B Tech & M Tech Courses
in
Electrical Engineering

A Brief Account of the Subjects Covered

DEPARTMENT OF APPLIED PHYSICS

UNIVERSITY COLLEGE OF TECHNOLOGY

UNIVERSITY OF CALCUTTA

4 Year 8 Semester

B Tech Electrical Engineering Course

[The 1st & 2nd Semester Courses that consist of some basic subjects have not been covered here]

EE- 3rd SEMESTER

THEORETICAL PAPERS

Course PCC-EE 301: **Engineering Mathematics –III**

Module 1: Probability and Distributions, Module 2: Introduction to Statistics, Module 3: Calculus of Variation.

Course PCC-EE 302: **Network Analysis and Synthesis**

Module 1: Network Theorems, Module 2: Electrical Circuit Analysis Using Laplace Transforms, Module 3: Two Port Network and Network Functions, Module 4: Filters, Module 5: Introduction to Network Synthesis.

Course PCC-EE 303: **Analog Electronics**

Module 1: BJT circuits, Module 2: MOSFET circuits, Module 3: Operational amplifiers and closed loop applications, Module 4: Open Loop Applications of OPAMP.

Course PCC-EE 304: **Digital Electronics**

Module 1: Fundamentals of Digital Systems and Logic Families, Module 2: Combinational Digital Circuits, Module 3: Sequential Circuits and systems, Module 4: A/D and D/A Converters, Module 5: Semiconductor memories and Programmable logic devices.

Course PCC-EE 305: **Electromagnetic Fields**

Module 1: Review of Vector Calculus, Module 2: Static Electric Field, Module 3: Conductors, Dielectrics and Capacitance, Module 4: Static Magnetic Fields, Module 5: Magnetic Forces, Materials and Inductance, Module 6: Time-Varying Fields and Maxwell's Equations, Module 7: Electromagnetic Waves.

Course PCC-EE 306: **Electrical Machines–I**

Module 1: Electromechanical energy conversion principle, Module 2: DC Machines, Module 3: Single phase transformer, Module 4: Three-phase and Special transformers.

PRACTICAL PAPERS: Electrical Machines–I Laboratory, Analog and Digital Electronics Laboratory, Network Analysis Laboratory.

EE- 4th SEMESTER

THEORETICAL PAPERS

Course PCC-EE 401: **Power Systems–I**

Module 1: Basic Concepts, Module 2: Power System Components, Module 3: Relays and Switchgear, Module 4: Fault Analysis, Module 5: Over-voltages and Insulation Requirements.

Course PCC-EE 402: **Control Systems-I**

Module 1: Introduction to Control Problem, Module 2: Time Response Analysis, Module 3: Frequency-response Analysis, Module 4: Introduction to Controller Design, Module 5: Control system components.

Course PCC-EE 403: **Microprocessors and Microcontrollers**

Module 1: 8085 Microprocessor Architecture, Module 2: Peripheral Interfacing and Data Transfer Techniques, Module 3: 8085 Instruction Set and Programming, Module 4: 8051 Microcontrollers, Module 5: Advanced RISC microcontrollers.

Course PCC-EE 404: **Electrical and Electronic Measuring Instruments**

Module 1: Indicating Instruments, Module 2: Power, power factor, Energy and frequency Measurements, Module 3: Electronic Measuring Instruments, Module 4: Current and Potential Transformers.

Course PCC-EE 405: **Computer Programming**

Lectures with laboratory Demonstrations: Module 1: Introduction to Visual Basic, Module 2: Visual Basic Programming, Module 3: Introduction to Python Libraries, Module 4: Python Programming.

Course OEC-EE 406: **Open Elective-I:** One paper from the Open Elective Course List is given below.

PRACTICAL PAPERS

Power Systems–I Laboratory, Measurements and Instrumentation Lab, Attending workshop/seminar.

EE- 5th SEMESTER

THEORETICAL PAPERS

Course PCC-EE 501: **Power Electronics**

Module 1: Power semiconductor switches, Module 2: Thyristor rectifiers, Module 3: DC-DC converter/Choppers, Module 4: Voltage source inverter, Module 5: Magnetics and Filter.

Course PCC-EE 502: **Electrical Machines–II**

Module 1: Three-Phase Induction Machines, Module 2: Synchronous Generator, Module 3: Synchronous Motor, Module 4: Fractional Horse Power and Special Motors.

