Tripura University
(A Central University)

Detailed syllabus for

B.Tech in Electronics and

Communication Engineering

(Fifth Semester)

2021

FIFTH SEMESTER

Sl. No.	Course Category	Subject Code	Subject Title	L	T	P	Contact Hours/ week	Credit	Full Marks
1.	Humanities Science -5	HU 501	Professional Practice, Law and Ethics	2	0	0	2	2	100
2.	Program Core-13	PC EC 502	Digital System Design	3	0	0	3	3	100
3.	Program Core-14	PC EC 503	Control System	3	0	0	3	3	100
4.	Program Core-15	PC EC 504	Analog and Digital Communication	4	0	0	4	4	100
5.	Program Core-16	PC EC 505	Embedded Systemsand IOT	3	0	0	3	3	100
6.	Program Core-17	PC EC 506	Network Theory	3	0	0	3	3	100
7.	Program Core-18	PC EC 507	Digital System Design Lab	0	0	2	2	1	100
8.	Program Core-19	PC EC 508	Control System Lab	0	0	2	2	1	100
9.	Program Core-20	PC EC 509	Analog and Digital Communication Lab	0	0	2	2	1	100
10.	Summer Internship-1	SI EC 510	Industry Internship - I	0	0	0	0	1	100
			Total :	18	0	6	24	**22**	**1000**

1. Professional Practice, Law and Ethics(HS 501)

Course Code	HS 501
Course Title	Professional Practice, Law & Ethics
Number of Credits	2 (L: 2, T: 0, P: 0)
Prerequisites	10+2
Course Category	Humanities Science (HS)
Number of classes	26 hours

Course Outcome:-

After completion of the course, students will be able to:

CO Number	CO Description	K Level
CO 1	Develop ideas of the professionalism, values and ethics in a profession	K3
CO 2	Develop a good insight into contracts and contracts management in engineering, arbitration anddispute resolution mechanisms	K3
CO 3	Interpret laws governing engagement of labour in construction related works and other related areas	K2
CO 4	Demonstrate an understanding of Intellectual Property Rights and Patents	K2

Course Content:

Module1: Professionalism, Values and Ethics in Profession (06 hours)

Professionalism: Professional characteristics, professional education, professional development in Industry. Values and Ethics in Profession- Value system- goodness, means and ends; Ethics-ethical premises, expectation, conflicts and practices; Moral and ego,Ethics and morality

Right, virtue ethics and justice, utility and justice, privacy, challenges to privacy, privacy on the Internet.

ProfessionalEthics–Definition of Ethics, Professional Ethics, Business Ethics, Corporate Ethics, Engineering Ethics, Personal Ethics; Code of Ethics as defined in the website of Institution of Engineers (India); Profession, Professionalism, Professional Responsibility, Professional Ethics; Conflict of Interest, Gift Vs Bribery, Environmental breaches, Negligence, Deficiencies in state-of-the-art; Vigil Mechanism, Whistle blowing, protected disclosures.

Module2: General Principles of Contracts Management and Arbitration (10 hours)

Indian ContractAct,1972 and amendments covering General principles of contracting; Valid & Voidable Contracts; Prime and Subcontracts Tenders, Request For Proposals, Bids &Proposals; Bid Evaluation; Cost escalation; Delays, Suspensions &Terminations; Time extensions &Force Majeure; Delay Analysis; Liquidated damages & Penalties; Insurance &Taxation.

Arbitration, Conciliation and ADR (Alternative Dispute Resolution) system*:* Arbitration– meaning, scope and types–distinction between laws of 1940 and 1996; Arbitration agreements–essential and kinds, validity, reference and interim measures by court; Arbitration tribunal–appointment, challenge, jurisdiction of

arbitral tribunal, powers, grounds of challenge, procedure and court assistance; Award including Form and content, Grounds for setting as ideal award, Enforcement, Appeal and Revision.

