

# EVALUATION SCHEME & SYLLABUS

**For**

UNDERGRADUATE DEGREE COURSE
IN

## ELECTRICAL ENGINEERING

**(Revised and effective from Session: 2019)**

# B. Tech in Electrical Engineering

## Program Educational Objectives (PEOs)

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The Department of Electrical Engineering has developed and maintained a well-defined set of educational objectives and desired program outcomes. Educational objectives of the program cater to the requirements of the stakeholders such as students, parents, employers, alumni, faculty etc. The program educational objectives are as follows:

- **PEO**1: Provide graduates with a strong foundation in mathematics, science and engineering fundamentals to enable them to devise and deliver efficient solutions to challenging problems in Electrical and allied disciplines.
- **PEO**2: Impart analytic and thinking skills to develop initiatives and innovative ideas for R&D, Industry and societal requirements.
- **PEO**3: Provide sound theoretical and practical knowledge of E&C Engineering, managerial and entrepreneurial skills to enable students to contribute to the well-being of society with a global outlook.
- **PEO**4: Inculcate qualities of teamwork as well as social, interpersonal and leadership skills and an ability to adapt to evolving professional environments in the domains of engineering and technology.
- **PEO**5: Motivate graduates to become good human beings and responsible citizens for the overall welfare of the society.

## Program outcomes (POs)

***Engineering Graduates will be able to:***

**PO**1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

**PO**2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

**PO**3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

**PO**4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

**PO**5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

**PO**6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

**PO**7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

**PO**8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

**PO**9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

**PO**10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
**PO**11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
**PO**12**. Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**Credit System-**Credit requirement for award of B.Tech:

- Every semester shall offer a minimum of **12 credits**.
- Credits for the Project or Thesis can vary from 10 to 15.
- The total number of credits for the B. tech Degree Course could vary from a **minimum of 158** credits to a **maximum of 178** credits.
- All courses of study put together would engage the students for a **minimum of 26 periods** or hours of study a week and a **maximum of 30 periods** or hours a week.

Under the Choice based credit system, which is a student or learner centric system, the courses of study in the B.Tech Degree course shall be as under:

a) Professional Core (PC) Course: A course, which should compulsorily be studied by a candidate as a core requirement is termed as a Core course.
b) Basic Sciences and Engineering Science (BS and ES) Course: A course which informs the Professional core and should compulsorily be studied.
c) Elective Course: Generally a course which can be chosen from a pool of courses and are of two types:
   (i) Professional Elective (PE) which may be very specific or specialized or advanced or supportive to the discipline or subject of study or which provides an extended scope
   (ii) Open Elective (OE) which enables an exposure to some other discipline or subject or domain or nurtures the candidate‘s proficiency or skill

The Weightage in terms of Credits for each of the above in the prescribed curriculum of the institution shall be as follows:

| S.no. | Credit Breakups | Credits | Percentage |
|---|---|---|---|
| 1 | Humanities and Social Sciences including Management courses | 12 | |
| 2 | Basic Science courses | 26 | |
| 3 | Engineering Science courses including workshop, drawing, basics of electrical/mechanical/computer etc. | 20 | |
| 4 | Professional core courses | 52 | |
| 5 | Professional Elective courses relevant to chosen specialization/branch | 18 | |
| 6 | Open subjects – Electives from other technical and /or emerging subjects | 18 | |
| 7 | Project work, seminar and internship in industry or elsewhere | 12 | |
| 8 | Mandatory Courses | 0 | |
| | | *158 | |

**Minor variation is allowed as per need of the respective disciplines.*

While calculating credits the following guidelines shall be adopted, namely: -

- 1 Hr. Lecture (L) per week 1 credit

- 1 Hr. Tutorial (T) per week 1 credit
- 1 Hr. Practical (P) per week 0.5
- 2 Hours Practical (Lab)/week 1 credit

**Credit distribution in each semester** (158 credits to 8 semesters)

| **Semester** | **Credits** | | |
|---|---|---|---|
| | Theory | Practical | Total |
| 1st | 15 | 5.5 | 20.5 |
| 2nd | 12 | 5.5 | 17.5 |
| 3rd | 25 | 2 | 27 |
| 4th | 18 | 3 | 21 |
| 5th | 18 | 3 | 21 |
| 6th | 15 | 3 | 18 |
| 7th | 12 | 4 | 16 |
| 8th | 9 | 8 | 17 |
| Total | 110 | 48 | 158 |

**Course coding system**

Every course coded as follows:

BSC : Basic Science Courses
ESC : Engineering Science Course
MC : Mandatory Courses
HSMC : Humanities and Social Sciences including Management
EE : Program core courses
PEC : Program Elective courses
OEC : Open Elective courses

