Syllabus of

UNDERGRADUATE DEGREE COURSE

B.Tech. VI Semester

Electronics Instrumentation & Control

Rajasthan Technical University, Kota

Effective from session: 2025-26

6EI3-01: Optical Instrumentation

Credit: 3 **Max. Marks: 100(IA:30, ETE:70)**
3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	Introduction: Objective, scope and outcome of the course.	01
2	OPTICAL FIBER OVERVIEW- Introduction, Ray theory, Optical fibers: multimode, single mode, step index, graded index, plastic & glass fibers. Transmission Characteristics of Optical Fibers - Introduction, Attenuation, Material absorption loss, Fiber bend loss, scattering, Dispersion (intermodal &intramodal), Dispersion Shifted Fibers, Dispersion Compensating Fibers. Manufacturing of optical Fibers – preparation of optical fiber, Liquid phase techniques, Vapour phase depositions techniques.	10
3	OPTICAL FIBER SOURCES- Laser- Emission and absorption of radiation, Einstein relation, Absorption of radiation, Population inversion, Optical feedback, Threshold condition. Population inversion and threshold, working of three levels & four level laser. Basic idea of solid state, semiconductors, gas & liquid laser. Basic concept of Q-switching and mode locking. Light Emitting Diode - Structure, Material, Characteristics, Power & Efficiency.	10
4	OPTICAL DETECTORS & CONNECTION - Optical detection principles, quantum efficiency, Responsivity, PIN photo diode, Avalanche photo diodes, Noise in Detectors, Photo Diode Materials. Fiber Alignment, fiber splices, fiber connectors, expanded beam connectors, fiber couplers.	06
5	OPTICAL FIBER MEASUREMENTS - Measurements of Fiber Attenuation, Dispersion, Refractive Index Profile, Cut off Wave Length, Numerical Aperture & Diameter. Field measurement through optical time domain reflectometry (OTDR), Laser based systems for measurement of distance, Velocity, Holography.	08
6	OPTICAL FIBER APPLICATIONS – Wavelength division multiplexing, DWDM, active and passive components, optical sensors, optical amplifiers, public network applications, military, civil and industrial applications.	06
	Total	41

6EI4-02: Power Electronics

Credit: 3 **Max. Marks: 100(IA:30, ETE:70)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	Introduction: Objective, scope and outcome of the course.	01
2	SEMICONDUCTOR POWER DEVICES: Introduction. Basic characteristics &working of Power Diodes, Diac, Triac, MOSFETs, IGBT, GTO, Power Transistor and SCR- Principle of operation, V-I Characteristics, Turn-On mechanism and its applications.	05
3	CONVERTERS: Basic concept, Working Principles of Single phase half Wave bridge converter, Single Phase Full Bridge Converter, 3 Phase Bridge Converter.	04
4	INVERTERS: Voltage Source Inverter, Current Source Inverter, PWM Control of Voltage Source Converter and applications.	06
5	INDUSTRIAL POWER SUPPLIES: Principle of operation of choppers. Step up, Step down and reversible choppers. Chopper control techniques, High frequency electronic ballast, Switch Mode Power Supply: Fly back converter, forward/buck converter, Boost converter and buck-boost converter. Uninterruptible Power Supply.	08
6	MOTOR CONTROL: Introduction to speed control of DC motors using phase controlled converters and choppers, Basic idea of speed control of three phase induction motors using voltage and frequency control methods.	08
7	STEPPER MOTORS: Principle of operation, Types of stepper motor: Variable reluctance, Permanent magnet and hybrid stepper motors. Brushless DC motor and its control. Induction and dielectric heating control.	08
	Total	40

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6EI4-03: Control System II

Credit: 3 **Max. Marks: 100(IA:30, ETE:70)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	Introduction: Objective, scope and outcome of the course.	01
2	State space Model- Review of vectors and matrices, Canonical Model from Differential Equations and Transfer Functions, Interconnection of Subsystems.	08
3	Analysis of Linear State Equations- First Order Scaler Differential Equation, System modes and modal decomposition, State Transition Matrix, Time –varying matrix case, Solution of state equations. Pole placement by state feedback, Ackermann's Formula.	12
4	Lyapunov's stability theory for Linear System- Equilibrium points and stability concepts, Stability Definitions, Linear system stability, The Direct method of Lyapunov, Use of Lyapunov's method in feedback design.	10
5	Controllability &Observability- Definitions, Controllability/Observability Criteria, Design of state feedback control systems, Full-order and Reduced-order observer Design, Stabilizability and Detectability.	10
	Total	41

