Course Curriculum

(Course Structure and Syllabi)

for

Minor Degree

in

Electrical Engineering

Department of Electrical Engineering

National Institute of Technology Hamirpur

Hamirpur (H.P) – 177 005 (India)

राष्ट्रीय प्रौद्योगिकी संस्थान हमीरपुर
हमीरपुर (हि॰प्र॰) – 177 005 (भारत)
NATIONAL INSTITUTE OF TECHNOLOGY HAMIRPUR
HAMIRPUR (H.P.) - 177 005 (INDIA)
(An Institute of National Importance under Ministry of HRD)

Department of Electrical Engineering

Teaching Scheme for Minor Degree in Electrical Engineering

For Minor Degree in Electrical Engineering the students are required to complete the following four courses with a total of twelve (12) credits.

S.no	Code	Subject	Semester	L	T	P	C
1.	EE-310	Circuits, Signals and Systems	5th	3	0	0	3
2.	EE-320	Measurement and Control	6th	3	0	0	3
3.	EE-410	Power Systems	7th	3	0	0	3
4.	EE-420	Fundamentals of Electrical Machines	8th	3	0	0	3
	EE-430	Power Electronics and Drives					
Total Credits						**12**	

*** The students may opt for only one course at Serial no 4.**

Course Name: **Circuits, Signals and Systems**
Course Code: **EE-310**
Course Type: **Minor Degree Course**

Contact Hours/Week: 3L **Course Credits: 03**

Course Objectives

- Apply Laplace Transform for typical circuits.
- To understand the significance of Fourier series and Fourier Transform and apply them for typical electrical systems.
- To learn the frequency domain analysis of signals and systems
- To understand state- space analysis and z-transform analysis.

Unit Number	Course Content	Contact Hours
Unit-01	**Dynamic Equations and Their Solutions:** Review of the "classical" formulation and solution of dynamic equations for simple electrical circuits.	**6**
Unit-02	**Laplace Transform and Interconnected systems:** The unilateral Laplace transform and its applications, System functions, Poles and zeros, Interconnected system, and feedback.	**6**
Unit-03	**Discrete-Time Signals and Z-Transform:** Discrete-time signals and linear difference equations, The unilateral Z-transform and its applications, Solution of difference equations.	**6**
Unit-04	**Unit Sample Response and Convolution:** The unit-sample response, Convolutional representations of continuous-time systems, Impulses, and the superposition integral, discrete-time convolution.	**6**
Unit-05	**Frequency-Domain and Fourier Transforms:** Frequency-domain methods for general LTI systems, Fourier series, Fourier transforms and Fourier's theorem, Sampling in time and frequency domain.	**6**
Unit-06	**Concept of state and state variables**: State space modeling for simple electrical and mechanical systems – state transition matrix - solution of state equations.	**6**

Course Outcomes

Upon successful completion of the course, the students will be able to
CO1: Computation of the response of linear systems via Laplace Transform techniques.
CO2: Understand Transfer function, impulse response, convolution, convolution theorems.
CO3: Model the systems in transfer function and state-space domains and analyze the system. using these models.
CO4: Apply Z-transforms for the analysis of discrete time systems.

Textbooks

1. Circuits, Signals, and Systems, William M. Siebert, The MIT Press, 1985.
2. Linear Systems and Signals, B. P. Lathi, Oxford University Press, 2005.

Reference Books

1. Circuits, Signals, and Speech and Image Processing, Richard C. Dorf, CRC Press, 2018.
2. Circuits, Devices and Systems: A First Course in Electrical Engineering, Smith, Ralph J., and Richard C. Dorf. John Wiley & Sons, 1992.
3. Signals and Systems, Haykin, Simon, and Barry Van Veen. John Wiley & Sons, 2007.