## Semester wise- course structure

## Fifth-Semester

| S. No | Course Code | Subject | Period | | | Evaluation Scheme | | | | | Total Credits |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Sessional Exam | | | End Exams | Subject Total | |
| | | | L | T | P | CA | TA | Total | | | |
| **THEORY** | | | | | | | | | | | |
| 1 | EE14 | Power Systems – I (Apparatus and Modelling) | 3 | 0 | 0 | 20 | 20 | 40 | 60 | 100 | 3 |
| 2 | EE16 | Control Systems | 3 | 0 | 0 | 20 | 20 | 40 | 60 | 100 | 3 |
| 3 | EE18 | Microprocessors | 3 | 0 | 0 | 20 | 20 | 40 | 60 | 100 | 3 |
| 4 | PEC-EE01 | Program Elective – 1 | 3 | 0 | 0 | 20 | 20 | 40 | 60 | 100 | 3 |
| 5 | OEC-EE 01 | Open Elective-1 | 3 | 0 | 0 | 20 | 20 | 40 | 60 | 100 | 3 |
| 6 | HSMC 501 | Management I(OB/F&A*) | 3 | 0 | 0 | 20 | 20 | 40 | 60 | 100 | 3 |
| 7 | MC-03 | Constitution of India | | | | | | | | 0 | |
| **PRACTICALS** | | | | | | | | | | | |
| 1 | EE15 | Power Systems Lab | 0 | 0 | 2 | 0 | 0 | 40 | 60 | 100 | 1 |
| 2 | EE17 | Control Systems Lab | 0 | 0 | 2 | 0 | 0 | 40 | 60 | 100 | 1 |
| 3 | EE19 | Microprocessors Lab | 0 | 0 | 2 | 0 | 0 | 40 | 60 | 100 | 1 |
| **Total** | | | | | | | | | | | **21** |

## Sixth-Semester

| S. No | Course Code | Subject | Period | | | Evaluation Scheme | | | | | Total Credits |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Sessional Exam | | | End Exams | Subject Total | |
| | | | L | T | P | CA | TA | Total | | | |
| **THEORY** | | | | | | | | | | | |
| 1 | EE20 | Power Systems – II (Operation and Control) | 3 | 0 | 0 | 20 | 20 | 40 | 60 | 100 | 3 |
| 2 | EE22 | Measurements and Instrumentation | 3 | 0 | 0 | 20 | 20 | 40 | 60 | 100 | 3 |
| 3 | PEC-EE02 | Program Elective – 2 | 3 | 0 | 0 | 20 | 20 | 40 | 60 | 100 | 3 |
| 4 | PEC-EE03 | Program Elective – 3 | 3 | 0 | 0 | 20 | 20 | 40 | 60 | 100 | 3 |
| 5 | OEC-EE02 | Open Elective-2 | 3 | 0 | 0 | 20 | 20 | 40 | 60 | 100 | 3 |
| **PRACTICALS** | | | | | | | | | | | |
| 1 | EE21P | Power Systems – II Lab | 0 | 0 | 4 | - | - | 40 | 60 | 100 | 2 |
| 2 | EE23P | Measurements and Instrumentation Lab | 0 | 0 | 2 | - | - | 40 | 60 | 100 | 1 |
| **Total** | | | | | | | | | | | **18** |
| PROJ EE | | Summer Internship | During Summer Vacations / Non-credit | | | | | | | | |

**DETAILED 3-YEAR CURRICULUM CONTENTS**

**Undergraduate Degree in Engineering &Technology**

**BRANCH/COURSE: ELECTRICAL ENGINEERING**

# SEMESTER-V/VI

## DETAILED CURRICULUM CONTENTS

**Course Code:** PCC-EE14 **Course Name:** Power Systems-I
**Course Credit:** 3 **Total Contact Hour:** 40hr

**Course Objective:**

- To know the importance of compensation in power system and study the different compensating techniques.
- Study about different transients and their protection those are introduced in power system.

**Course Description:**

This course is an introductory subject in the field of electric power systems and electrical to mechanical energy conversion. The course material includes: fundamentals of energy-handling electric circuits, power electronic circuits such as inverters, and electromechanical apparatus.

**Course Contents:**

**Unit 1:** Basic Concepts

Evolution of Power Systems and Present-Day Scenario. Structure of a power system: Bulk Power Grids and Micro-grids.

Generation: Conventional and Renewable Energy Sources. Distributed Energy Resources. Energy Storage. Transmission and Distribution Systems: Line diagrams, transmission and distribution voltage levels and topologies (meshed and radial systems). Synchronous Grids and Asynchronous (DC) interconnections. Review of Three-phase systems. Analysis of simple three-phase circuits. Power Transfer in AC circuits and Reactive Power.

**Unit 2: Power System Components**

Overhead Transmission Lines and Cables: Electrical and Magnetic Fields around conductors, Corona. Parameters of lines and cables. Capacitance and Inductance calculations for simple configurations. Travelling-wave Equations. Sinusoidal Steady state representation of Lines: Short, medium and long lines. Power Transfer, Voltage profile and Reactive Power.

Characteristics of transmission lines. Surge Impedance Loading. Series and Shunt Compensation of transmission lines.

Transformers: Three-phase connections and Phase-shifts. Three-winding transformers, auto- transformers, Neutral Grounding transformers. Tap-Changing in transformers.

Transformer Parameters. Single phase equivalent of three-phase transformers.

