Ch. Charan Singh University Campus Meerut

EVALUATION SCHEME & SYLLABUS

FOR

B. TECH. THIRD YEAR

ELECTRONICS AND INSTRUMENTATION ENGINEERING

AS PER

AICTE MODEL CURRICULUM

[Effective from the Session: 2020-21]

B. Tech

(Electronics and Instrumentation)

PROGRAMME OUTCOME

The objective of this course is to familiarize the prospective engineers with techniques in sequences, multivariate integration, ordinary and partial differential equations and complex variables. It aims to equip the students to deal with advanced level of mathematics and applications that would be essential for their disciplines.

The students will learn:

- The effective mathematical tools for the solutions of differential equations that model physical processes
- To apply integral calculus in various field of engineering. Apart from some other applications students will have a basic understanding of Beta and Gamma functions.
- The tool of Fourier series for learning advanced Engineering Mathematics.
- The tools of differentiation of functions of complex variables that are used in various techniques dealing with engineering problems

1. facilitate software based learning to provide the required English Language proficiencyto students.
2. To acquaint students with specific dimensions of communication skills i.e. Reading,Writing, Listening, Thinking and Speaking.
3. To train students to use the correct and error-free writing by being well versed in rules ofEnglish grammar.
4. To cultivate relevant technical style of communication and presentation at their work placeand also for academic uses.
5. To enable students to apply it for practical and oral presentation purposes by being honed upin presentation skills and voice-dynamics.
6. To understand the basic concepts of IoT, followed by major components, its layer architecture and how IoT is impacting the Industry in the various forms along with major applications.
7. To make students aware about basic concepts of cloud computing, its benefits and different applications along with insights of major service providers.
8. To understand the basic concepts of Blockchain and its underlying technologies with its implementation as cryptocurrencies.
9. To understand the concept of Additive Manufacturing, its applications in various fields and the basic concepts of drones, their assembly and government regulations involved.
10. To introduce students to the upcoming technology and to develop the required skills for practical applications.

B. Tech

(Electronics and Instrumentation)
Program specific out come

After successful completion of 160 credits, a student shall be eligible to get Under Graduate degree in Engineering. A student will be eligible to get Under Graduate degree with Honours only, if he/she completes additional university recommended courses only (Equivalent to 20 credits; NPTEL Courses of 4 Weeks, 8 Weeks and 12 Weeks shall be of 2, 3 and 4 Credits respectively) through MOOCs. For registration to MOOCs Courses, the students shall follow NPTEL Site http://nptel.ac.in/ as per the NPTEL policy and norms. The students can register for these courses through NPTEL directly as per the course offering in Odd/Even Semesters at NPTEL. These NPTEL courses (recommended by the University) may be cleared during the B. Tech degree program (not necessary one course in each semester). After successful completion of these MooCs courses the students, shall, provide their successful completion NPTEL status/certificates to the University (COE) through their college of study only. The student shall be awarded Hons. Degree (on successful completion of MOOCS based 20 credit) only if he/she secures 7.50 or above CGPA and passed each subject of that Degree Programme in single attempt without any grace marks.

B.Tech. V Semester
Electronics and Instrumentation Engineering

S. No.	Course Title	Periods			Evaluation Scheme				End Semester		Total	Credits
		L	T	P	CT	TA	Total	PS	TE	PE		
1	Integrated Circuits	3	1	0	30	20	50		100		150	4
2	Microprocessor & Microcontroller	3	1	0	30	20	50		100		150	4
3	Instrumentation & Measurement	3	1	0	30	20	50		100		150	4
4	Department Elective-I	3	0	0	30	20	50		100		150	3
5	Department Elective-II	3	0	0	30	20	50		100		150	3
6	Integrated Circuits Lab	0	0	2				25		25	50	1
7	Microprocessor & Microcontroller Lab	0	0	2				25		25	50	1
8	Instrumentation & Measurement Lab	0	0	2				25		25	50	1
9	Mini Project/Internship **	0	0	2				50			50	1
10	Constitution of India, Law and Engineering / Indian Tradition, Culture and Society	2	0	0	15	10	25		50			NC
11	MOOCs (Essential for Hons. Degree)											
	Total										**950**	**22**

Course Code **Course Title**

Department Elective-I

Transducer and Sensor Measurement System
Computer Architecture and Organization
Industrial Electronics
Advance Digital Design using Verilog

Department Elective-II

Signal Processing
Artificial Neural Networks
Electrical Machine
Optical Communication

B.Tech. VI Semester
Electronics and Instrumentation Engineering

S. No.	Course Title	Periods			Evaluation Scheme				End Semester		Total	Credits
		L	T	P	CT	TA	Total	PS	TE	PE		
1	Embedded System Design	3	1	0	30	20	50		100		150	4
2	Control Systems	3	1	0	30	20	50		100		150	4
3	Industrial Measuring Instruments	3	1	0	30	20	50		100		150	4
4	Department Elective–III	3	0	0	30	20	50		100		150	3
5	Open Elective-I	3	0	0	30	20	50		100		150	3
6	Embedded System Design Lab	0	0	2				25		25	50	1
7	Control Systems Lab	0	0	2				25		25	50	1
8	Industrial Instrumentation Lab	0	0	2				25		25	50	1
9	Constitution of India, Law and Engineering / Indian Tradition, Culture and Society	2	0	0	15	10	25		50			NC
10	MOOCs (Essential for Hons. Degree)											
	Total										**900**	**21**