Module3:EngagementofLabour&otherconstruction-relatedLaws (05hours)

Role of Labour in Civil Engineering; Methods of engaging labour-on rolls, labour sub-contract, piece rate work; Industrial Disputes Act,1947; Collective bargaining; Industrial Employment (Standing Orders) Act, 1946; Workmen's Compensation Act,1923; Building & Other Construction Workers (regulation of employment and conditions of service) Act(1996) and Rules (1998); RERAAct2017, NBC 2017

Module4:LawrelatingtoIntellectualproperty (05 hours)

Introduction– meaning of intellectual property, main forms of IP, Copyright, Trademarks, Patents and Designs, Secrets; Copy Rights Act, 1957,Meaning of copyright–computer programs, Ownership of copyrights and assignment, Criteria of infringement, Piracy in Internet– Remedies and procedures in India; Law relating to Patents under Patents Act, 1970 including Concept and historical perspective of patents law in India. Process of obtaining patent–application, examination, opposition and sealing of patents. Duration of patents–law and policy considerations, Infringement and related remedies;

***TEXT/REFERENCEBOOKS*:**

1. B.S. Patil, Legal Aspects of Building and Engineering Contracts, 1974.
2. TheNationalBuildingCode,BIS,2017
3. Meena Rao (2006), Fundamental concepts in Law of Contract, 3rd Edn. Professional Offset
4. Neelima Chandiramani (2000), The Law of Contract: An Outline, 2nd Edn. Avinash Publications Mumbai.
5. Avtar singh (2002),Law of Contract, Eastern Book Co. 7.Dutt(1994), Indian Contract Act Eastern Law House
6. T. Ramappa (2010),Intellectual Property Rights Law in India, Asia Law House 9.Baretext (2005),Right to Information Act.
7. O.P.Malhotra, Law of Industrial Disputes, N.M. Tripathi Publishers
8. Ethics in Engineering- M.W. Martin & R. Schinzinger, McGraw-Hill
9. EngineeringEthics,National InstituteforEngineeringEthics,USA.
10. Ethics & Mgmt and Ethos , Ghosh, VIKASH
11. Business Ethics; Concept and Cases, Velasqez, Pearson

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2. Digital System Design (PC EC 502)

Course Code	PC EC 502
Course Title	Digital System Design
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Digital Electronics
Course Category	Program Core
Number of classes	38 hours

Course objectives: After completing the course, the students will be able to-

CO Number	CO Description	K-level
CO-1	Construct Mealy and Moore state machines for common applications	K3
CO-2	Identify design methodologies in digital system using Verilog HDL	K3
CO-3	Illustrate datatypes, module and ports of Verilog HDL	K2
CO-4	Apply the concepts of gate level, dataflow and behavioral style of modeling in Verilog HDL	K3
CO-5	Demonstrate the working principles of programmable logic devices.	K2

Module-1: State Machine (8)

Review of Sequential logic circuits. Flip flop excitation tables.Introduction to state machines. Classification of State Machines. State Machine Applications. Analysis State Machine, State table, State Diagram, State Equation, State reduction and State assignment. Design of Synchronous State Machine.

Module-2: Verilog HDL Part I (10)

Generalized HDL-based design flow, trends in HDLs, Hierarchical Modeling Concepts: Top-down and bottom-up design methodology, differences between modules and module instances, parts of a simulation, design block, stimulus block. Basic Conecpts: Lexical conventions, data types, system tasks, compiler directives.

Module-3: Verilog HDL Part II(10)

Modules and Ports: Module definition, port declaration, connecting ports, hierarchical name referencing. Gate-Level Modeling: Modeling using basic Verilog gate primitives, description of and/or and buf/not typegates, rise, fall and turn-off delays, min, max, and typical delays.Fundamental concept of dataflow and behavioural modelling.

Module-4: Programmable Logic Devices(10)

Advantages of PLDs. Classification of PLDs. Concept of PROM, PAL, PLA, Registered PAL, Configurable PAL, GAL – Architecture and Comparison. CPLD and FPGA architecture. Simulation and testing, types of FPGAs, Xilinx solutions: Xilinx CPLDs and applications areas, JTAG Development and Debugging Support. Soft Processor.