Synchronous Machines: Steady-state performance characteristics. Operation when connected to infinite bus. Real and Reactive Power Capability Curve of generators. Typical waveform under balanced terminal short circuit conditions – steady state, transient and sub-transient equivalent circuits. Loads: Types, Voltage and Frequency Dependence of Loads. Per-unit System and per-unit calculations.

**Unit 3: Over-voltages and Insulation Requirements**

Generation of Over-voltages: Lightning and Switching Surges. Protection against Over- voltages, Insulation Coordination. Propagation of Surges. Voltages produced by traveling surges. Bewley Diagrams.

**Unit 4: Fault Analysis and Protection Systems**

Method of Symmetrical Components (positive, negative and zero sequences). Balanced and Unbalanced Faults. Representation of generators, lines and transformers in sequence networks. Computation of Fault Currents. Types of Circuit Breakers. Attributes of Protection schemes, Back-up Protection. Protection schemes (Over-current, directional, distance protection, differential protection) and their application.

**Unit 5: Introduction to DC Transmission & Renewable Energy Systems**

DC Transmission Systems: Line-Commutated Converters (LCC) and Voltage Source Converters (VSC). LCC and VSC based dc link, Real Power Flow control in a dc link. Comparison of ac and dc transmission. Solar PV systems: I-V and P-V characteristics of PV panels, power electronic interface of PV to the grid. Wind Energy Systems: Power curve of wind turbine. Fixed and variable speed turbines. Permanent Magnetic Synchronous Generators and Induction Generators. Power Electronics interfaces of wind generators to the grid.

**Course Learning Outcomes (CLOs):**

At the end of this course students will demonstrate the ability to

- Understand the concepts of power systems.
- Understand the various power system components.
- Evaluate fault currents for different types of faults.
- Understand the generation of over-voltages and insulation coordination.
- Understand basicprotection schemes.
- Understand concepts of HVdc power transmission and renewable energy generation.

**Text books:**


1. J. Grainger and W. D. Stevenson, “Power System Analysis” , McGraw Hill Education, 1994.
2. O. I. Elgerd, “ Electric Energy Systems Theory” , McGraw Hill Education, 1995.
3. A. R. Bergen and V. Vittal, “ Power System Analysis”, Pearson Education Inc., 1999.
4. D. P. Kothari and I. J. Nagrath, “ Modern Power System Analysis” , McGraw Hill Education, 2003.


**References books:**


1. B. M. Weedy, B. J. Cory, N. Jenkins, J. Ekanayake and G. Strbac, “ Electric Power Systems”, Wiley, 2012.


**Online links for study & reference materials:**

https://nptel.ac.in/courses/108/105/108105104/

**Assessment method:** (Continuous Internal Assessment = 40%, Final Examination = 60%)

| | |
|---|---|
| Assessment -1 | - 05% |
| Assessment -2 | - 05% |
| Assessment -3 (Mid exam) | - 20% |
| Assessment -3 | - 05% |
| Assessment -4 | - 05% |
| **Total Internal Assessment** | **- 40%** |

**Course Code:** PCC-EE15 **Course Name:** Power Systems – I Laboratory

**Course Credit:** 1 **Total Contact Hour:** 20hr

Hands-on experiments related to the course contents of EE14. Visits to power system installations (generation stations, EHV substations etc.) are suggested. Exposure to fault analysis and Electro-magnetic transient program (EMTP) and Numerical Relays are suggested.

**Course Code:** PCC-EE16 **Course Name:** Control Systems
**Course Credit:** 3 **Total Contact Hour:** 40hr

**Course Objective:**

• To introduce different types of system and identify a set of algebraic equations to represent and model a complicated system into a more simplified form to interpret different physical and mechanical systems in terms of electrical system to construct equivalent electrical models for analysis.

• To employ time domain analysis to predict and diagnose transient performance parameters of the system for standard input functions and identify the needs of different types of controllers and compensator to ascertain the required dynamic response from the system.

**Course Description:**

Transfer functions; Stability; Dynamic and steady-state performance; Root locus diagrams; Bode plots; Cascade compensation using root locus and frequency response techniques. Introduction to state-space modelling and analysis. Analysis and design of digital control systems.

**Course Contents:**

**Unit 1: Introduction to control problem**

Industrial Control examples. Mathematical models of physical systems. Control hardware and their models. Transfer function models of linear time-invariant systems. Feedback Control: Open-Loop and Closed-loop systems. Benefits of Feedback. Block diagram algebra.

**Unit 2: Time Response Analysis**

Standard test signals. Time response of first and second order systems for standard test inputs. Application of initial and final value theorem. Design specifications for second-order systems based on the time-response.

Concept of Stability. Routh-Hurwitz Criteria. Relative Stability analysis. Root-Locus technique. Construction of Root-loci.

**Unit 3: Frequency-response analysis**

Relationship between time and frequency response, Polar plots, Bode plots. Nyquist stability criterion. Relative stability using Nyquist criterion – gain and phase margin. Closed-loop frequency response.