Course Code	Course Title
	Department Elective-III
	Opto Electronics
	Digital Measurement Techniques
	Data Communication Networks
	Analog Signal Processing
	Random Variables & Stochastic Process

B.Tech 3rd Year
V Semester
Syllabus

	INTEGRATED CIRCUITS	3L:1T:0P	4 Credits

Unit	Topics	Lectures
I	**The 741 IC Op-Amp**: General operational amplifier stages (bias circuit, the input stage, the second stage, the output stage, short circuit protection circuitry), device parameters, DC and AC analysis of input stage, second stage and output stage, gain, frequency response of 741, a simplified model, slew rate, relationship between ft and slew rate.	8
II	**Linear Applications of IC Op-Amps:** Op-Amp based V-I and I-V converters, instrumentation amplifier, generalized impedance converter, simulation of inductors. **Active Analog filters:** Sallen Key second order filter, Designing of second order low pass and high pass Butterworth filter, Introduction to band pass and band stop filter, all pass active filters, KHN Filters. Introduction to design of higher order filters.	8
III	**Frequency Compensation & Nonlinearity:** Frequency Compensation, Compensation of two stage Op-Amps, Slewing in two stage Op-Amp. Nonlinearity of Differential Circuits, Effect of Negative feedback on Nonlinearity. **Non-Linear Applications of IC Op-Amps:** Basic Log–Anti Log amplifiers using diode and BJT, temperature compensated Log-Anti Log amplifiers using diode, peak detectors, sample and hold circuits. Op-amp as a comparator and zero crossing detector, astable multivibrator & monostable multivibrator. Generation of triangular waveforms, analog multipliers and their applications.	4 8
IV	**Digital Integrated Circuit Design:** An overview, CMOS logic gate circuits basic structure, CMOS realization of inverters, AND, OR, NAND and NOR gates. **Latches and Flip flops**: the latch, CMOS implementation of SR flip-flops, a simpler CMOS implementation of the clocked SR flip-flop, CMOS implementation of J-K flip-flops, D flip- flop circuits.	6
V	**Integrated Circuit Timer:** Timer IC 555 pin and functional block diagram, Monostable and Astable multivibrator using the 555 IC. Voltage Controlled Oscillator: VCO IC 566 pin and functional block diagram and applications. **Phase Locked Loop (PLL)**: Basic principle of PLL, block diagram, working, Ex-OR gates and multipliers as phase detectors, applications of PLL.	6

Text Book:

1. Microelectronic Circuits, Sedra and Smith, 7th Edition, Oxford, 2017.
2. Behzad Razavi: Design of Analog CMOS Integrated Circuits, TMH

Reference Books:

1. Gayakwad: Op-Amps and Linear Integrated Circuits, 4th Edition Prentice Hall of India, 2002.
2. Franco, Analog Circuit Design: Discrete & Integrated, TMH, 1st Edition.
3. Salivahnan, Electronics Devices and Circuits, TMH, 3rd Edition, 2015
4. Millman and Halkias: Integrated Electronics, TMH, 2nd Edition, 2010

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

1. Explain complete internal analysis of Op-Amp 741-IC.
2. Examine and design Op-Amp based circuits and basic components of ICs such as various types of filter.
3. Implement the concept of Op-Amp to design Op-Amp based non-linear applications and wave-shaping circuits.
4. Analyse and design basic digital IC circuits using CMOS technology.
5. Describe the functioning of application specific ICs such as 555 timer ,VCO IC 566 and PLL.

	MICROPROCESSOR & MICROCONTROLLER	3L:1T:0P	4 Credits

Unit	Topics	Lectures
I	**Introduction to Microprocessor:** Microprocessor architecture and its operations, Memory, Input & output devices, The 8085 MPU- architecture, Pins and signals, Timing Diagrams, Logic devices for interfacing, Memory interfacing, Interfacing output displays, Interfacing input devices, Memory mapped I/O.	8
II	**Basic Programming concepts**:, Flow chart symbols, Data Transfer operations, Arithmetic operations, Logic Operations, Branch operation, Writing assembly language programs, Programming techniques: looping, counting and indexing. Additional data transfer and 16 bit arithmetic instruction, Logic operation: rotate, compare, counter and time delays, 8085 Interrupts.	8
III	**16-bit Microprocessors (8086):** Architecture, Pin Description, Physical address, segmentation, memory organization, Addressing modes. **Peripheral Devices:** 8237 DMA Controller, 8255 programmable peripheral interface, 8253/8254programmable timer/counter, 8259 programmable interrupt controller, 8251 USART and RS232C.	8
IV	**8051 Microcontroller Basics**: Inside the Computer, Microcontrollers and Embedded Processors, Block Diagram of 8051, PSW and Flag Bits, 8051 Register Banks and Stack, Internal Memory Organization of 8051, IO Port Usage in 8051, Types of Special Function Registers and their uses in 8051, Pins Of 8051. Memory Address Decoding, 8031/51 Interfacing With External ROM And RAM. 8051 Addressing Modes.	8
V	**Assembly programming and instruction of 8051:** Introduction to 8051 assembly programming, Assembling and running an 8051 program, Data types and Assembler directives, Arithmetic, logic instructions and programs, Jump, loop and call instructions, IO port programming. Programming 8051 Timers. Serial Port Programming, Interrupts Programming, **Interfacing:** LCD & Keyboard Interfacing, ADC, DAC & Sensor Interfacing, External Memory Interface, Stepper Motor and Waveform generation.	8