***REFERENCES / SUGGESTED LEARNING RESOURCES*:**

1) Modern Digital Design, R.P. Jain, TMH.
2) Digital Logic Design, M. Morris Mano, PHI
3) Digital Logic and State Machine Design, Comer, OUP
4) Modern Digital Design, R.S. Sandige, MGH.
5) Verilog HDL - Samir Palnitkar, 2nd Edition, Pearson Education, 2009.
6) Advanced Digital Design with Verilog HDL - Michel D. Ciletti, PHI, 2009.
7) Design Through Verilog HDL, T.R. Padmanabhan, B Bala Tripura Sundari, Wiley 2009.
8) Digital System Design with FPGA, CemUnsalan and Tar Bora, McGrawHill, 2017
9) The Designer's Guide to VHDL, Morgan Kaufman Publishers(Elsevier), LPE.

10) Design Warrior's Guide to FPGAs: Devices Tools and Flows, Clive "Max" Maxfield, Elsevier Publication.
11) Field-Programmable Gate Array Technology, S. Trimberger, ed., Kluwer Academic Publishers.

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3. Control System Engineering (PC EC 503)

Course Code	PC EC503
Course Title	Control System Engineering
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Electrical Circuits, Basic Mathematics
Course Category	Program core
Number of classes	38 hours

Course Outcome:

After completing the course, the students will be able to-

CO Number	CO Description	K-level
CO-1	Explain basics of Control dynamics, mathematical modeling of systems and different components used for control System	K2
CO-2	Explain stability analysis, State variable analyses of Systems	K2
CO-3	Apply the modeling of Systems which are essential for Industrial applications and also for higher courses of Electrical Engineering	K3
CO-4	Identify thetime & Frequency responses of Systems, predict systems behavior based on time and frequency domain analysis	K3

Course Content:

Module 1:Introduction to Control Systems (10 hours)

Classification of control systems with examples. Block diagram representation and Signal flow graph representation of Systems. Properties of Control Systems: System dynamics, sensitivity, steady-state & transient errors, Error constants, System types. Time response of system: Time domain specifications, Step response of second order system, concept of dominant poles, Effect of addition of Poles & Zeroes in second Order Systems. Basic Control actions: Proportional, integral, derivative, and their combinations, design of controllers to meet system specification.

Module 2:Control System Components (10 hours)

DC & AC Servo motors, Amplidyne, Synchros, Position & velocity Sensors, encoders, Gears and different Mechanical Parameters, Examples of DC and AC servomechanisms, Effect of velocity feedback with or without controller. Instrumentation Systems for control Engineering and their implementations.
Frequency response of Second order System: Frequency Domain Specifications in open loop, closed loop systems and their significance, Concept of Bandwidth and Cut-off frequency, frequency responses of different function of Systems.

Module 3: Stability of Linear Systems (8hours)

Routh-Hurwitz criterion, Root locus techniques, Polar Plot, Nyquist criterion, Bode & Nichols Plots, Stability margins. Effects of system on stability, Introduction to Lag, lead and lead-lag compensators and their frequency responses.

Module4:State Variable Formulation of Control System (10 hours)

State variable formulation of control system, diagonalization. Time response of state model of linear time-invariant system. Representations in state space of Systems in cascade form, parallel form, controllable canonical form, observable canonical form. Elementary concept of controllability & observability with physical examples and testing methods of Controllability & Observability. Control Law design for full state feedback of linear control Systems. Pole placement by state feedback.

***REFERENCE BOOKS*:**

1. Norman S. Nise, Control Systems Engineering, 6th edition, Wiley, 2011.
2. I.J.Nagrath and M.Gopal, Control Systems Engineering, 5th edition, New Age International, 2009.
3. Benjamin C. Kuo and Farid Golnaraghi, Automatic Control Systems, 9th edition, Wiley; 2009.
4. M. Gopal, Control Systems Principles and Design, 3rd edition, Tata Mgraw Hill, 2008.
5. Naresh K. Sinha, Control Systems, 3rd edition, New Age International, 2004.
6. Richard C. Dorf and Robert H. Bishop, Modern Control Systems, 12th Edition.