6EI4-04: Process Control System

Credit: 3 **Max. Marks: 100(IA:30, ETE:70)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	Introduction: Objective, scope and outcome of the course.	01
2	GENERAL CONCEPTS: General Concepts and terminology, Piping and Instrumentation diagram.	02
3	TYPES OF DYNAMIC PROCESS: Instantaneous, Integral, First and second Order, self-regulating, interacting and non-interacting processes. Dead time elements.	03
4	MATHEMATICAL MODELING OF SYSTEMS: Liquid Systems (Level and flow), perturbation variable and linearization methods. Response of a thermometer bulb, Concentration response of a stirred tank. Temperature response of a stirred tank, Process lag, load disturbance and their effect on processes.	06
5	BASIC CONTROL ACTION: Basic control action, two position, multi Position, continuous controller modes: proportional, integral and Derivative Composite Controller modes PI, PD, PID, Integral wind up and anti-wind up. Response of controllers for different test Input .Selection of control modes for processes like level, temperature and flow.	08
6	CONTROLLER TUNING METHODS: Evaluation criteria IAE, ISE, ITAE etc. process reaction curve method, continuous oscillation method, damped oscillation method, auto tuning.	04
7	FINAL CONTROL ELEMENTS: Pneumatic control value, construction details and types, value sizing, selection of control valves, Inherent and Installed characteristics valve actuators and positioners.	05
8	ADVANCED CONTROL SYSTEM: Cascade control, ratio control, feed forward control. Over-ride, split range and selective control. Multivariable process control, Interaction of control loops.	05
9	CASE STUDY: Distillation column, Basic features of composition control schemes. Control of overhead composition, Bottom composition and both product compositions, Location of sensing element, Control of columns with varying feed rates, Pressure control, Control of feed temperature and internal reflux control, boiler drum level control.	08
	Total	42

6EI4-05: Neural Networks And Fuzzy Logic Control

Credit: 3 **Max. Marks: 100(IA:30, ETE:70)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	Introduction: Objective, scope and outcome of the course.	01
2	NEUROPHYSIOLOGY: Introduction: Elementary neurophysiology – From neurons to ANNs - Neuron model McCulloch-Pitts model, Hebbian Hypothesis; limitations of single-layered neural networks. Applications Of Neural Networks: Pattern classification, Associative memories, Optimization, Applications in Image Processing-Iris, finger print & face, Applications in decision making.	06
3	THE PERCEPTRON: The Perceptron and its learning law. Classification of linearly separable patterns. Linear Networks: Adaline - the adaptive linear element. Linear regression. The Wiener-Hopf equation. The Least-Mean-Square (Widrow-Hoff) learning algorithm. Method of steepest descent. Adaline as a linear adaptive filter. A sequential regression algorithm. Multi-Layer Feedforward Neural Networks: Multi-Layer Perceptrons. Supervised Learning. Approximation and interpolation of functions. Back-Propagation Learning law. Fast training algorithms. Applications of multilayer perceptrons: Image coding, Paint-quality inspection, Nettalk.	10
4	FUZZY LOGIC: Introduction -Uncertainty & precision, Statistics and random process, Uncertainty in information, Fuzzy sets and membership. Membership Functions: Features of membership function. Standard forms and boundaries, Fuzzification, Membership value assignment – Intuition, Inference, Neural networks. Fuzzy To Crisp Conversions: Maximum membership principle.	08
5	DEFUZZIFICATION METHODS- Centroid method, Weighted average method, Meanmax membership. Fuzzy Rule Based Systems: Natural language, linguistic hedges, Rule based system –Canonical rule forms, Decomposition of compound rules, Likelihood and truth qualification Aggregation of Fuzzy rules. Graphical techniques of reference.	08
6	FUZZY CONTROL SYSTEM- Simple Fuzzy Logic controller, General FLC, Control System Design Problem Control (Decision) Surface, Assumptions in a Fuzzy Control System Design, Special forms of FLC system models, Industrial application: Aircraft Landing Control Problem. Fuzzy Engineering Process Control: Classical Feedback Control, Classical PID Control, Multi-input, Multi-output (MIMO) Control Systems, Fuzzy Statistical Process Control.	08
	Total	41