Text Books:

1. Ramesh Gaonkar, "Microprocessor Architecture, Programming, and Applications with the 8085", 6th Edition, Penram International Publication (India) Pvt. Ltd.,2013
2. D. V. Hall : Microprocessors Interfacing, TMH 3rd Edition,
3. Mazidi Ali Muhammad, Mazidi Gillispie Janice, and McKinlay Rolin D., "The 8051 Microcontroller and Embedded Systems using Assembly and C", Pearson, 2nd Edition,2006

Reference Books:

1. Kenneth L. Short, "Microprocessors and programmed Logic", 2nd Ed, Pearson Education Inc.,2003
2. Barry B. Brey, "The Intel Microprocessors, 8086/8088, 80186/80188, 80286, 80386, 80486, Pentium, PentiumPro Processor, PentiumII, PentiumIII, Pentium IV, Architecture, Programming & Interfacing", Eighth Edition, Pearson Prentice Hall, 2009.
3. Shah Satish, "8051 Microcontrollers MCS 51 Family and its variants", Oxford,2010

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

1. Demonstrate the basic architecture of 8085.
2. Illustrate the programming model of microprocessors & write program using 8085 microprocessor.
3. Demonstrate the basics of 8086 Microprocessor and interface different external Peripheral Devices like timer, USART etc. with Microprocessor (8085/8086).
4. Compare Microprocessors & Microcontrollers, and comprehend the architecture of 8051 microcontroller
5. Illustrate the programming model of 8051 and implement them to design projects on real time problems.

	MEASUREMENTS & INSTRUMENTATION	3L:0T:0P	3 CREDITS

Unit	Topics	Lectures
I	**Electrical Measurements:** Measurement system, Characteristics of instruments, Methods of measurement, Errors in Measurement & Measurement standards, Measurement error combination, **Review of indicating and integrating instruments:** PMMC instrument, Galvanometer, DC ammeter, DC voltmeter, Series ohm meter.	8
II	**Electronic Instruments:** Transistor voltmeter circuits, AC electronic voltmeter, current measurement with electronic instruments, probes, **Digital voltmeter systems**: Digital multimeter, digital frequency meter System, Oscilloscope **Instrument calibration:** Comparison method, digital multimeter as standard instrument, Calibration instrument.	8
III	**Measuring Methods:** Voltmeter and Ammeter methods, Wheatstone bridge, Measurement of low, medium and high resistances, Insulation resistance measurement, AC bridges for inductance and capacitance measurement, Q meter.	8
IV	Electronic Measurements: Electronic instruments: Wattmeter & Energy meter. Time, Frequency and phase angle measurements using CRO; Storage oscilloscope, Spectrum & Wave analyzer, Digital counter, Frequency meter.	8
V	**Instrumentation**: Transducers, classification & selection of transducers, strain gauges, Thermistors, Thermocouples, LVDT, Inductive & capacitive transducers, Piezoelectric and Hall-effect transducers, Measurement of motion, force, pressure, temperature, flow and liquid level. Concept of signal conditioning and data acquisition systems, Concept of smart sensors and virtual instrumentation.	8

Text Book:

1. A K Sawhney, "Electrical & Electronic Measurement & Instrument", Dhanpat Rai & Sons, India (2015).
2. BC Nakra & K. Chaudhary, "Instrumentation, Measurement and Analysis," TMH, 2nd Edition (2009).
3. WD Cooper, "Electronic Instrument & Measurement Technique", Prentice Hall International (2001).
4. E. O. Doebelin, "Measurements systems: Applications and Design", 6th Edition, Tata McGraw Hil 2017.

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

1. Classify the Instrumentation and Measurement system and various measurement errors.
2. Analyze and design voltmeter circuits, AC electronic voltmeter, digital frequency meter and current measurement with electronic instruments.
3. Evaluate various resistance and impedance measuring methods using Bridges and Q-meter.
4. Analyze fundamental operation of CRO and some special type of oscilloscopes like DSO, Sampling oscilloscope.
5. Demonstrate calibration method to calibrate various instruments and classify transducers like for force, pressure, motion, temperature measurement etc.