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4. Analog and Digital Communication (PC EC 504)

Course Code	PC EC 504
Course Title	Analog and Digital Communication
Number of Credits	4 (L: 4, T: 0, P: 0)
Prerequisites	Signals and systems
Course Category	Program Core (PC)
Number of classes	48 hours

Course Outcome:

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

CO Number	CO Description	K-level
CO-1	Compare different analog modulation schemes for their efficiency and bandwidth	K2
CO-2	Explain the communication system in presence of noise	K2
CO-3	Apply the knowledge of pulsed modulation system and analyze their system performance	K3
CO-4	Identify and explain different digital modulation schemes and can compute the bit error performance	K3
CO-5	Explain digital modulation tradeoffs and equalization	K2

Module 1: Analog modulation and noise: (12 hours)

Review of signals and systems, Frequency domain representation of signals, Principles of AmplitudeModulation Systems- DSB, SSB and VSB modulations. Angle Modulation, Representation of FM and PM signals, Spectral characteristics of angle modulated signals.

Review of probability and random process. Gaussian and white noise characteristics,Noise in amplitude modulation systems, Noise in Frequency modulation systems. Pre-emphasis and De-emphasis, Threshold effect in angle modulation.

Module 2: Pulse modulation (12 hours)

Pulse modulation. Sampling process. Pulse Amplitude and Pulse code modulation (PCM),Differential pulse code modulation. Delta modulation, Noise considerations in PCM, Time Division multiplexing, Digital Multiplexers.

Module 3: Digital modulation (12 hours)

Elements of Detection Theory, Optimum detection of signals in noise,Coherent communication with waveforms- Probability of Error evaluations. BasebandPulse Transmission- Inter symbol Interference and Nyquist criterion.Pass band Digital Modulation schemes- Phase Shift Keying, Frequency Shift Keying,Quadrature Amplitude Modulation, Continuous Phase Modulation and Minimum Shift Keying.

Module 4: Digital Modulation tradeoffs and Equalization (12 hours)

Digital Modulation tradeoffs. Optimum demodulation of digital signals over band-limited channels- Maximum likelihood sequence detection (Viterbi receiver). Equalization Techniques. Synchronization and Carrier Recovery for Digital modulation.

***TEXT/REFERENCE BOOKS*:**

1) Haykin S., "Communications Systems", John Wiley and Sons, 2001.
2) Proakis J. G. and Salehi M., "Communication Systems Engineering", Pearson Education, 2002.
3) Taub H. and Schilling D.L., "Principles of Communication Systems", Tata McGraw Hill, 2001.
4) Wozencraft J. M. and Jacobs I. M., ``Principles of Communication Engineering", John Wiley, 1965.
5) Barry J. R., Lee E. A. and Messerschmitt D. G., ``Digital Communication", Kluwer Academic Publishers, 2004.
6) Proakis J.G., ``Digital Communications", 4th Edition, McGraw Hill, 2000.

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5. Embedded Systems &IoT (PCEC 505)

Course Title:	Embedded Systems & IoT
Course Code	PCEC 505
Number of credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Microcontrollers
Course Category	Program Core
Total no. of lecture periods	38

Course Outcome:-
On completion of the syllabus, the Students will be able to:-

CO Number	CO Description	K-level
C.O.1	Illustrate the concept of Embedded systems and RTOS.	K2
C.O.2	Relate to the concept of ARM-7.	K2
C.O.3	Experiment with arduino, raspberry pi coding for IoT implementation	K3
C.O.4	Outline the Basic idea of IoT, Sensing, Actuation, Networking, CommunicationProtocols, Sensor Networks.	K2
C.O.5	Summarize the real-life applications of IoT in various fields	K2

Course Content:

Module I- Introduction to Embedded systems (10 Hours)

Introduction to embedded systems. Features of embedded systems. Characteristics of Embedded Systems. Classification of embedded systems. Examples of embedded systems.
Architecture of embedded systems. Brief introduction to embedded microcontroller cores CISC, RISC, ARM, DSP and SoC. Real time systems, examples of real time systems. Types of real time systems.Introduction to RTOS, difference between RTOS and General-purposeOS. Need for RTOS in embedded systems. kernel and its functions.Case study on automatic washing machine and electronic micro-oven.