Course Name: **Measurement and Control**
Course Code: **EE-320**
Course Type: **Minor Degree Course**

Contact Hours/Week: 3L **Course Credits: 03**

Course Objectives

- Students will understand the fundamentals of Measurement system involving sensors and signal conditioning circuits.
- To impart the knowledge of control system analysis and design techniques

Unit Number	Course Content	Contact Hours
Unit-01	**Introduction to Measurement:** Methods of measurement – Direct Method, Indirect Method. Elements of Generalized Measurement System. Error Analysis, Characteristics of measurement system: Linearity, Hysteresis, Dead Zone, Loading effect, Accuracy, Precision and Resolution. Indicating Instruments: Galvanometer – Construction, torque equation and dynamic behavior. Permanent Magnet Moving Coil Instruments (PMMC): Analog Ammeter and Voltmeter.	**6**
Unit-02	**Sensors and Transducers:** Basic requirements of a Transducer, Type of transducers for measuring displacement, strain, temperature, velocity (angular and linear). Basic principles of resistive transducers, Inductive transducers, capacitive transducers, Piezoelectric transducers, Hall effect transducers.	**6**
Unit-03	**Signal Conditioning:** Introduction to signal conditioning, ideal op-amp, Operational amplifier specifications, zero crossing detector, inverting and non-inverting amplifiers, Voltage-follower, adder, subtractor, integrator, Differentiator, Differential-amplifier, Instrumentation amplifier.	**5**
Unit-04	**Control Systems and its Components:** Introduction, Historical overview, system, servomechanism, open loop and closed loop systems, mathematical modelling of physical systems Block diagram representation and reduction techniques, feedback and non-feedback systems, advantages of feedback, Control Components, general block diagram of a control system, Introduction to PID controller.	**6**
Unit-05	**Time Domain Analysis:** Servomotor, position control system, standard input signals, Response of 1st and 2nd order systems, time domain specifications, Steady state errors for unit step, Effect of addition of pole and zero to the system	**6**
Unit-06	**Stability Analysis of Control Systems:** concept of stability, conditions for stable system, asymptotic, relative, and marginal stability, Routh-Hurwitz criterion for stability, Root Locus Technique: concepts of root locus, construction of root loci, and various rules pertaining to locus diagram development, Bode plot and Nyquist criterion.	**7**

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: understand different components of the measurement system.

CO2: understand the working principle of sensors and transducers.

CO3: Describe the mathematical relation between input and output for LTI systems.

CO4: Assess the performance of LTI system and design controllers to meet the desired performance.

Textbooks

1. A course in Electrical, Electronic Measurements and Instrumentation by A.K. Sawhney, Dhanpat Rai & Sons.
2. Modern Control Engineering by K. Ogata, Prentice Hall India
3. Control System Engineering by I.J. Nagrath and M. Gopal, Wiley Eastern.
4. Transducers and Instrumentation by D.V.S. Murty, Prentice Hall of India Private Limited.

Reference Books

1. Measurement Systems (Application & Design) by Ernest O. Doebelin, McGraw Hill Higher Education, New Delhi
2. Control System Engineering by N.S. Nise, Wiley India (P) Limited.

Course Name: **Power Systems**
Course Code: **EE-410**
Course Type: **Minor Degree Course**

Contact Hours/Week: 3L **Course Credits: 03**

Course Objectives

- Learn modelling, analysis, and operation of power systems.
- Instills a practical knowledge of large-scale power system analysis.
- Explore modern power system trends like smart grids distributed generation and microgrids.