	TRANSDUCER AND SENSOR MEASUREMENT SYSTEM	**3L:0T:0P**	**3 Credits**

Unit	Topics	Lectures
I	**GENERALISED CONFIGURATIONS, FUNCTIONAL DISCRIPTION & PERFORMANCE CHARACTERISTICS OF MEASURING INSTRUMENTS:** Functional elements of an instrument; active & passive transducers; analog & digital modes of operation; null & deflection methods; I/O configuration of measuring instruments & instrument system – methods of correction for interfering & modifying inputs. Static characteristics; Meaning of static calibration, accuracy, precision & bias. Combination of component errors in overall system-accuracy calculation. Static sensitivity, linearity, threshold, resolution, hysteresis and dead space. Scale readability. Span. Generalized static stiffness & input impedance. Computer aided calibration & measurement, multiple regressions.	8
II	**MEASUREMENT OF DISPLACEMENT, FORCE, TORQUE & SHAFT POWER:** Principle of measurement of displacement. Resistive potentiometers, variable inductance & variable reluctance pickups, LVDT, capacitance pickup. Principle of measurement of Force, Torque, Shaft power standards & calibration; basic methods of force measurement; characteristics of elastic force transducer- Bonded strain gauge, differential transformer, piezo electric transducer, variable reluctance/FM-oscillator, digital systems. Loading effects; Torque measurement on rotating shafts, shaft power measurement (dynamometers).	8
III	**TEMPERATURE MEASUREMENT**: Standards & calibration; thermal expansion methods- bimetallic thermometers, liquid-in-glass thermometers, pressure thermometers; thermoelectric sensor (thermocouple) – common thermocouple, special materials, configuration & techniques; electrical resistance sensors – conductive sensor (resistance thermometers), bulk semiconductor sensors (thermistors), bulk semiconductor sensors (thermistors); junction semiconductor sensors; digital thermometers. Radiation Methods – radiation fundamentals, radiation detectors, unchopped (dc) broadband radiation thermometers. Chopped (AC) selective band (photon) radiation thermometers, automatic null balance radiation thermometers (optical pyrometers). Two color radiation thermometers, Black body-tipped fibre optic radiation thermometer, IR imaging systems. Fluoroptic temperature measurement.	8
IV	**PRESSURE MEASUREMENT:** Standards & calibration; basic methods of pressure measurement; dead weight gauges & manometer, manometer dynamics; elastic transducers; high pressure measurement; low pressure (vaccum) measurement – Mcleod gage, Knudsen gage, momentum-transfer (viscosity) gages, thermal conductivity gages, ionization gages, dual gage technique.	8
V	**FLOW MEASUREMENT:** Local flow velocity, magnitude and direction. Flow visualization. Hot wire and hot film anemometer. Hot-film shock-tube velocity sensor. Laser Doppler velocity meter; gross volume flow rate: calibration and standards. Constant-area, variable-pressure-drop meters (obstruction meters). Averaging pilot tubes. Constant pressure drop, variable area meters (rotameters), turbine meters, and positive displacement meters. Metering pumps. Electromagnetic flow meters. Drag force flow meters. Ultrasonic flow meters, vortex shedding flow meters. **LEVEL MEASUREMENT:** Capacitance probe; conductivity probes; diaphragm level detector, deferential pressure level detector, radiation level sensors, RADAR level gauges, level transmitter, ultrasonic level detector.	8

Text Books:

1. Transducers and Instrumentation – D. V. S. Murty, 2nd Edition, PHI, 2009
2. Instrumentation Measurement and Analysis- B. C. Nakra and K. K. Choudhry, 3rd Edition, McGraw Hill Education (India) Pvt. Ltd. 2009
3. Measurement systems application and design, ERNEST DOEBELIN, IV Edn.
4. Introduction to Measurements and Instrumentation – A. K. Ghosh, 2nd Edition, PHI, 2007.

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

1. Explain the working of measurement systems and different types of sensors and transducers.
2. Formulate the sensor to measure various physical parameters used in Industry and normal measurement applications.
3. Analyze the working principle of resistive, inductive and capacitive transducers and their applications.
4. Differentiate the thermocouples, piezoelectric and pyro-electric transducers and apply them in various applications.
5. Describe acoustic, optical sensors and other sensors and their applications.

	Computer Architecture and Organization	3L:0T:0P	3 Credits

Unit	Topics	Lectures
I	**Introduction to Design Methodology**: System Design – System representation, Design Process, the gate level (revision), the register level components and PLD (revision), register level design The Processor Level: Processor level components, Processor level design.	8
II	**Processor basics:** CPU organization- Fundamentals, Additional features Data Representation - Basic formats, Fixed point numbers, Floating point numbers. Instruction sets - Formats, Types, Programming considerations.	8
III	**Data path Design:** Fixed point arithmetic - Addition and subtraction, Multiplication and Division, Floating point arithmetic, pipelining.	8
IV	**Control Design:** basic concepts - introduction, hardwired control, Micro programmed control -introduction, multiplier control unit, CPU control unit, Pipeline control- instruction pipelines, pipeline performance.	8
V	**Memory organization:** Multi level memories, Address translation, Memory allocation, Caches - Main features, Address mapping, structure vs performance, System Organization: Communication methods- basic concepts, bus control. Introduction to VHDL concept and programmimg.	8