Module II–Introduction to ARM-7 (10 Hours)

ARM 7 Architecture, ARM Development tools, Instruction set: Data processing, Data transfer,Control flow. Addressing modes, Memoryorganization.Writing simple assembly languageprograms, Pipelining, Brief introduction toexceptions and interrupts handling.Overview and features of LPC 2478. Case study on embedded system: Washing machine, Microwave oven etc.

Module III–Introduction to IoT (10 Hours)

Introduction to IoT, Sensing, Actuation, Basics of Networking, Communication Protocols,
Sensor Networks.Machine-to-Machine Communications, Interoperability in IoT, Introduction to Arduino Programming, Integration of Sensors and Actuators with Arduino.

Module IV- Interoperability of IoT (08 Hours)

Introduction to Python programming, Introduction to Raspberry Pi, Implementation of IoT with Raspberry Pi. Introduction to SDN, SDN for IoT. Introduction to cloud computing, fog computing. IoT Case Study: Agriculture, Healthcare, Activity Monitoring, smart home, smart city, smart grid.

***SUGGESTED LEARNING RESOURCES*:**

1. K.J. Ayala, "The 8051 Microcontroller: Architecture, Programming, and Applications",

Penram Intl, 1996.
2. J.W. Valvano, "Embedded Microcomputer System: Real Time Interfacing", Brooks/Cole, 2000.
3. Real Time Operating System-Rajib Mall
4. Introduction to embedded systems, Shibu K. V., McGraw Hill
5. ARM System on chip Architecture, Steve Furber, Pearson, edition second
6. Embedded systems an integrated approach, Laya B. Das, Pearson, Third impression, 2013
7. ARM system developer‟s guide, Andrew N. Sloss, Dominic Symes, Chris Wright, Morgan Kaufmann Publishers.
8. Embedded system design A Unified hardware/software Introduction, Frank Vahid, Tony Givargis, Wiely .
9. "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", by Pethuru Raj andAnupama C. Raman (CRC Press)
10. "Internet of Things: A Hands-on Approach", by ArshdeepBahga and Vijay Madisetti (Universities Press)

SUGGESTED SOFTWARE/LEARNING WEBSITES:
1. https://www.arduino.cc/reference/en/
2. https://learn.adafruit.com/category/learn-arduino
3. NPTEL

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6. Network Theory (PC EC 506)

Course Code	PC EC 506
Course Title	Network Theory
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Basic mathematics and physics
Course Category	Program core
Number of classes	38 hours

Course Outcome:

After the completion of the course, students will be able to-

CO Number	CO Description	K-level
CO-1	Illustrate Type of source transformation, graph theory, Resonance and Active filter	K2
CO-2	Explain Laplace transform in a circuit theory, Sinusoidal steady state analysis of RLC circuit, Frequency and time domain analysis of RLC circuit.	K2
CO-3	Solve the problems related to coupled circuit, Two port network analysis, Application of network theorem in AC circuit	K3
CO-4	Apply the knowledge of transmission line, its parameters, characteristics, etc.	K3

Course Content:

Module 1: Introduction to Network Theory (10 Hours)

Type of Source transformation – Dot convection and formation of loop and node analysis.
Network theorems-Thevenin's theorem, Norton's theorem, Superposition law, maximum power transfer law, reciprocity theorem, compensation theorem, Millman's theorem, Tellegen's theorem, and AC network theorems.
Introduction to graph theory - graph of a network, relation between twigs and links, properties of tree in a graph, number of tree in a graph, tie-set matrix, incidence matrix, fundamental cut set and fundamental circuit matrices**.**
Resonance – Series and parallel resonance, Resonance between parallel RL and RC circuit, Parallel resonance of RLC circuit.