**Unit 4: Introduction to Controller Design**

Stability, steady-state accuracy, transient accuracy, disturbance rejection, insensitivity and robustness of control systems. Root-loci method of feedback controller design.

Design specifications in frequency-domain. Frequency-domain methods of design. Application of Proportional, Integral and Derivative Controllers, Lead and Lag compensation in designs.

Analog and Digital implementation of controllers.

**Unit 5: State variable Analysis**

Concepts of state variables. State space model. Diagonalization of State Matrix. Solution of state equations. Eigenvalues and Stability Analysis. Concept of controllability and observability.

Pole-placement by state feedback. Discrete-time systems. Difference Equations. State-space models of linear discrete-time systems. Stability of linear discrete-time systems.

**Course Learning Outcomes (CLOs):**

At the end of this course students will demonstrate the ability to

- Understand the modelling of linear-time-invariant systems using transfer function and state-space representations.
- Understand the concept of stability and its assessment for linear-time invariant systems.
- Design simple feedback controllers.

**Text books:**

1. M. Gopal, "Control Systems: Principles and Design", McGraw Hill Education, 1997.
2. B. C. Kuo, "Automatic Control System", Prentice Hall, 1995.
3. K. Ogata, "Modern Control Engineering", Prentice Hall, 1991.

**References books:**

1. I. J. Nagrath and M. Gopal, “ Control Systems Engineering”, New Age International, 2009

**Online links for study & reference materials:**
https://nptel.ac.in/courses/107/106/107106081/

**Assessment method:** (Continuous Internal Assessment = 40%, Final Examination = 60%)

| | |
|---|---|
| Assessment -1 | - 05% |
| Assessment -2 | - 05% |
| Assessment -3 (Mid exam) | - 20% |
| Assessment -3 | - 05% |
| Assessment -4 | - 05% |
| **Total Internal Assessment** | **- 40%** |

**Course Code:** PCC-EE17

**Course Name:** Control Systems Laboratory

**Course Credit:** 1

**Total Contact Hour:** 20hr

Hands-on/Computer experiments related to the course contents of EE16.

**Course Code:** PCC-EE18

**Course Name:** Microprocessors

**Course Credit:** 3

**Total Contact Hour:** 40hr

**Course Objective:**

- To introduce students with the architecture and operation of typical microprocessors and microcontrollers.

- To familiarize the students with the programming and interfacing of microprocessors and microcontrollers.
- To provide strong foundation for designing real world applications using microprocessors and microcontrollers.

**Course Description:**

The purpose of this course is to teach students the fundamentals of microprocessor and microcontroller systems. The student will be able to incorporate these concepts into their electronic designs for other courses where control can be achieved via a microprocessor/controller implementation. Topics include Semiconductor memory devices and systems, microcomputer architecture, assembly language programming, I/O programming, I/O interface design, I/O peripheral devices, data communications, and data acquisition systems.

**Course Contents:**

**Unit 1: Fundamentals of Microprocessors**

Fundamentals of Microprocessor Architecture. 8-bitMicroprocessor and Microcontroller architecture, Comparison of 8-bit microcontrollers, 16-bit and 32-bit microcontrollers. Definition of embedded system and its characteristics, Role of microcontrollers in embedded Systems. Overview of the 8051 family.

**Unit 2: The 8051 Architecture**

Internal Block Diagram, CPU, ALU, address, data and control bus, Working registers, SFRs, Clock and RESET circuits, Stack and Stack Pointer, Program Counter, I/O ports, Memory Structures, Data and Program Memory, Timing diagrams and Execution Cycles.

**Unit 3: Instruction Set and Programming**

Addressing modes: Introduction, Instruction syntax, Data types, Subroutines Immediate addressing, Register addressing, Direct addressing, Indirect addressing, Relative addressing, Indexed addressing, Bit inherent addressing, bit direct addressing. 8051 Instruction set, Instruction timings. Data transfer instructions, Arithmetic instructions, Logical instructions, Branch instructions, Subroutine instructions, Bit manipulation instruction. Assembly language programs, C language programs. Assemblers and compilers. Programming and debugging tools.

Module4: Memory and I/O Interfacing (6 Hours):

Memory and I/O expansion buses, control signals, memory wait states. Interfacing of peripheral devices such as General Purpose I/O, ADC, DAC, timers, counters, and memory devices.

**Unit 5: External Communication Interface**

Synchronous and Asynchronous Communication. RS232, SPI, I2C. Introduction and interfacing to protocols like Blue-tooth and Zig-bee.

Module6: Applications (06 Hours)

LED, LCD and keyboard interfacing. Stepper motor interfacing, DC Motor interfacing, sensor interfacing.

**Course Learning Outcomes (CLOs):**

At the end of this course students will demonstrate the ability to

- Do assembly language programming.
- Do interfacing design of peripherals like I/O, A/D, D/A, timer etc.
- Develop systems using different microcontrollers.