Unit Number	Course Content	Contact Hours
Unit-01	**Elements of Power System:** Basic structure and concepts of Power System, Significance of Electrical Energy, Single-Line Diagram of a Power Supply Network, Working and Applications of Power Transformer, Distribution Transformer and Alternator. Introduction to Load Characteristics, various factors and power factor improvement.	**7**
Unit-02	**Power Generation Systems:** Sources of electric energy: wind, solar, hydro, thermal nuclear, Battery Energy Storage Systems, Cogeneration, Distributed Generation.	**6**
Unit-03	**Power Transmission system:** Long Length Transmission Line Models, ABCD Parameters and (T and π models), calculation of efficiency and voltage regulation, Ferranti effect, Series and shunt compensation, Surge Impedance Loading (SIL), Introduction to underground cables.	**6**
Unit-04	**Protective Relays:** Basics of different types of relays, over current relay, IDMT relay, differential protection, distance protection of transmission lines through impedance, reactance and mho relay, comparison between distance relays, static relays.	**7**
Unit-05	**Power System Economics:** Characteristics of generating units, Incremental Cost, Economic dispatch with and without losses using λ-Iteration Method.	**3**
Unit-06	**Modern power systems:** Deregulated power systems, Smart grids, demand side management, microgrids - types of microgrids.	**5**

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Provide a solid understanding of the theoretical aspects of power systems.
CO2: Understand different types of power generation systems.
CO3: Understand the operation of power systems and various protection relays.
CO4: Adapt to modern power system trends for industry relevance.

Textbooks

1. Electric Power Systems by C. L. Wadhwa, New Age International, New Delhi.
2. Power System Engineering by D.P. Kothari and I.J. Nagrath, Tata McGraw Hill, New Delhi.
3. Switchgear and Protection by Sunil S. Rao, B. Ravindernath & M. Chander, Khanna Publishers, Delhi.

Reference books

1. Power System Analysis, John J. Grainger, William D. Stevenson, McGraw-Hill Education
2. Smart Grids: Infrastructure, Technology, and Solutions, Stuart Borlase, David J. Hill, CRC Press

Course Name: **Fundamentals of Electrical Machines**
Course Code: **EE-420**
Course Type: **Minor Degree Course**

Contact Hours/Week: 3L **Course Credits: 03**

Course Objectives

- To acquire knowledge about the operation, testing, efficiency, and various configurations of single phase and three phase transformers.
- To impart knowledge about operation, various characteristics, starting and speed control of DC machines.
- To learn about operation, characteristics, testing and control of induction machines.
- To impart knowledge about the operation, synchronization, and parallel operation of alternators.

Unit Number	Course Content	Contact Hours
Unit-01	**Transformers:** Construction, Theory, and operation, E.M.F. equation, phasor diagram, rating of transformers, equivalent circuit, open and short circuit tests, back-to-back test, voltage regulation and efficiency, auto-transformers, parallel operation of single-phase transformers.	**6**
Unit-02	**Fundamentals of DC Machine Operation:** Introduction, Action of commutator, E.M.F. generated in armature, Torque in DC machines, Methods of excitation, armature reaction and flux density waveform of DC Machines, Commutation process, compensating windings.	**5**
Unit-03	**DC Machine Performance Analysis:** Basic performance equations of DC machine, DC motor starting and speed control, losses and efficiency, applications of DC motors.	**5**
Unit-04	**Polyphase Induction Machines:** Theory of three phase induction motors, Principle of operation, slip, phasor diagram, equivalent circuits, expression for torque, maximum torque, starting torque and output power, torque-slip and power-slip characteristics, no-load and blocked rotor test, Starting of Induction motors, Speed control of induction motor, Cogging & Crawling, applications of poly-phase induction motors.	**6**
Unit-05	**Single-Phase Induction Machines:** Principle of operation single phase induction motor based on double revolving field theory, Starting methods of single-phase induction machine.	**4**
Unit-06	**Synchronous Machines:** Types of Exciters for synchronous machines, flux and MMF phasor diagrams for cylindrical rotor synchronous machines, Armature reaction, open and short circuit characteristics, Leakage reactances, Synchronous reactance, Phasor diagram under loaded conditions, Steady state power flow equations, Power angle characteristics.	**6**

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Understand the operation of a transformer and carry out its various performance tests.

CO2: Understand the working Principle of a DC Machine and, its generating & motoring aspects.

CO3: Explain various phenomena associated with synchronous machines.