Course PCC-EE 503: **Control Systems-II**

Module 1: State variable analysis, Module 2: State feedback control, Module 3: Digital control system, Module 4: State Space Approach for discrete-time systems, Module 5: Introduction to Nonlinear Control.

Course PEC-EE 504: **Professional Elective-I:** One paper from the Professional Elective Course List.

Course OEC-EE 505: **Open Elective -II:** One paper from the Open Elective Course List is given below.

PRACTICAL PAPERS: Electrical Machines-II Laboratory, Control Systems Laboratory, Microprocessor and Microcontroller Laboratory

Course MC-EE 509: **Internship:** This is a zero-credit but mandatory course. Each candidate has to undergo at least one week of industrial/academic internship program within the entire semester period and has to submit one technical report.

EE- 6th SEMESTER

THEORETICAL PAPERS

Course PCC-EE 601: **Power Systems–II**

Module 1: Power Flow Analysis, Module 2: Stability Constraints in Synchronous Grids, Module 3: Control of Frequency and Voltage, Module 4: Fault Analysis.

Course PCC-EE 602: **Electrical Drives**

Module 1: Introduction of Electrical drives, Module 2: DC motor drive, Module 3: Induction and Synchronous Motor Drive, Module 4: Traction Drive.

Course PCC-EE603: **Wind and Solar Energy**

Module 1: Comprehensive Overview of Energy Sources, Sustainable Development, and Energy Management, Module 2: Wind Energy in India: Conversion Principles, Site Selection, and Hybrid Energy Systems, Module 3: Introduction to Solar Energy and Solar Photovoltaic, Module 4: Utilization and Storage of Solar Energy.

Course PEC-EE 604: **Professional Elective-II:** One paper from the Professional Elective Course List.

Course OEC-EE 605: **Open Elective-III:** One paper from the Open Elective Course List.

PRACTICAL PAPERS: Electrical Engineering Drawing

List of Experiments: Introduction to AutoCAD, Drafting in AutoCAD with Adding and making changes, Dimensioning, Creating Block libraries and attributes, Isometric drafting, CAD Management Implementation, Introduction to Customizing AutoCAD, AutoCAD for Electrical Engineering – SLD etc.

Power Electronics and Drives Laboratory, Power Systems-II Laboratory

Industrial Training: This is a zero-credit but mandatory course. Each candidate has to undergo at least a one-week industrial training program within the entire semester period and has to submit one technical report.

EE- 7th SEMESTER

THEORETICAL PAPER

Course PEC-EE 701: **Professional Elective-III:** One paper from the Professional Elective Course List.

Course PEC-EE 702: **Professional Elective-IV:** One paper from the Professional Elective Course List.

Course OEC-EE 703: **Open Elective-IV:** One paper from the Open Elective Course List.

PRACTICAL PAPERS:

Course LC-EE 704**: Renewable Energy Systems Lab, Course PROJ-EE 705: Project Stage-I**

EE- 8th SEMESTER

THEORETICAL PAPERS

Course HSMC 801: **HS-II**: Out of the subjects mentioned in Humanities, Social Science including Management courses (HSMC), only one will be offered for study.

Course HSMC 802**: HS-III**: Out of the subjects mentioned in Humanities, Social Science including Management courses (HSMC), only one will be offered for study.

PRACTICAL PAPERS: Project Stage-II

General Viva-Voce

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PROFESSIONAL ELECTIVE COURSES

Course PE01: **Line Commutated and Active PWM Rectifiers**

Module 1: Diode rectifiers with passive filtering, Module 2: Thyristor rectifiers with passive filtering, Module 3: Multi-Pulse converter, Module 4: Single-phase ac-dc single-switch boost converter, Module 5: Ac-dc bidirectional boost converter, Module 6: Isolated single-phase ac-dc flyback converter.

Course PE-EE02: **Electrical Machine Design**

Module 1: Introduction, Module 2: DC Machines, Module 3: Transformers, Module 4: Induction Motors, Module 5: Computer-aided Design (CAD)

Course PE03: **Power System Protection**

Module 1: Transformer protection, Module 2: Generator protection, Module 3: Motor protection, Module 4: Transmission line protection, Module 5: Modern relaying technology

Course PE04: **HVDC Transmission Systems**

Module 1: DC Transmission Technology, Module 2: Analysis of Line Commutated and Voltage Source Converters, Module 3: Control of HVDC Converters & Components of HVDC systems, Module 4: Stability Enhancement using HVDC Control, Module 5: MT DC Links.