**Text books:**


1. M. A.Mazidi, J. G. Mazidi and R. D. McKinlay, “The8051Microcontroller and Embedded Systems: Using Assembly and C”,Pearson Education, 2007.
2. K. J. Ayala, “8051 Microcontroller”, Delmar Cengage Learning, 2004.
3. R. Kamal, “Embedded System”, McGraw Hill Education, 2009.
4. R. S. Gaonkar, “, Microprocessor Architecture: Programming and Applications with the 8085”, Penram International Publishing, 1996


**References books:**


1. D. A. Patterson and J. H. Hennessy, "Computer Organization and Design: The Hardware/Software interface”, Morgan Kaufman Publishers, 2013.
2. D. V. Hall, “Microprocessors & Interfacing”, McGraw Hill Higher Education, 1991.

**Online links for study & reference materials:**
https://nptel.ac.in/courses/108/107/108107029/

**Assessment method:** (Continuous Internal Assessment = 40%, Final Examination = 60%)

| | |
|---|---|
| Assessment -1 | - 05% |
| Assessment -2 | - 05% |
| Assessment -3 (Mid exam) | - 20% |
| Assessment -3 | - 05% |
| Assessment -4 | - 05% |
| **Total Internal Assessment** | **- 40%** |

**Course Code:** PCC-EE19

**Course Name:** Microprocessor Laboratory

**Course Credit:** 1

**Total Contact Hour:** 20hr

Hands-on experiments related to the course contents of EE18.

**Course Code:** PCC-EE20

**Course Name:** Power Systems – II

**Course Credit:** 3

**Total Contact Hour:** 40hr

**Course Objective:**

- To introduce the students to the general structure of the network for transferring power from generating stations to the consumers.

- To expose the students to the different electrical & mechanical aspects of the power network along with its environmental and safety constraints.

**Course Description:**

This course will cover fundamentals on power system modeling for the purposes of dynamic studies and stability control, teach the methods for analyzing main stability issues of power systems and introduce the tools for planning and operating a modern interconnected power grid to meet reliability criteria under disturbances. There will be minor programming work in MATLAB or using professional power system software.

**Course Contents:**

**Unit 1: Power Flow Analysis**

Review of the structure of a Power System and its components. Analysis of Power Flows: Formation of Bus Admittance Matrix. Real and reactive power balance equations at a node. Load and Generator Specifications. Application of numerical methods for solution of non- linear algebraic equations – Gauss Seidel and Newton-Raphson methods for the solution of the power flow equations. Computational Issues in Large-scale Power Systems.

**Unit 2: Stability Constraints in synchronous grids**

Swing Equations of a synchronous machine connected to an infinite bus. Power angle curve. Description of the phenomena of loss of synchronism in a single-machine infinite bus system following a disturbance like a three--phase fault. Analysis using numerical integration of swing equations (using methods like Forward Euler, Runge-Kutta $4^{th}$ order methods), as well as the Equal Area Criterion. Impact of stability constraints on Power System Operation. Effect of generation rescheduling and series compensation of transmission lines on stability.

**Unit 3: Control of Frequency and Voltage**

Turbines and Speed-Governors, Frequency dependence of loads, Droop Control and Power Sharing. Automatic Generation Control. Generation and absorption of reactive power by various components of a Power System. Excitation System Control in synchronous generators, Automatic Voltage Regulators. Shunt Compensators, Static VAR compensators and STATCOMs. Tap Changing Transformers.

Power flow control using embedded dc links, phase shifters and

**Unit 4: Monitoring and Control**

Overview of Energy Control Centre Functions: SCADA systems. Phasor Measurement Units and Wide-Area Measurement Systems. State-estimation. System Security Assessment. Normal, Alert, Emergency, Extremis states of a Power System. Contingency Analysis. Preventive Control and Emergency Control.

**Unit 5: Power System Economics and Management**

Basic Pricing Principles: Generator Cost Curves, Utility Functions, Power Exchanges, Spot Pricing. Electricity Market Models (Vertically Integrated, Purchasing Agency, Whole-sale competition, Retail Competition), Demand Side-management, Transmission and Distributions charges, Ancillary Services. Regulatory framework.

**Course Learning Outcomes (CLOs):**

At the end of this course students will demonstrate the ability to

- Use numerical methods to analyse a power system in steady state.
- Understand stability constraints in a synchronous grid.
- Understand methods to control the voltage, frequency and power flow.
- Understand the monitoring and control of a power system.
- Understand the basics of power system economics.

**Text books:**

1. J. Grainger and W. D. Stevenson, “Power System Analysis”, McGraw Hill Education, 1994.
2. O. I. Elgerd, “Electric Energy Systems Theory”, McGraw Hill Education, 1995.
3. A. R. Bergen and V. Vittal, “Power System Analysis”, Pearson Education Inc., 1999.
4. D. P. Kothari and I. J. Nagrath, “Modern Power System Analysis”, McGraw Hill Education, 2003.