Module 2: Transient and Steady State Analysis (8 Hours)

Laplace transform of various signal of excitation, wave form synthesis, Laplace transform network, determination and representation of initial condition,response of impulse function and its relation to network admittance.
Transient and steady state analysis of series & parallel R-L,R-C,R-L-C circuits, Frequency responses of different combinations of series & parallel Circuits, Cut-off frequency & Bandwidth. Time response of Electric circuits due to Step, Ramp and periodic signals. Concept of Transfer function and its relation with step response of an Electric Circuit, Introduction to the 1^{st}& 2^{nd} order R-C Active Filters, its frequency responses, Design of 2^{nd} order Active Filters.

Module 3: Coupled Circuits and Two Port Networks (10 Hours)

Analysis of coupled circuit – self and mutual inductances,coefficient of coupling, series and parallel connection of coupled circuit, dot convention in coupled circuit, electrical equivalent of magnetically coupled circuit.
Two port network analysis – network element, driving point and transfer function, Z-parameter, Y-parameter, H-parameter, ABCD-parameter, condition of Reciprocity and Symmetry in two port parameter, inter-relationship between parameters, different type of interconnection(series, parallel, cascade).

Module 4: Transmission Line (10 Hours)

Transmission line – Type, parameter, Transmission line Equation, primary and secondary constant, Expression for characteristic impedance, propagation constant, phase and group velocity, infinite line concept, lossless/loss characterization, distortion condition for distortion less and medium attenuation, loading –type of loading related problem, input impedance relations, SC and OC line, reflection coefficient, VSWR.UHF line as a circuit element: $\frac{\lambda}{2}$,$\frac{\lambda}{4}$,$\frac{\lambda}{8}$ lines, impedance transformation. Smith chart-configuration and application, single and double stub matching.

REFERENCE BOOKS:

1. Network Analysis and Synthesis by S Ghosh& A Chakraborty
2. Network Analysis by M. E. Van Valkenburg&T.S. Rathore
3. Network Theory By A V Bakshi&U A Bakshi
4. Circuit Theory - Analysis and Synthesis by Abhijit Chakrabarti
5. Electrical Circuit Theory by B.L.Theraja, M.E.Van.Valkenburg
6. Fundamentals of Electric Circuits by Charles K. Alexander, Matthew N.O. Sadiku

7. Engineering Circuit Analysis by William H. Hayt, Jack Kemmerly, Steven M. Durbin

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7. Digital System Design Laboratory(PC EC 507)

Course Code	PC EC 507
Course Title	Digital System Design Laboratory
Number of Credits	1(L: 0, T: 0, P: 2)
Prerequisites	Digital Electronics
Course Category	Program Core
Number of classes	24 hours

Course Outcome:-

After completion of the course, students will be able to:

CO Number	CO Description	K-level
CO-1	Demonstrate the Verilog HDL design flow to implement Logic Gates and Boolean function	K2
CO-2	Develop Verilog HDL model of combinational logic circuits and implement them CPLD/FPGA	K3
CO-3	Develop Verilog HDL model of sequential logic circuits and implement on CPLD/FPGA	K3
CO-4	Construct State machines in Verilog HDL and implement on CPLD/FPGA	K3

List of Experiments ***(Minimum 6 experiments to be performed). Use of virtual laboratory to perform few experiments may be explored if available.***

Prepare Verilog HDL model to design and implement of the following digital circuits/systems on CPLD/FPGA platform.