Course PE05: **Industrial Electrical Systems**

Module 1: Electrical System Components, Module 2: Residential and Commercial Electrical Systems, Module 3: Illumination Systems, Module 4: Industrial Electrical Systems I, Module 5: Industrial Electrical Systems II, Module 6: Industrial Electrical System Automation.

Course PE06: **Digital Signal Processing**

Module 1: Basics of signals and systems, Module 2: LTI systems and their property, Module 3: Fourier, Laplace, and z-Transforms, Module 4: Digital Filters and their design, Module 5: Dealing with non-stationary signals.

Course PE07: **Computer Architecture**

Module 1: Introduction to Computer Organization, Module 2: Memory Organization, Module 3: Input-Output Organization, Module 4:16 and 32 microprocessors, Module 5: Pipelining, Module 6: Different Architectures.

Course PE08: **Electrical and Hybrid Vehicles**

Module 1: Introduction, Module 2: Electric Trains, Module 3: Energy Storage, Module 4: Energy Management Strategies: Case Studies: Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).

Course PE09: **Power Quality and FACTS**

Module 1: Transmission Lines and Series/Shunt Reactive Power Compensation, Module 2: Thyristor-based Flexible AC Transmission Controllers (FACTS), Module 3: Voltage Source Converter-based (FACTS) controllers, Module 4: Power Quality Problems in Distribution Systems and DSTATCOM, Module 5: Dynamic Voltage Restorer and Unified Power Quality Conditioner.

Course PE10: **Control Systems Design**

Module1: Design Specifications, Module 2: Design of Classical Control System in the time domain, Module 3: Design of Classical Control System in the frequency domain, Module 4: Design of PID controllers, Module 5: Control System Design in state space, Module 6: Nonlinearities and its effect on system performance.

Course PE11: **Power System Dynamics and Control**

Module 1: Introduction to Power System Operations, Module 2: Analysis of Linear Dynamical System and Numerical Methods, Module 3: Modelling of Synchronous Machines and Associated Controllers, Module 4: Modelling of Other Power System Components, Module 5: Stability Analysis, Module 6: Enhancing System Stability.

Course PE12: **Advanced Electric Drives**

Module 1: Power Converters for AC drives, Module 2: Induction motor drives, Module 3: Synchronous motor drives, Module 4: Permanent magnet motor drives, Module 5: Switched reluctance motor drives, Module 6: DSP-based motion control.

Course PE13: **Electrical Energy Conservation and Auditing**

Module 1: Energy Scenario, Module 2: Basics of Energy and its various forms, Module 3: Energy Management & Audit, Module 4: Energy Efficiency in Electrical Systems, Module 5: Energy Efficiency in Industrial Systems, Module 6: Energy Efficient Technologies in Electrical Systems.

Course PE14: **High Voltage Engineering**

Module 1: Breakdown in Gases, Module 2: Breakdown in liquid and solid Insulating materials, Module 3: Generation of High Voltages, Module 4: Measurements of High Voltages and Currents, Module 5:

Lightning and Switching Over-voltages, Module 6: High Voltage Testing of Electrical Apparatus and High Voltage Laboratories.

Course PE15: **Power Station and Substation Practice**

Module 1: Power Station Engineering, Module 2: Substation Engineering, Module 3: Power System Economics and Management.

OPEN ELECTIVE COURSES

Course OE01: **Electronic Devices**

Module 1: Fundamentals of Semiconductor Physics, Module 2: Carrier Dynamics and P-N Junctions, Module 3: Advanced Semiconductor Devices, Module 4: Optoelectronic Devices and IC Fabrication.

Course OE02: **Data Structures and Algorithms**

Module 1: Introduction, Module 2: Stacks and Queues, Module 3: Linked Lists: Singly linked lists: Circular Linked Lists: Trees, Module 4: Sorting and Hashing.

Course OE03: **VLSI Circuits**

Module 1: Design of digital circuits, Module 2: The Wiring Network, Module 3: MOS Components and Sub-circuits, Module 4: CMOS Amplifiersm, Module 5: Switched capacitors circuit.

Course OE04: **Image Processing**

Module 1: Digital Image Fundamentals, Module 2: Colour Image Processing, Module 3: Wavelets and Multi-resolution Image Processing, Module 4: Fundamentals of Video Coding.

Course OE05: **Communication Techniques and Networking**

Module 1: Basics of Communication and CW Modulation, Module 2: Pulse Modulation Techniques, Module 3: Serial Communication Standards, Module 5: Industrial Networking.

