Muzaffarpur Institute of Technology, Muzaffarpur
Department of Electrical Engineering

Detailed Syllabus of 5th Semester (3rd Year)

103 – ELECTRICAL ENGINEERING						
Semester: V			**Branch/Course: Electrical Engineering**			
Sl. no.	**CODE**	**Course Title**	**L**	**T**	**P**	**Credit**
1	100507	Power Systems–I (Apparatus and Modelling)	3	0	0	3
2	100507P	Power Systems Laboratory - I	0	0	2	1
3	100502	Control Systems	3	0	0	3
4	100502P	Control Systems Laboratory	0	0	2	1
5	100504	Microprocessors	3	0	0	3
6	100504P	Microprocessors Laboratory	0	0	2	1
7	100506	Power Electronics	3	0	0	3
8	100506P	Power Electronics Laboratory	0	0	2	1
9	104503	Program Elective - 1 (Linear Control System)	3	0	0	3
10	100511P	OE-1(MOOC) MOOCs / SWAYAM / NPTEL Courses - 1	3	0	0	3
11	100510	Summer Entrepreneurship-II	0	0	12	6
12		Graduate Employability Skills and Competitive Courses (GATE, IES, etc.)	3	0	0	0
			TOTAL			**33**

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103 - Electrical Engineering V Semester

100507	**Power Systems-I**	**3L:0T:0P**	**3 credits**

Course Outcomes:
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 basic protection schemes.
- Understand concepts of HVDC power transmission and renewable energy generation.

Module 1: Basic Concepts (4 hours)
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. Skin effect and Ferranti effect

Module 2: Power System Components (15 hours)
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.

Module 3: Over-voltages and Insulation Requirements (4 hours)

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

Module 4: Introduction to DC Transmission & Renewable Energy Systems (9 hours)

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.

Text/References:

- J. Grainger and W. D. Stevenson, "Power System Analysis", McGraw Hill Education, 1994.
- O. I. Elgerd, "Electric Energy Systems Theory", McGraw Hill Education, 1995.
- A. R. Bergen and V. Vittal, "Power System Analysis", Pearson Education Inc., 1999.
  D. P. Kothari and I. J. Nagrath, "Modern Power System Analysis", McGraw Hill Education, 2003.
- B. M. Weedy, B. J. Cory, N. Jenkins, J. Ekanayake and G. Strbac, "Electric Power Systems", Wiley,2012.

100507P: Power Systems – I Laboratory (0:0:2 – 1 credit)

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.

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100502	Control Systems	3L:0T:0P	3 credits

Course Outcomes:

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.

Module 1: Introduction to control problem (4 hours)
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. Signal flow graph

Module 2: Time Response Analysis (10 hours)

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.

Module 3: Frequency-response analysis (6 hours)
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.

Module 4: Introduction to Controller Design (10 hours)
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.

Module 5: State variable Analysis (6 hours)
Concepts of state variables. State space model. Diagonalization of State Matrix. Solution of state equations. Eigen values 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.
Text/References:

- M. Gopal, "Control Systems: Principles and Design", McGraw Hill Education, 1997.
- B. C. Kuo, "Automatic Control System", Prentice Hall, 1995.
- K. Ogata, "Modern Control Engineering", Prentice Hall, 1991.
- I. J. Nagrath and M. Gopal, "Control Systems Engineering", New Age International,2009

100502P: Control Systems Laboratory (0:0:2 – 1 credit)

Hands-on/Computer experiments related to the course contents of EE17.

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100504	**Microprocessors**	**3L:0T:0P**	**3 credits**

Course Outcomes:

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.

Module 1: Fundamentals of Microprocessors: (7 Hours)
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 microcontroller sin embedded Systems. Overview of the 8051family.

M**odule 2: The 8051 Architecture (8 Hours)**
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.

Module 3: Instruction Set and Programming (8 Hours)
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.

Module 4: 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, memory devices.

Module 5: External Communication Interface (6 Hours)

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

Module 6: Applications (6 Hours)

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

Text / References:

- M. A.Mazidi, J. G. Mazidi and R. D. McKinlay, “The8051Microcontroller and Embedded Systems: Using Assembly and C”,Pearson Education,2007.
- K. J. Ayala, “8051 Microcontroller”, Delmar CengageLearning,2004.
- R. Kamal, “Embedded System”, McGraw HillEducation,2009.
- R. S. Gaonkar, “, Microprocessor Architecture: Programming and Applications with the 8085”, Penram International Publishing,1996
- D.A. Patterson and J.H. Hennessy, "Computer Organization and Design: The Hardware/Software interface”, Morgan Kaufman Publishers,2013. D. V. Hall, “Microprocessors & Interfacing”, McGraw Hill Higher Education,1991.