6EI5-11: Control System Design

Credit: 2 **Max. Marks: 100(IA:30, ETE:70)**

2L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	Introduction: Objective, scope and outcome of the course.	01
2	Design of Feedback Control Systems: Introduction; Approaches to System Design; Cascade Compensation Networks; Phase-Lead Design Using the Bode Diagram; Phase-Lead Design Using the Root Locus; System Design Using Integration Networks; Phase-Lag Design Using the Root Locus; Phase-Lag Design Using the Bode Diagram; Design on the Bode Diagram Using Analytical Methods; Systems with a Pre-filter; Design for Deadbeat Response; Design Examples.	10
3	Design of State Variable Feedback Systems Introduction, State space representation of physical systems, State space models of some common systems like R-L-C networks, DC motor, inverted pendulum etc.,.	05
4	Controllable Canonical Form, Observable Canonical Form, Diagonal Canonical Form, State transition matrix, Solution of state equations, Controllability and Observability, Full-State Feedback Control Design; Observer Design; Integrated Full-State Feedback and Observer; Tracking Reference Inputs; Internal Model Design; Design Examples.	06
5	Lyapunov's stability and optimal control positive/negative definite, positive/negative semi-definite functions, Lyapunov stability criteria, introduction to optimal control, Riccatti Equation, Linear Quadratic Regulator, Design Examples.	06
	Total	28

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6EI5-12: Embedded System Design

Credit: 2 **Max. Marks: 100(IA:30, ETE:70)**

2L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	Introduction: Objective, scope and outcome of the course.	1
2	Embedded system architecture and classifications, challenges, choice and selection of microcontrollers for embedded systems design. ARM Processor – Evolution, Architecture versions, Processor Families, Instruction Set – ARM state and Thumb state instructions, Software development tools.	9
3	TIVA ARM Cortex Architecture, Programming: Internal blocks – Processor core features, system peripherals, Memory map, bus system, debug support, User Peripherals, Serial Interfaces, Programming the peripherals using C – examples. Case studies of hardware design and software development.	7
4	OS Concepts and types, tasks & task states, process, threads, inter process communication, task synchronization, semaphores, role of OS in real time systems, scheduling, resource allocation, interrupt handling, other issues of RTOS. Examples of RTOS. Working with TI-RTOS with TIVA ARM Cortex embedded controllers.	11
	Total	**28**

6EI5-13:Robotics

Credit: 2 **Max. Marks: 100(IA:30, ETE:70)**

2L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	Introduction: Objective, scope and outcome of the course.	01
2	INTRODUCTION- Introduction: Basic concepts, definition and origin of robotics, different types of robots, robot classification, applications, robot specifications.	04
3	INTRODUCTION TO AUTOMATION – Components and subsystems, basic building block of automation, manipulator arms, wrists and end effectors. Transmission elements: Hydraulic, pneumatic and electric drives. Gears, sensors, materials, user interface, machine vision, implications for robot design, controllers.	07
4	KINEMATICS, DYNAMICS AND CONTROL- Object location, three dimensional transformation matrices, inverse transformation, kinematics and path planning, Jacobian work envelope, manipulator dynamics, dynamic stabilization, position control and force control, present industrial robot control schemes.	08
5	ROBOT PROGRAMMING- Robot programming languages and systems, levels of programming robots, problems peculiar to robot programming, control of industrial robots using PLCs.	04
6	AUTOMATION AND ROBOTS- Case studies, multiple robots, machine interface, robots in manufacturing and non-manufacturing applications, robot cell design, selection of a robot.	04
	Total	28

6EI4-21: Electronics Instrumentation Lab

Credit: 2 **Max. Marks: 100(IA:60, ETE:40)**

0L+0T+4P **End Term Exam: 2 Hours**

SN	Contents
1	Introduction: Objective, scope and outcome of the course.
2	Measurement of following parameters of op-amp : (a) Input impedance. (b) Output impedance. (c) Input & Output offset voltage. (d) Input bias currents. (e) Slew rate. (f) Supply voltage rejection ratio (SVRR). (g) Common mode rejection ratio (CMRR). (h) Gain Bandwidth product. (i) Power consumption. (j) Transient response.
3	(a) Differentiator (b) Integrator
4	(a) Wein's Bridge Oscillator (b) RC Phase shift Oscillator
5	Following filters for first order response. (a) High pass filter (b) Low pass filter (c) Notch filter
6	Wave generators – (a) Square wave generator (b) Saw tooth Generator
7	Instrumentation amplifier.
8	A Comparator.
9	(a) Voltage to current converter. (b) Current to voltage converter.
10	Frequency divider
11	Study and make the following circuits on bread board using 555 timer & determine the o/p frequency and Duty cycle: (a) Astablemultivibrator (b) Monostablemultivibrator (c) Bistablemultivibrator