Course OE06: **Strength of Materials**

Module 1: Deformation in solids, Module 2: Beams and types transverse loading on beams, Module 3: Moment of inertia, Module 4: Stresses and deformation.

Course OE07: **Embedded Systems**

Module 1: Embedded Systems Architecture, Module 2: ARM Controller Architecture, Module 3: Embedded System-based Data Acquisition Systems, Module 4: Interfacing of real-world devices.

Course OE08: **Power Plant Engineering**

Module 1: Thermal power plants, Module 2: Gas turbine power plants, Module 3: Nuclear energy power plants, Module 4: Hydroelectric power plants.

Course OE09: **Computer Networks**

Module1: Data communication Components, Module 2: Data Link Layer and Medium Access sub-layer, Module 3: Network Layer, Module 4: Transport Layer, Module 5: Application Layer.

Course OE10: **Internet of Things**

Module 1: Introduction to IoT, Module 2: Elements of IoT, Module 3: IoT Application Development, Module 4. IoT-Case Studies.

Course OE11: **Transducers and Process Measurements Course Outcomes**

Module 1: Measurement systems presentation and performance parameters, Module 2: Industrial temperature measurement systems, Module 3: Industrial pressure and displacement measurement systems, Module 4: Advanced measurements systems.

Course OE12: **Process Control Instrumentation**

Module 1: Fundamental of process control, Module 2: Components of a process control system, Module 3: Sequential process control, Module 4: Computers in process control.

Course OE13: **Non-destructive evaluation and biomedical Instrumentation**

Module 1: Basics of Non-destructive Evaluation, Module 2: Advanced NDE methods, Module 3: Biomedical measurement, Module 4: ECG basics and analysis.

Course OE14: **Introduction to Robotics**

Module 1: Basics of Robotics, Module 2: Robotics Kinematics, Module 3: Robot Dynamics, Module 4: Robotic Motion.

Course OE15: **Machine Learning and its Application**

Module 1: Introduction to Machine Learning, Module 2: Feature Extraction and Classification, Module 3: Performance evaluation, Module 4: Introduction to deep learning, Module 5: Machine learning applications in electrical engineering.

2-Year 4-Semester M. Tech. Degree in Electrical Engineering

with Specialization in:

I. Smart Grid Systems

II. Control and Robotics

(with effect from the academic year 2024 - 2025)

[Note: There are two categories of students in the M Tech course of studies in Electrical Engineering. One is the M Tech Degree in Electrical Engineering for regular students preferably with a GATE qualification. The other is the M Tech degree in Electrical Engineering for Working Professionals. The latter one is a self-financed course for employed persons. The course curriculum for both streams is the same.]

[EE(I): Stands for Smart Grid Systems Specialisation & EE(II): Stands for Control and Robotics Specialisation]

Semester I

Theoretical Papers:

EE901: **Computational Intelligence**

Module 1: Machine learning, Module 2: Feature extraction and classification, Module 3: Artificial neural network, Module 4: Optimization techniques

EE902: **Measurements and Control Techniques**

Module 1: Fundamentals of Measurement Systems, Module 2: Sensors, transducers and signal conditioning, Module 3: State Space Analysis, Module 4: State feedback Controller design.

EE(I)903: **Smart Grid Architecture**

Module 1: Introduction, Module 2: Smart Grid Communications Protocols, Module 3: Introduction of renewable energy integration, Demand Side Integration, Module 4: Devices and Systems.

EE(II)903: **Nonlinear and Optimal Control**

Module 1: Nonlinear System Analysis, Module 2: Stability Analysis of Nonlinear Systems, Module 3: Optimal control Theory, Module 4: Optimal Control Systems Design.

Practical Papers:

RE904: **Research Methodology**

EE(I)905: **Advanced Power System Lab**

EE(II)905: **Advanced Control System Lab**

Semester II

Theoretical Papers:

EE1001: **Embedded Systems**

Module 1: General Concepts, Module 2: 8051 Microcontroller architecture, Moule 3: PIC microcontrollers, Module 4: Applications of embedded systems.

EE1002: **Condition Monitoring and Predictive maintenance**

Module 1: Condition monitoring and diagnostic engineering, Module 2: Condition monitoring of rotating electrical machines, Module 3: Condition monitoring of transformers and high voltage equipment, Module 4: Signal processing tools and AI techniques methods condition monitoring.

EE(I)1003: **EHVAC, HVDC Transmission**

Module 1: EHVAC Transmission, Module 2: Voltage Stability in Power Transmission, Module 3: HVDC Transmission, Module 4: CSC and VSC Transmission.