Text Book:

1. John P Hayes "Computer Architecture and Organization", 3rd Edition McGraw Hill Publication. (2017)
2. M Morris Mano, "Computer System Architecture", 3rd Edition ,Pearson,. (2017)

Reference Books:

1. Carl Hamacher, ZvonkoVranesic and SafwatZaky, "Computer Organization and Embedded Systems", McGraw Hill Publication. (2009)
2. David A. Patterson and John L. Hennessy, "Computer Organization and Design: The Hardware/Software Interface", Elsevier Publication. (2007)

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

1. Discuss about the basic concepts of system design methodology and processor level design.
2. Explain the basics of processor and basic formats of data representation.
3. Perform fixed and floating point arithmetic operations.
4. Describe the basic concepts of control design and pipeline performance.
5. Explain the architecture and functionality of central processing unit.

	INDUSTRIAL ELECTRONICS	3L:0T:0P	3 Credits

Unit	Topics	Lectures
I	**Introduction to Power Switching Devices:** Description of working & constructional features, Switching Characteristics, ratings and Applications of Power Transistor, Power MOSFET, SCR, DIAC, TRIAC, IGBT and MCT.	8
II	**SCR Performance and Applications:** Protection of SCR, SCR Triggering and Commutation Circuits/Methods, Series and Parallel operation of SCR, two transistor model of SCR, , Describe Construction & Working of Opto- Isolators, Opto-TRIAC, Opto-SCR.	8
III	**Power Converter Performance & Applications:** Introduction to Basic Power Converters Architecture - Single Phase, there performance under different types of Loads, Average/RMS output Voltage & Current, Freewheeling Diode, Feedback Diode, State Relay using Opto SCR, SMPS and UPS functioning through Block Diagrams.	8
IV	**Timers & Delay Elements, High Frequency Power Heating, Sensor and Actuators:** RC Base Constant Timers, Timer Circuits using SCR, IC-555, Programmable Timer and their Industrial Applications, Induction Heating and Dielectric Heating System and Their Applications, Sensors, Transducers, and Transmitters for Measurement, Control & Monitoring : Thermoresistive Transducer, Photoconductive Transducers, Pressure Transducers, Flow Transducers, Level Sensors, Speed Sensing, Vibration Transducers, Variable-Frequency Drives, Stepper Motors and Servomotor Drives.	8
V	**Automation and Control:** Data Communications for Industrial Electronics, Telemetry, SCADA & Automation, AC & DC Drives, Voltage & Power Factor Control through Solid State Devices, Soft Switching, Industrial Robots.	8

Text Books:

1. M.H. Rashid, "Power Electronics: Circuits, Devices & Applications", Pearson, 4rd Edition, 2013.
2. P.C.Sen, "Power Electronics", McGraw Hill Education (India) Pvt. Ltd 2nd Ed, 2017
3. V.R. Moorthy, "Power Electronics: Devices, Circuits and Industrial Applications" Oxford University Press, 2007.
4. B. Paul, Industrial Electronic and Control, Prentice Hall of India Private Limited (2004).
5. Ned Mohan, T.M. Undeland and W.P. Robbins, "Power Electronics: Converters, Applications and Design", Wiley India Ltd, 2008.
6. P.S. Bhimbra, "Power Electronics", Khanna Publishers.

Reference Books:

1. Thomas E. Kissell, Industrial Electronics: Applications for Programmable Controllers, Instrumentation and Process Control, and Electrical Machines and Motor Controls, 3rd edition, 2003, Prentice Hall.
2. Chakrabarti & Rai, "Fundamentals of Power Electronics & Drives" Dhanpat Rai & Sons.
3. S.N.Singh, "A Text Book of Power Electronics" Dhanpat Rai &Sons.
4. G.K. Dubey, Power Semiconductor Controlled Drives, Prentice Hall inc. (1989).

Course Outcomes: At the end of this course students will be able to:

1. Describe the characteristics, operation of power switching devices and identify their ratings and applications.
2. Recognize the requirement of SCR Protection and describe the Functioning of SCR.
3. Analyze and design Power Converter based on SCR for various Industrial Applications.
4. Explain High Frequency Heating Systems, Timers, Relevant Sensors & Actuator and their application in industrial setting.
5. Explain and apply Data Communication, Telemetry & SCADA System in industrial applications.