6EI4-22: Control System Simulation Lab

Credit: 1 **Max. Marks: 100(IA:60, ETE:40)**
0L+0T+2P **End Term Exam: 2 Hours**

SN	Contents
1	Introduction: Objective, scope and outcome of the course.
2	Introduction to `Matlab'. Computing control software, defining systems in TF, ZPK form.
3	Use of for, while loops in Matlab programming.
4	(a). Plot step response a given TF and system in state-space. Take different valves of damping ratio and natural undamped frequency and observe the difference. (b). Plot ramp and impulse response for the same.
5	For a given 2nd order system write a program to obtain time response specifications maximum overshoot, peak time, settling time etc.
6	Write a program to check for the stability of a given closed loop system by (a) Finding close loop poles (b) using Routh's stability criterion.
7	Sketch the root locus for a given system and determine the system gain. Also simulate the same using MATLAB.
8	Sketch the Bode plot (actual and asymptotic) for a given system and analyses the stability. Also simulate the same using MATLAB and find the values of GM and PM for different values of gain.
9	Design of lead controller to satisfy given specifications using bode plot.
10	Use MATLAB to plot Nyquist plot for a given system and comment upon stability.
11	To design a PID controller for the given system to meet desired specifications. Observe the response using MATLAB.

6EI4-23: Process Control Lab

Credit: 2 **Max. Marks: 100(IA:60, ETE:40)**

0L+0T+4P **End Term Exam: 2 Hours**

SN	Contents
1	Introduction: Objective, scope and outcome of the course.
2	To perform experiments on Linear system simulator.
3	To draw response of temperature controlled process for On/Off, P, PI, PID Controller.
4	Tuning of controllers on a pressure loop.
5	To study the design and application of Lag compensator circuits.
6	To study the design and application of Lead compensator circuit.
7	To study process simulator. (a) To perform experiments on P, PI, PD, PID controller with Process simulation. (b) To study the effect of loading the process.
8	To study the operation of linear & equal percentage type control valves and determine the Following:- (i) Valve flow coefficient (ii) characteristics of control valve (iii) Rangeability of control valves.
9	To perform experiments on Ratio Control Scheme and Cascade Control Scheme on liquid level and flow system.
10	To plot and analyze step/impulse response of a first order system in (i) Non interacting mode (ii) Interacting mode.
11	(a) Study of basic logic operations, timer, counter, arithmetic operations in PLC. (b) Problem solving In PLC. (c) To perform experiments on PLC controlled process.

6EI4-24: Power Electronics Lab

Credit: 1 **Max. Marks: 100(IA:60, ETE:40)**

0L+0T+2P **End Term Exam: 2 Hours**

SN	Contents
1	Introduction: Objective, scope and outcome of the course.
2	Study the characteristics of SCR and observe the terminal configuration, measure the breakdown voltage, latching and holding current. Plot V-I characteristics.
3	Perform experiment on triggering circuits for SCR. i.e. R triggering, R-C triggering and UJT triggering circuit.
4	Study and test AC voltage regulators using triac, anti parallelthyristors and triac&diac.
5	Study and obtain the waveforms for single-phase bridge converter.
6	Perform experiment on single phase PWM inverter.
7	Perform experiment on buck, boost and buck-boost regulators.
8	Control speed of a dc motor using a chopper and plot armature voltage versus speed characteristic.
9	Control speed of a single-phase induction motor using single phase AC voltage regulator.
10	(i) Study single-phase dual converter (ii) Study speed control of dc motor using single-phase dual converter
11	Study single-phase cyclo converter.
12	Perform experiment on Motor control – open loop & closed loop.
13	Design, observe and perform experiment on various type of pulse generation from DSP/ FPGA platform. Perform experiment for PWM inverters and choppers.