1) Logic gates and Boolean function
2) Decoder and Encoder
3) Multiplexer and De-multiplexer
4) Full adder and Full subtractor
5) 8-bit Arithmetic logic unit
6) Flip flops
7) Counters
8) Universal shift register
9) Sequence detector
10) Traffic light controller

***REFERENCES/ SUGGESTED LEARNING RESOURCES*:-**

1) Digital Logic Design, M. Morris Mano, PHI
2) Digital Logic and State Machine Design, Comer, OUP
3) Verilog HDL - Samir Palnitkar, 2nd Edition, Pearson Education, 2009.
4) Advanced Digital Design with Verilog HDL - Michel D. Ciletti, PHI, 2009.
5) Design Through Verilog HDL, T.R. Padmanabhan, B Bala Tripura Sundari, Wiley 2009.

6) Digital System Design with FPGA, CemUnsalan and Tar Bora, McGrawHill, 2017
7) Fundamentals of Digital logic with Verilog design-2e, Brown Vranesic, McGrawHill education

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8. Control System Engineering Lab (PC EC 508)

Course Code	PC EC 508
Course Title	Control System Engineering Lab
Number of Credits	1 (L: 0, T: 0, P: 2)
Prerequisites	Basic Mathematics, Electrical circuits
Course Category	Program core
Number of classes	20-24 hours

Course Outcome:

After the completion of the course, students will be able to-

CO Number	CO Description	K-level
CO-1	Analyze the characteristics of Synchro Transmitter, Receiver and differential Transducer	K4
CO-2	Solve transfer function of D.C. Servo Motor by applying Step input and verification from frequency response graph of D,C. Servomotor	K3
CO-3	Examine the error / steady state error of DC Servomechanism due to Step, Ramp and Parabolic inputs	K4
CO-4	Analyze the position Control of second order DC Servomechanism and determination of Parameters of the System from the experimental Results	K4
CO-5	Experiment with Velocity feedback on Position control of DC Servomechanism and determination of Parameters due to velocity feedback at different values	K3
CO-6	Analyze the control of D.C. Servo Mechanism using P, P+I, P+D, P+I+D Controllers to study the characteristics of second order System and indication of Position Control using Gray-coded disk	K4

Course Content:

List of Experiments*(Minimum 6experiments to be performed). Use of virtual laboratory to perform few experiments may be exploredif available.*

The following Experiments are required to be carried out using Hardware Trainers and Experiments using Hardware Trainers from Sl. No. 2 to 10 are required to be interfaced with Computers for Experimentations.

1. Study of Characteristics of Synchro Transmitter, Receiver and differential Transducer (Transmitter).
2. Determination of Transfer function of D.C. Servo Motor by applying Step input.
3. Verification of Transfer function from frequency response graph of D,C. Servomotor (at different Mechanical loadings) as in Experiment No. 2.
4. Determination of error / steady state error of DC Servomechanism due to Step, Ramp and Parabolic inputs.

5. Position Control of second order DC Servomechanism and determination of Parameters of the System from the experimental Results.
6. Study the effect of Velocity feedback on Position control of DC Servomechanism and determination of Parameters due to velocity feedback at different values.
7. Position control of D.C. Servo Mechanism using P, P+I, P+D, P+I+D Controllers to study the characteristics of second order System and indication of Position Control using Gray-coded disk.
8. Experimentation for Speed Control of a DC Servo Motor with PI Controller+ derivative output Compensation technique.

REFERENCE BOOKS:

1. Norman S. Nise, Control Systems Engineering, 6th edition, Wiley, 2011.
2. I.J.Nagrath and M.Gopal, Control Systems Engineering, 5th edition, New Age International, 2009.
3. Benjamin C. Kuo and FaridGolnaraghi, Automatic Control Systems, 9th edition, Wiley; 2009.
4. M. Gopal, Control Systems Principles and Design, 3rd edition, Tata Mgraw Hill, 2008.
5. Naresh K. Sinha, Control Systems, 3rd edition, New Age International, 2004.
6. Richard C. Dorf and Robert H. Bishop, Modern Control Systems, 12th Edition.