	ADVANCED DIGITAL DESIGN USING VERILOG	3L:0T:0P	3 Credits

Unit	Topic	Lectures
I	Introduction to Mixed Logic, Logic Representation and Minimization with cost, Multiple output minimization, Entered Variable K- Map including don't care handling, XOR Pattern Handling.	8
II	Combinational Circuit Design, Multiplexers, Decoders, Encoders, Code Comparators, Adders, Subtractors, Multipliers, Introduction to Verilog, Behavioral and Structural specification of logic circuits, Boolean function implementation using Verilog, Timing Analysis, Hazard Detection and Elimination	8
III	Synchronous Sequential Circuits Design, Mapping Algorithm, Synchronous State Machines, ASM Charts, Asynchronous Sequential Circuit Design, Races, Multi-level minimization and optimization.	8
IV	Factoring, Decomposition, BDD, Ordered BDD, LPDD, Fault Detection and Analysis incombinational and sequential systems, Path Sensitization method, Boolean Difference Method, Initial State Method.	8
V	Study of programmable logic families, PLD, CPLD, FPGA, ASIC, PLA, Architectures,Design of Combinational and sequential circuits using CPLD and FPGA, Design Examples.	8

Text Books:

1. Richard F. Tinder, "Engineering Digital Design", Academic Press.
2. Parag K. Lala, "Digital system Design Using PLDs", PHI India Ltd.
3. Stephen Brown and ZvonkoVranesiv, "Fundamental of Digital Logic with Verilog Design", Tata McGraw Hill.

Reference Books:

1. John Williams, "Digital VLSI Design with Verilog", Springer Publication..
2. Samuel C. Lee, "Digital Circuit and Logic Design", PHI India Ltd.
3. Alexander Miczo, "Digital Logic Testing and Simulation",Wiley Interscience.

Course Outcome: After completion of the course student will be able to

1. Describe mixed logic circuits and their implementation.
2. Implement combinational circuits using mixed logic and Verilog.
3. Design sequential circuits using mixed logic and Verilog with mapping of Algorithm.
4. Understand faults and its elimination in sequential and combinational circuits.
5. Understand the working of programmable logic families.

	SIGNAL PROCESSING	3L:0T:0P	3 Credits

Unit	Topics	Lectures
I	**LTI Systems:** Definition, representation, impulse response, derivation for the output sequence, concept of convolution, graphical, analytical and overlap add methods to compute convolution supported with examples, properties of convolution, interconnections of LTI systems with physical interpretations, stability and causality conditions, recursive and non-recursive systems.	8
II	**Realisation of Digital Linear Systems:** IIR Filter Realization: Direct form, cascade realization, parallel form realization, Ladder structures- continued fraction expansion of H(z). FIR Filter Realization: Direct, Cascade, FIR Linear Phase Realization	8
III	**Discrete Fourier Transform:** Concept and relations for DFT/IDFT, Twiddle factors and their properties, computational burden on direct DFT, DFT/IDFT as linear transformations, DFT/IDFT matrices, computation of DFT/IDFT by matrix method, multiplication of DFTs, circular convolution, computation of circular convolution by graphical, DFT/IDFT and matrix methods, linear filtering using DFT, aliasing error, filtering of long data sequences – Overlap-Save and Overlap-Add methods with examples. **Fast Fourier Transform:** Radix-2 algorithm, decimation-in-time, decimation-in-frequency algorithms, signal flow graphs, Butterflies, computations in one place, bit reversal, examples for DIT & DIF FFT Butterfly computations with examples.	8
IV	**Filter Design:** Basic concepts of IIR and FIR filters, difference equations, design of Butterworth IIR analog filter using impulse invariant and bilinear transforms, frequency transformation. Design of FIR filters using windowing technique, Examples of Filter Designs Using Windows (Rectangular and Hamming windows).	8
V	**Digital Signal Processors** Introduction, Architecture, Features, Addressing Formats, Functional modes. Introduction to Commercial Digital Signal Processors.	8

Text Books:

1. John G Prokias, Dimitris G Manolakis, Digital Signal Processing. Pearson , 4th Edition, 2007
2. Johnny R. Johnson, Digital Signal Processing, PHI Learning Pvt Ltd., 2009.
3. S. Salivahanan, A. Vallavaraj, Digital Signal Processing, TMH, 4th Edition 2017.
4. Oppenheim & Schafer, Digital Signal Processing. Pearson Education 2015
5. S.K. Mitra, 'Digital Signal Processing–A Computer Based Approach, TMH, 4th Edition.

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

1. Design and describe different types of realizations of digital systems (IIR and FIR) and their utilities.
2. Select design parameters of analog IIR digital filters (Butterworth and Chebyshev filters) and implement various methods such as impulse invariant transformation and bilinear transformation of conversion of analog to digital filters.
3. Design FIR filter using various types of window functions.
4. Define the principle of discrete Fourier transform & its various properties and concept of circular and linear convolution. Also, students will be able to define and implement FFT i.e. a fast computation method of DFT.
5. Define the concept of decimation and interpolation. Also, they will be able to implement it in various practical applications.