CO4: Describe and explain various methods of synchronization and conditions for parallel operation of alternators

Textbooks

1. Electrical Machinery by P.S. Bhimbra, Khanna Publishers,
2. Electric Machinery by A.E. Fitzerald, C. Kingsley and S.D. Umans, Tata McGraw Hill.
3. Electrical Machines by Ashfaq Hussian, Dhanpat Rai & Company.

Reference Books

1. Electrical Machinery Fundamentals by S. J. Chapman, McGraw Hill, New York.
2. Theory of AC Machinery by A.S. Langsdorf, Tata McGraw Hill.
3. Electric Machines by I. J. Nagrath and D. P. Kothari, Tata McGraw Hill

Course Name: **Power Electronics and Drives**
Course Code: **EE-430**
Course Type: **Minor degree Course**

Contact Hours/Week:3L **Course Credits:03**

Course Objectives

- To learn the basics and types of power switches and their uses in power electronics systems
- To provide the knowledge of the different types of power electronic converters and to learn the types of output waveforms.
- To enable the students to understand the basics of electric drives with their suitable control

Unit Number	Course Content	Contact Hours
Unit-01	**Introduction and characteristics of different switches:** Concept of power electronics, brief introduction of different types of power electronics devices, converter systems, areas of application, device construction and characteristics of power diode, power BJT, power MOSFET, power IGBT, SCR, basics of firing/triggering circuit	**6**
Unit-02	**Basics of phase-controlled rectifiers and choppers:** Principle and operation of phase-controlled rectifiers (single/three phase), performance parameters, evaluation of single-phase half-controlled/fully controlled converter with different loads, Basic principle of DC-DC switched mode converters, classifications and quadrant operation, step-up and step-down choppers.	**6**
Unit-03	**Introduction to the Inverters and AC Voltage Controllers:** Introduction of inverter operation, classification of inverters and its applications, performance parameters, analyze the performance of single-phase half-bridge and full-bridge voltage source inverters with different load condition, basics of single-phase and three-phase AC voltage controllers.	**6**
Unit-04	**Basics of Electric Drive:** Concept of electrical drive, advantages over other drives, different parts and classifications, choice of electrical drives, fundamental torque equation, speed torque conventions and multi-quadrant operation, basics of closed-loop control of drives	**6**
Unit-05	**Fundamentals of DC drives:** Basics and characteristics of DC motor, speed control (closed/open loop) of separately excited DC motor using single-phase and three-phase controlled rectifiers and choppers.	**6**
Unit-06	**Fundamentals of AC drives:** Basics and characteristics of induction motor, open/closed loop control of induction motor (IM) drives.	**6**

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Understanding the basics of power electronics and drives and switching devices.

CO2: Study and analyze the operation of different converters for a given performance and application.

CO3: Demonstrate the various parts of electrical motor drives.

CO4: Examine the characteristics and control of AC and DC electrical motor drive

Textbooks

1. Power Electronics by P.S. Bhimbra, Khanna Publishers, Delhi.
2. Power Electronics by M.D. Singh and Khanchandani, Mc Graw Hill Education
3. Power Electronics Devices, Circuits and Applications by M.H. Rashid, Pearson Education.
4. Fundamentals of Power Electronics by Robert W. Erickson D. Maksimovic, Springer Science

Business Media
5. A First Course on Electrical Drives by S.K. Pillai, Willey Eastern Ltd.
6. Fundamentals of Electrical Drives by G.K. Dubey, Narosa
7. Power Electronics Converters, Applications and Design by Ned Mohan, Wiley

Reference Books

1. Modern Power Electronics by B.K. Bose, IEEE Press, New York
2. Thyristorised Power Controllers by Dubey, Doradla and Joshiand Sinha, New age International Pub., New Delhi.
3. Modern Power Electronics and AC drives by B.K. Bose, Pearson publications
4. Electric Motor Drives Modeling, Analysis and Control by R. Krishnan, Pearson Publications