100504P: Microprocessor Laboratory (0:0:2 – 1 credit) Hands-on experiments related to the course contents of EE19.

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100506	Power Electronics	3L:0T:0P	3 credits

Course Outcomes:

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

- Understand the differences between signal level and power level devices.
- Analyse controlled rectifier circuits.
- Analyse the operation of DC-DC choppers.
- Analyse the operation of voltage source inverters.

Module 1: Power switching devices (8 Hours)
Diode, Thyristor, MOSFET, IGBT: I-V Characteristics; Firing circuit for thyristor; Voltage and current commutation of a thyristor; Gate drive circuits for MOSFET and IGBT.

Module 2: Thyristor rectifiers (7 Hours)
Single-phase half-wave and full-wave rectifiers, Single-phase full-bridge thyristor rectifier with R- load and highly inductive load; Three-phase full-bridge thyristor rectifier with R-load and highly inductive load; Input current wave shape and power factor.

Module 3: DC-DC converter (10 Hours)
Elementary chopper with an active switch and diode, concepts of duty ratio and average voltage, power circuit of a buck converter, analysis and waveforms at steady state, duty ratio control of output voltage.
Power circuit of a boost converter, analysis and waveforms at steady state, relation between duty ratio and average output voltage.

Module 4: Single-phase and 3-phase voltage source inverter (14 Hours)
Power circuit of single-phase voltage source inverter, switch states and instantaneous output voltage, square wave operation of the inverter, concept of average voltage over a switching cycle, bipolar sinusoidal modulation and unipolar sinusoidal modulation, modulation index and output voltage Power circuit of a three-phase voltage source inverter, switch states, instantaneous output voltages, average output voltages over a sub-cycle, three-phase sinusoidal modulation. Current Source Inverter

Text/References:

- M. H. Rashid, “*Power electronics: circuits, devices, and applications*”, Pearson Education India, 2009.
- N. Mohan and T. M. Undeland, “Power Electronics: Converters, Applications and Design”, John Wiley & Sons, 2007.

- R. W. Erickson and D. Maksimovic, "Fundamentals of Power Electronics", Springer Science& Business Media, 2007.
- L. Umanand, "Power Electronics: Essentials and Applications", Wiley India, 2009.

100506P: Power Electronics Laboratory (0:0:2 – 1credit) Hands-on experiments related to the course contents ofEE21.

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Program Elective - 1

Linear Control System **3L: 1T: 0P** **3 Credits**

1. **Control Systems:** Basics & Components, Introduction to basic terms, Classifications and types of Control Systems, Block diagrams & Signal flow graphs. Transfer function, Determination of transfer function using Block diagram re-duction techniques and Mason's Gain formula. Control system components: Electrical, Mechanical, Electronic, AC/DC Servo Motors, Stepper Motors, Tacho Generators, Synchro's, Magnetic Amplifiers, Servo Amplifiers
8 Hrs.
2. **Time-Domain Analysis:** Time domain performance specifications, Transient response of first and second order systems, Steady state errors and Static error constants in unity feedback control systems, response with P, PI and PID controllers, Limitations of time domain analysis. **8 Hrs.**
3. **Frequency Domain Analysis:** Polar and inverse polar plots, Frequency domain specifications and Performance of LTI systems, Logarithmic plots (Bode plots), Gain and Phase Margins, Relative stability. Correlation with time domain performance, Closed loop frequency responses from Open loop response. Limitations of frequency domain analysis, Minimum/Non-minimum phase systems **8 Hrs.**
4. **Stability and Compensation Techniques**: Concepts, absolute, Asymptotic, Conditional and Marginal stability, Routh–Hurwitz and Nyquist stability criterion, Root locus technique and its application. Concepts of compensation, series/parallel/series parallel/feedback compensation, Lag/Lead/Lag- Lead networks for compensation, Compensation using P, PI, PID controllers
8 Hrs.
5. **Control System Analysis using State Variable Methods:** Control Systems Engineering Syllabus State variable representation-Conversion of state variable models to transfer functions-Conversion of transfer functions to state variable models-Solution of state equations-Concepts of Controllability and Observability Stability of linear systems Equivalence between transfer function and state variable representations-State variable analysis of digital control system-Digital control design using state feedback.**8 Hrs.**

Sl. No. Name of Authors / Books /Publishers

1 "Automatic Control System", B. C. Kuo, Prentice Hall of India, 7th edition, 2001
2 "Control Systems Engineering -Principles and Design", Nagraath and Gopal New Age Publishers
3 "Control systems engineering", Norman S. Nise, John Wiley and Sons (Asia) Singapore
4 "Design of Feedback Control System", Raymond T. Stefani, Oxford University Press
5 "Modern control engineering", K. Ogata, Pearson, 2002