	ARTIFICIAL NEURAL NETWORKS	3L:0T:0P	3 Credits

Unit	Topic	Lectures
I	**Introduction to ANN:** Features, structure and working of Biological Neural Network Trends in Computing Comparison of BNN and ANN. **Basics of Artificial Neural Networks** - History of neural network research, characteristics of neural networks terminology, models of neuron McCulloch - Pitts model, Perceptron, Ada line model, Basic learning laws, Topology of neural network architecture	8
II	**Back propagation networks**: (BPN) Architecture of feed forward network, single layer ANN, multilayer perceptron, back propagation learning, input - hidden and output layer computation, back propagation algorithm, applications, selection of tuning parameters in BPN, Numbers of hidden nodes, learning.	8
III	**Activation & Synaptic Dynamics**: Introduction, Activation Dynamics models, synaptic Dynamics models, stability and convergence, recall in neural networks. **Basic functional units of ANN for pattern recognition tasks:** Basic feed forward, Basic feedback and basic competitive learning neural network. Pattern association, pattern classification and pattern mapping tasks.	8
IV	**a)Feed forward neural networks --** Linear responsibility X-OR problem and solution. - Analysis of pattern mapping networks summary of basic gradient search methods. **b) Feedback neural networks Pattern** Storage networks, stochastic networks and simulated annealing, Boltzmann machine and Boltzmann learning.	8
V	**Competitive learning neural networks**: Components of CL network pattern clustering and feature. Mapping network, ART networks, Features of ART models, character recognition using ART network. **Applications of ANN**: Pattern classification - Recognition of Olympic games symbols, Recognition of printed Characters. Neocognitron - Recognition of handwritten characters. NET Talk: to convert English text to speech. Recognition of consonant vowel (CV) segments, texture classification and segmentation	8

Text Book:

1.B. Yegnanarayana, "Artificial neural Networks", PHI Publication.

Reference Books:

1. S. Raj Sekaran , Vijayalakshmi Pari," Neural networks, Fuzzy logic and Genetic Algorithms", PHI Publication.
2. Elaine Rich and Kevin Knight, "Artificial Intelligence", TMH Publication.

Course Outcome: After completion of the course student will be able to-

1. Recall the functionality of human brain neurons and design the basic artificial model for neuron.
2. Understand the various learning process for artificial neural model.
3. Construct the artificial neural model for pattern mapping, pattern recognition and pattern classification.
4. Explain feed forward and feedback network for artificial neural network.
5. Summarize the concept of artificial neural network and practical application of ANN.

	ELECTRICAL MACHINES	3L:0T:0P	3 Credits

Unit	Topics	Lectures
I	**Basic concept of rotating machines:** Introduction, Review of magnetic system, Energy in Magnetic system, Introduction to Elementary machines - synchronous machines, dc machine, Asynchronous machines: concept of Rotating magnetic field, generated emf, torque in round rotor machines, matching characteristics of electric machines and load.	8
II	**DC Machine:** Introduction, emf equation, torque equation, power balance, linear magnetization, circuit model, generating mode, motoring mode, armature reaction, compensating winding, commutation, method of excitation, characteristics of dc shunt, series and compound motors and generators. Starting of dc motor, speed control of dc motor, breaking of dc motor.	8
III	**Synchronous machines:** Introduction of basic synchronous machine model, circuit model of synchronous machine, determination of armature reaction ampere turn and leakage reactance of synchronous machine, synchronizing to infinite bus bar, operating characteristics, power flow equations, parallel operation of synchronous generators, hunting in synchronous machines.	8
IV	**Induction Motor:** Introduction, construction, flux and mmf phasor in induction motors, slip and frequency of rotor currents, rotor emf, power, induction motor phasor diagram, torque slip characteristics, determination of equivalent circuit parameters, circle diagram, starting of induction motor, speed control.	8
V	**Single Phase Motors:** Introduction, types of single-phase motor, single phase induction motor, split phase motors, single phase commutator motor, single phase synchronous motor, stepper motor.	8

Text Book:

1. DP Kothari & I J Nagrath, "Electric Machines", Tata McGraw Hill Publication.
2. G.C. Garg, Electrical Machines – I, II, Khanna Publishing House, Delhi.

Reference Book:

1. Fitzgerald, C. Kingsley and S.Umans , "Electric Machinery", Tata McGraw Hill Publication.
2. P.S. Bimbhra, Electrical Machines, Khanna Book Publishing Co. (P) Ltd., Delhi..

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

1. Explain the various types of torques produced in electrical machines and fundamental principles of operation of rotating electrical machines.
2. Categorize different phenomena occurring in DC machines.
3. Explain the working and performance characteristics of synchronous machines.
4. Develop the equivalent circuit and phasor diagram of induction motor and analyze their performance using the equivalent circuit.
5. Identify the types of single-phase motors with their working principle.