**References books:**

1. B. M. Weedy, B. J. Cory, N. Jenkins, J. Ekanayake and G. Strbac, “Electric Power Systems”, Wiley, 2012.

**Online links for study & reference materials:**
https://nptel.ac.in/courses/108/105/108105067/

**Assessment method:** (Continuous Internal Assessment = 40%, Final Examination = 60%)

| | |
|---|---|
| Assessment -1 | - 05% |
| Assessment -2 | - 05% |
| Assessment -3 (Mid exam) | - 20% |
| Assessment -3 | - 05% |
| Assessment -4 | - 05% |
| **Total Internal Assessment** | **- 40%** |

**Course Code:** PCC-EE21
**Course Name:** Power Systems-II Laboratory
**Course Credit:** 1
**Total Contact Hour:** 20hr

Hands-on and computational experiments related to the course contents of EE20. This should include programming of numerical methods for solution of the power flow problem and stability analysis. Visit to load dispatch Centre is suggested.

**Course Code:** PCC-EE22 **Course Name:** Measurements and Instrumentation Laboratory

**Course Credit:** 3 **Total Contact Hour:** 40hr

**Lectures/Demonstrations:**

1. Concepts relating to Measurements: True value, Accuracy, Precision, Resolution, Drift, Hysteresis, Dead-band, Sensitivity.

2. Errors in Measurements. Basic statistical analysis applied to measurements: Mean, Standard Deviation, Six-sigma estimation, $C_p$, $C_{pk}$.
3. Sensors and Transducers for physical parameters: temperature, pressure, torque, flow. Speed and Position Sensors.
4. Current and Voltage Measurements. Shunts, Potential Dividers. Instrument Transformers, Hall Sensors.
5. Measurements of R, L and C.
6. Digital Multi-meter, True RMS meters, Clamp-on meters, Meggers.
7. Digital Storage Oscilloscope.

**Experiments**

1. Measurement of a batch of resistors and estimating statistical parameters.
2. Measurement of L using a bridge technique as well as LCR meter.
3. Measurement of C using a bridge technique as well as LCR meter.
4. Measurement of Low Resistance using Kelvin's double bridge.
5. Measurement of High resistance and Insulation resistance using Megger.
6. 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.
7. Download of one-cycle data of a periodic waveform from a DSO and use values to compute the RMS values using a C program.
8. Usage of DSO to capture transients like a step change in R-L-C circuit.
9. Current Measurement using Shunt, CT, and Hall Sensor.

**Course Learning Outcomes (CLOs):**

At the end of this course students will demonstrate the ability to

- Design and validate DC and AC bridges.
- Analyze the dynamic response and the calibration of few instruments.
- Learn about various measurement devices, their characteristics, their operation and their limitations.
- Understand statistical data analysis.
- Understand computerized data acquisition.

**Course Code:** PCC-EE23 **Course Name:** Electronics Design Laboratory

**Course Credit:** 3 **Total Contact Hour:** 40hr

**Lectures/Demonstrations:**

Basic concepts on measurements; Noise in electronic systems; Sensors and signal conditioning circuits; Introduction to electronic instrumentation and PC based data acquisition; Electronic system design, Analog system design, Interfacing of analog and digital systems, Embedded systems, Electronic system design employing microcontrollers, CPLDs, and

FPGAs, PCB design and layout; System assembly considerations. Group projects involving electronic hardware (Analog, Digital, mixed signal) leading to implementation of an application.

**<u>Course Learning Outcomes (CLOs)</u>:**

At the end of this course students will demonstrate the ability to

- Understand the practical issues related to practical implementation of applications using electronic circuits.
- Choose appropriate components, software and hardware platforms.
- Design a Printed Circuit Board, get it made and populate/solder it with components.

**Text books:**


1. A. S. Sedra and K. C. Smith, "Microelectronic circuits", Oxford University Press, 2007.
2. P. Horowitz and W. Hill, "The Art of Electronics", Cambridge University Press, 1997.
3. H.W.Ott, "Noise Reduction Techniques in Electronic Systems", Wiley, 1989.
4. W.C. Bosshart, "Printed Circuit Boards: Design and Technology", Tata McGraw Hill, 1983.


**References books:**


1. G.L. Ginsberg, "Printed Circuit Design", McGraw Hill, 1991.

**Course Code:** PEC-EE01 **Course Name:** Non-Conventional Energy Resources

**Course Credit:** 3 **Total Contact Hour:** 40hr

**Course Objective:**

Apply engineering techniques to build solar and wind.

Analyze and evaluate the implication of renewable energy.

Concepts in solving numerical problems pertaining to solar radiation geometry and wind energy systems

**Course Description:**

This course involves the description, theory design and operation of wind and solar energy systems. The energy systems presented are: wind energy, solar PV and solar thermal systems. The theory governing these systems and their working principles are explained.

**Course Contents:**

**UNIT 1: Introduction**

Conventional and non-conventional sources Introduction to Energy Sources: Energy Consumption - World Energy Futures Discussion on conventional Energy Sources - Availability and Non-conventional Energy Sources - Green coal technologies - Petroleum and natural gas – Nuclear fuels and power plants - Hydro sources and power plants - Energy strategies Energy conservation - Energy audit - Cost of energy.

**UNIT 2: Solar Resources**

Introduction, solar radiation spectra, solar geometry, Earth Sun angles, observer Sun angles, solar day length, Estimation of solar energy availability.