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9. Analog and Digital Communication Lab(PC EC 509)

Course Code	PC EC 509
Course Title	Analog and Digital Communication Lab
Number of Credits	1 (L: 0, T: 0, P: 2)
Prerequisites	Signals and systems
Course Category	Program Core (PC)
Number of classes	24 hours

Course Outcome:

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

CO Number	CO Description	K-level
CO-1	Experiment with different amplitude modulation schemes (AM, SSB, DSB).	K3
CO-2	Experiment with frequency modulation, demodulation.	K3
CO-3	Analyze the noise effects, pre-emphasis and de-emphasis.	K4
CO-4	Experiment with pulse code, deferential pulse code and delta modulation.	K3
CO-5	Compare and analyze various digital modulation techniques (ASK, FSK, PSK).	K4

Course Content:

List of Experiments*(Minimum 6 experiments to be performed). Use of virtual laboratory to perform few experiments may be explored if available.*

1. Study of amplitude modulation and demodulation.
2. Study of Double Side Band Suppressed Carrier (DSB-SC) & Demodulation technique.
3. Study of Single Side Band Suppressed Carrier (SSB-SC) & Demodulation technique.
4. Study of Frequency Modulation and demodulation.

5. Study of Noise Effect in communication system.
6. Study of pre-emphasis and de-emphasis.
7. Study of Pulse code modulation
8. Study of Differential pulse code modulation.
9. Study of Delta modulation.
10. Study of Amplitude, Frequency and Phase shift keying.
11. Software simulation of Amplitude, Frequency and Phase shift keying.

***TEXT/REFERENCE BOOKS*:**

7) Lab Manual
8) Haykin S., "Communications Systems", John Wiley and Sons, 2001.
9) Proakis J. G. and Salehi M., "Communication Systems Engineering", Pearson Education, 2002.
10) Taub H. and Schilling D.L., "Principles of Communication Systems", Tata McGraw Hill, 2001.
11) Wozencraft J. M. and Jacobs I. M., ``Principles of Communication Engineering",John Wiley, 1965.
12) Barry J. R., Lee E. A. and Messerschmitt D. G., ``Digital Communication", Kluwer Academic Publishers, 2004.
13) Proakis J.G., ``Digital Communications", 4th Edition, McGraw Hill, 2000.

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10. Industry Internship – I (SIEC 510)

Course Code	SIEC 510
Course Title	Industry Internship – I
Number of Credits	1 (L: 0, T: 0, P: 0)
Prerequisites	Nil
Course Category	Summer Internship (SI)
Number of classes	-

Course Outcome:-

After completion of the course, students will be able to:

CO Number	CO Description	K-level
CO-1	Solve real life challenges in the workplace by analysing work environment and conditions, and selecting appropriate skill sets acquired from the course of study	K3
CO-2	Develop a right work attitude, self-confidence, interpersonal skills and ability to work as a team in a real organizational setting	K3
CO-3	Demonstrate the skill to communicate and collaborate effectively and appropriately with different professionals in the work environment through written and oral means	K2
CO-4	Show professional ethics by displaying positive disposition during internship.	K2
CO-5	Decide career options by considering opportunities in company, sector, industry, professional, educational advancement and entrepreneurship;	K5

Course Content:-

The industry internship aims to provide the student with:

1. A practice-oriented and 'hands-on' working experience in the real world or industry, and to enhance the student's learning experience.
2. An opportunity to develop a right work attitude, self-confidence, interpersonal skills and ability to work as a team in a real organisational setting.
3. An opportunity to further develop and enhance operational, customer service and other life-long knowledge and skills in a real world work environment.
4. Pre-employment training opportunities and an opportunity for the company or organisation to assess the performance of the student and to offer the student an employment opportunity after his/her graduation, if it deems fit.

Each student shall

1) Identify an internship program of relevance in his/her branch of engineering to undergo during summer break between 4^{th} and 5^{th} semester,
2) Get approval of the concerned HOD,
3) Undergo the industry internship program for minimum 4 weeks duration
4) Prepare their own report
5) Present in the class among fellow students and faculty members / deliver viva voce.
6) Submit the report and participation/course completion certificate.

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