EE(II)1003: **Introduction to Robotics**

Module 1: Robotics Overview and Components, Module 2: Robot Arm Kinematics, Module 3: Dynamic Formulation for Robots, Module 4: Robot Arm Control.

PE(I)1004 / PE(II)1004: **Elective – I:**

Details are given in a later page.

Practical Papers:

PR(I)1005: **Renewable Energy Integration Lab**

PR(II)1005: **Robotics Lab**

PR1006: Term **Paper leading towards Thesis work**

PR1107: **Mini Project with Seminar**

Semester III

Theoretical Papers

EE(I)1101 /EE(II)1101: **Elective – II:**

Details are given in later pages

Practical Papers

PR1102: **Thesis Phase –I**

Semester IV

Practical Papers

PR1201: **Thesis Phase - II**

Elective Papers - I: PE(I)1004/PE(II)1004

Elective - I:

EL11: **Grid Integration of Renewable Energy Resources**

Module 1: Introduction to renewable energy, Module 2: Grid integration issues, Module 3: Stability Assessment of Smart Grid, Module 4: Grid Code Compliance and Load Flow.

EL12: **Advanced Power System Analysis**

Module 1: Fault Analysis, Module 2: Power System Load Flow Analysis, Module 3: Optimal Power Flow Analysis, Module 4: Power system Tariff.

EL13: **Advanced Electric Drives**

Module 1: Concept of Drive, Module 2: Induction machine drive, Module 3: Traction drives, Module 4: Special machines drive.

EL14: **Power System Harmonics, Quality and Reliability**

Module 1: Harmonics in Power Systems, Module 2: Power System Quality, Module 3: Power System Restructuring and Distributed Generation, Module 4: Ensuring Power System Reliability.

EL15: **Smart Sensors and Advanced Measurement Techniques**

Module 1: Signal Conditioning and Virtual Instrumentation, Module 2: Intelligent Sensors and Soft Sensors, Module 3: Communication with Smart Sensors and Standards, Module 4: Wireless Sensor Networks.

EL16: **Navigation of Mobile Robots and Machine Vision**

Module 1: Introduction to mobile robots, Module 2: Robotic sensors, Module 3: Robotic actuators, Module 4: Machine vision for mobile robot.

EL17: **Robust and Adaptive Control**

Module 1: Introduction to robust control system, **Module 2**: H-infinity Control, **Module 3**: Adaptive control, **Module 4**: Different types of adaptive control.

EL18: **Mechatronic and Haptic Systems**

Module 1: Introduction To Mechatronics, Module 2: Sensors And Transducers, Module 3: Actuators, Module 4: Introduction To Haptic Technology and Human Haptics.

Elective Papers – II: PE(I)1101/PE(II)1101

EL21: **Electric Vehicles**

Module 1: Introduction to Electric Vehicles, Module 2: Electric Drives in EVs, Module 3: Energy Sources and Power Systems for EVs, Module 4: EV Modelling

EL22: **Converters, Storage and FACTs**

Module 1: Converters, Module 2: Synchronization with grid, Module 3: Storage, Module 4: FACTS.

EL23: **Smart Grid Security and Reliability**

Module 1: Smart Grid Protection and System Security, Module 2: Security Assessment and System Restoration, Module 3: Grid Standards, Reliability, and Assessment, Module 4: Scheduling.

EL24: **Power System Stability and Protection**

Module 1: Power system stability, Module 2: Transformer protection, Module 3: Generator and Motor protection, Module 4: Static relays and Transmission line protection.

EL25: **Intelligent Control for Robotics**

Module 1: Fundamentals of Fuzzy Sets, Module 2: Fuzzy Control, Module 3: Advanced Topics in Fuzzy Control, Module 4: Applications of Fuzzy Controllers.

EL26: **Applications of Robotic and Mechatronic Systems**

Module 1: Robotics in Healthcare, Module 2: Internet of Medical Robotic Things (IoMRT), Module 3: Robotics for Precision agriculture, Module 4: Underwater applications of Robotics.

EL27: **Cyber Physical Systems**

Module 1: Introduction to Cyber Physical Systems and Industry 4.0, Module 2: Hardware and Wireless Technologies for CPS, Module 3: Models of Computation in CPS, Module 4: Security and Privacy in CPS.

EL28: **IoT and Edge Computing**

Module 1: IoT and Edge Computing, Module 2: Communications And Information Theory, Module 3: Cloud And Fog Topologies, Module 4: IoT and Edge Security.