**Unit 3: Solar photovoltaic**

Technologies-Amorphous, monocrystalline, polycrystalline; V-I characteristics of a PV cell, PV module, array, Power Electronic Converters for Solar Systems, Maximum Power Point Tracking (MPPT) algorithms. Converter Control.

**UNIT 4: Wind Energy**

Wind energy Wind energy - Energy chains - Application - Historical background - Merits and limitations - Nature of wind - Planetary and local day / night winds - Wind energy quantum - Wind power density - Power calculations - Power in wind turbine –Efficiency - Kinetic energy - Torque thrust calculations - Velocity at different heights - Site selection - Favorable wind speed range - Wind energy conversion system - Energy pattern factor.

**UNIT 5: Biomass**

Biomass energy Principles of bio-conversion - Anaerobic/aerobic digestion - Types of bio-gas digesters - Gas yield - Combustion characteristics of bio-gas - Utilization for cooking – IC engine operation and economic aspects - Waste to biomass resources - Terms and definitions - Incineration, wood and wood waste, harvesting super trees and energy forests –Pyrolyis.

**Course Learning Outcomes (CLOs):**

At the end of this course students will demonstrate the ability to

- Understand the energy scenario and the consequent growth of the power generation from renewable energy sources.
- Understand the basic physics of wind and solar power generation.
- Understand the power electronic interfaces for wind and solar generation.
- Understand the issues related to the grid-integration of solar and wind energy systems.

**Text books:**


1. T. Ackermann, "Wind Power in Power Systems" , John Wiley and Sons Ltd., 2005.
2. G. M. Masters, "Renewable and Efficient Electric Power Systems**",** John Wiley and Sons, 2004.
3. S. P. Sukhatme, "Solar Energy: Principles of Thermal Collection and Storage", McGraw Hill, 1984.
4. H. Siegfried and R. Waddington, "Grid integration of wind energy conversion systems" John Wiley and Sons Ltd., 2006.


**References books:**


1. G. N. Tiwari and M. K. Ghosal, "Renewable Energy Applications" , Narosa Publications, 2004.
2. J. A. Duffie and W. A. Beckman, "Solar Engineering of Thermal Processes", John Wiley & Sons, 1991.


**Online links for study & reference materials:**

https://onlinecourses.nptel.ac.in/noc21_ch11/

**Assessment method:** (Continuous Internal Assessment = 40%, Final Examination = 60%)

| | |
|---|---|
| Assessment -1 | - 05% |
| Assessment -2 | - 05% |
| Assessment -3 (Mid exam) | - 20% |
| Assessment -3 | - 05% |
| Assessment -4 | - 05% |
| **Total Internal Assessment** | **- 40%** |

**Course Code:** PEC-EE03 **Course Name:** Electrical Drives

**Course Credit:** 3 **Total Contact Hour:** 40hr

**Course Objective:**

To provide fundamental knowledge in dynamics and control of Electric Drives. To justify the selection of Drives for various applications. To familiarize the various semiconductor controlled drives employing various motors.

**Course Description:**

The course aims at giving a broad overview of Electrical Drive Systems. It is assumed that the students have prior exposure to Electrical Machines and Power Electronics.

**Course Contents:**

**Unit 1: DC motor characteristics**

Review of emf and torque equations of DC machine, review of torque-speed characteristics of separately excited dc motor, change in torque-speed curve with armature voltage, example load torque-speed characteristics, operating point, armature voltage control for varying motor speed, flux weakening for high speed operation.

**Unit 2: Chopper fed DC drive**

Review of dc chopper and duty ratio control, chopper fed dc motor for speed control, steady state operation of a chopper fed drive, armature current waveform and ripple, calculation of losses in dc motor and chopper, efficiency of dc drive, smooth starting.

**Unit 3: Multi-quadrant DC drive**

Review of motoring and generating modes operation of a separately excited dc machine, four quadrant operation of dc machine; single-quadrant, two-quadrant and four-quadrant choppers; steady-state operation of multi-quadrant chopper fed dc drive, regenerative braking.

**Unit 4: Closed-loop control of DC Drive**

Control structure of DC drive, inner current loop and outer speed loop, dynamic model of dc motor – dynamic equations and transfer functions, modeling of chopper as gain with switching delay, plant transfer function, for controller design, current controller specification and design, speed controller specification and design.

**Unit 5: Induction motor characteristics**

Review of induction motor equivalent circuit and torque-speed characteristic, variation of torque-speed curve with (i) applied voltage, (ii) applied frequency and (iii) applied voltage and frequency, typical torque-speed curves of fan and pump loads, operating point, constant flux operation, flux weakening operation.

**Unit 6: Scalar control or constant V/f control of induction motor**

Review of three-phase voltage source inverter, generation of three-phase PWM signals, sinusoidal modulation, space vector theory, conventional space vector modulation; constant V/f control of induction motor, steady-state performance analysis based on equivalent circuit, speed drop with loading, slip regulation.

**Unit 7: Control of slip ring induction motor**

Impact of rotor resistance of the induction motor torque-speed curve, operation of slip-ring induction motor with external rotor resistance, starting torque, power electronic based rotor side control of slip ring motor, slip power

**Course Learning Outcomes (CLOs):**

At the end of this course students will demonstrate the ability to

- Understand the characteristics of dc motors and induction motors.
- Understand the principles of speed-control of dc motors and induction motors.
- Understand the power electronic converters used for dc motor and induction motor speed control.

**Text books:**


1. G. K. Dubey, "Power Semiconductor Controlled Drives", Prentice Hall, 1989.
2. R. Krishnan, "Electric Motor Drives: Modeling, Analysis and Control" , Prentice Hall, 2001.
3. G. K. Dubey, "Fundamentals of Electrical Drives", CRC Press, 2002.


**References books:**


1. W. Leonhard, "Control of Electric Drives", Springer Science & Business Media, 2001.


**Online links for study & reference materials:**

https://nptel.ac.in/courses/108/104/108104140/

**Assessment method:** (Continuous Internal Assessment = 40%, Final Examination = 60%)

| | |
|---|---|
| Assessment -1 | - 05% |
| Assessment -2 | - 05% |
| Assessment -3 (Mid exam) | - 20% |
| Assessment -3 | - 05% |
| Assessment -4 | - 05% |
| **Total Internal Assessment** | **- 40%** |

**Course Code:** PEC EE-15 **Course Name:** Computer Architecture
**Credit:** 3 **Total Contact Hour:** 40hr

**Course Objective:**

1. Discuss the basic concepts and structure of computers.
2. Understand concepts of register transfer logic and arithmetic operations.
3. Explain different types of addressing modes and memory organization.
4. Learn the different types of serial communication techniques.
5. Summarize the Instruction execution stages.

**Course Description:**

This **course** provides students with a solid understanding of fundamental **architectural** techniques used to build today's high-performance processors and systems. **Course** topics include pipelining, superscalar, out of order execution, multithreading, caches, virtual memory, and multiprocessors.

**Course Contents:**

**<u>Unit-</u> I**

**Introduction to computer organization**

Architecture and function of general computer system, CISC Vs RISC, Data types, Integer Arithmetic - Multiplication, Division, Fixed and Floating point representation and arithmetic, Control unit operation, Hardware implementation of CPU with Micro instruction, microprogramming, System buses, Multi-bus organization

**<u>Unit-II</u> Memory organization**

System memory, Cache memory - types and organization, Virtual memory and its implementation, Memory management unit, Magnetic Hard disks, Optical Disks.

**<u>Unit-III</u> Input – output Organization**

Accessing I/O devices, Direct Memory Access and DMA controller, Interrupts and Interrupt Controllers, Arbitration, Multilevel Bus Architecture, Interface circuits - Parallel and serial port. Features of PCI and PCI Express bus.

**<u>Unit-</u> IV 16 and 32 microprocessors**

80x86 Architecture, IA – 32 and IA – 64, Programming model, Concurrent operation of EU and BIU, Real mode addressing, Segmentation, Addressing modes of 80x86, Instruction set of 80x86, I/O addressing in 80x86

**<u>Unit-</u> V Pipelining**

Introduction to pipelining, Instruction level pipelining (ILP), compiler techniques for ILP, Data hazards, Dynamic scheduling, Dependability, Branch cost, Branch Prediction, Influence on instruction set.

**Different Architectures**

VLIW Architecture, DSP Architecture, SoC architecture, MIPS Processor and programming

**Course Learning Outcomes (CLOs) :**

- Understand the concepts of microprocessors, their principles and practices.
- Write efficient programs in assembly language of the 8086 family of microprocessors.
- Organize a modern computer system and be able to relate it to real examples.
- Develop the programs in assembly language for 80286, 80386 and MIPS processors in real and protected modes.
- Implement embedded applications using ATOM processor.

**Text/Refence Books**

1. V. Carl, G. Zvonko and S. G. Zaky, "Computer organization", McGraw Hill, 1978.
2. B. Brey and C. R. Sarma, "The Intel microprocessors", Pearson Education, 2000.
3. J. L. Hennessy and D. A. Patterson, "Computer Architecture A Quantitative Approach", Morgan Kauffman, 2011.
4. W. Stallings, "Computer organization", PHI, 1987.
5. P. Barry and P. Crowley, "Modern Embedded Computing", Morgan Kaufmann, 2012.
6. N. Mathivanan, "Microprocessors, PC Hardware and Interfacing", Prentice Hall, 2004.

**Online links for study & reference materials:**

https://nptel.ac.in/courses/117/106/117106086/

**Assessment method:**(Continuous Internal Assessment = 40% , Final Examination = 60%)

| | |
|---|---|
| Assessment -1 | - 05% |
| Assessment-2 | - 05% |
| Assessment-3(Midexam) | - 20% |
| Assessment-3 | - 05% |
| Assessment-4 | - 05% |
| **Total Internal Assessment** | **- 40%** |

**Course Code: PROJ-EE** **Course Name:** Summer Industry Internship
**Credit:** 3 **Total Contact Hour:** 40hr