	OPTICAL COMMUNICATION	3L:0T:0P	3 Credits

Unit	Topics	Lectures
I	**Introduction to Optical Communication:** Optical Spectral Band with Operating Windows, General Communication System, Optical Communication System with its advantages. **Optical Fiber Waveguides:** Ray Theory of Transmission with TIR, Acceptance Angle, Numerical Aperture and Skew Rays, Electromagnetic Mode Theory for Optical Propagation, Modes in a Planar Guide, Phase and Group Velocity, Phase Shift with Total Internal Reflection, Evanescent Field, Goos-Haenchen Shift, Cylindrical Fiber Modes, Mode Coupling, Step Index fibers Vs Graded Index fibers, Single Mode Fibers- Cut off wavelength, MFD & Spot Size.	08
II	**Signal Loss in Optical Fibers:** Attenuation, Material Absorption Losses (Intrinsic and Extrinsic absorption), types of Linear and Non-Linear Scattering Losses, Fiber Bending Losses, Kerr Effect. **Dispersion:** Introduction with its types: Chromatic / Intramodal Dispersion (Material and Waveguide Dispersion), Intermodal dispersion (for MSI and MGI fibers), Overall (Total) Fiber Dispersion in Multimode and Singe Mode Fiber, Dispersion Modified Single Mode Fibers, Polarization & Fiber Birefringence.	08
III	**Optical Sources: LEDs-**Introduction to LEDs & Materials used for fabrication, LED Power and Efficiency, LED Structures, LED Characteristics, Modulation Bandwidth. **Laser Diodes-**Introduction, Optical Feedback & Laser Oscillations, Resonant Frequencies, Laser Modes, and Threshold Condition for Laser Oscillation, Laser Diode Rate Equations, Semiconductor injection Laser- Efficiency, Laser Single Mode operation, Reliability of LED & ILD.	08
IV	**Power Launching in Fiber:** Source to Fiber Power Launching and Coupling Techniques, Power Launching Vs Wavelength, Equilibrium Numerical Aperture. **Photo Detectors:** Introduction, Physical Principles of Photodiodes: The PIN Photo Detector, Avalanche Photodiodes, Temperature Effect on Avalanche Gain, Detector Response Time, Photo Detector Noise: Noise Sources, Signal to Noise Ratio, Comparison of Photo Detectors, Fundamental Receiver Operation with Digital Signal Transmission.	08
V	**Digital Receiver Performance:** Probability of Error / BER, Receiver Sensitivity & The Quantum Limit, Error Control Techniques, Eye Diagram Pattern Features, Coherent Detection: Homodyne Detection and Heterodyne Detection, Digital links: Point to Point Links, Power Penalties, Multichannel & Multiplexing Transmission Techniques, basic concept of Free Space Optics (FSO) based Communication System.	08

Text Book:

1. John M. Senior, "Optical Fiber Communications", Pearson, 3rd Edition, 2010.
2. Gerd Keiser, "Optical Fiber Communications", McGraw Hill, 5th Edition, 2013.
3. Govind P. Agrawal, "Fiber Optic Communication Systems", John Wiley, 3rd Edition, 2004.

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

1. Define and explain the basic concepts and theory of optical communication.
2. Describe the signal losses with their computation and dispersion mechanism occurring inside the optical fiber cable.
3. Differentiate the optical sources used in optical communication with their comparative study.
4. Identify different optical components on receiver side; assemble them to solve real world problems related to optical communication systems.
5. Evaluate the performance of an optical receiver to get idea about power budget and ultimately be an engineer with adequate knowledge in optical domain.

	INTEGRATED CIRCUITS LAB	0L:0T:2P	1 Credit

SUGGESTIVE LIST OF EXPERIMENTS:

1. Design the following using Op-Amp: ***(Through Virtual Lab Link 1)***
   a) A unity gain amplifier.
   b) An inverting amplifier with a gain of "A".
   c) A non-inverting amplifier with a gain of "A"
2. Study and design Log and antilog amplifiers.
3. Voltage to current and current to voltage convertors.
4. Second order filters using operational amplifier for: ***(Through Virtual Lab Link 1)***
   a) Low pass filter of cutoff frequency 1 KHz.
   b) High pass filter of frequency 12 KHz.
5. Realization of Band pass filter with unit gain of pass band from 1 KHz to 12 KHz.
6. Study and design voltage comparator and zero crossing detectors.
7. Function generator using operational amplifier (sine, triangular & square wave).
8. Design and construct astable multivibrator using IC 555 and
   a) Plot the output waveform
   b) Measure the frequency of oscillation ***(Through Virtual Lab Link 2)***
9. Design and construct a monostable multivibrator using IC 555 and
   a) Plot the output waveform
   b) Measure the time delay ***(Through Virtual Lab Link 2)***
10. Implement Schmitt Trigger Circuit using IC 555. ***(Through Virtual Lab Link 2)***
11. Implement voltage-controlled oscillator using IC566 and plot the waveform. ***(Through Virtual Lab Link 2)***
12. Study and design ramp generator using IC 566.

Virtual Lab Link:

1. http://vlabs.iitkgp.ernet.in/be/exp17/index.html
2. http://hecoep.vlabs.ac.in/Experiment8/Theory.html?domain=ElectronicsandCommunications&lab=Hybrid%20Electronics%20Lab

Available on: http://www.vlab.co.in/broad-area-electronics-and-communications

Course Outcomes:

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

1. Design different non-linear applications of operational amplifiers such as log, antilog amplifiers and voltage comparators.
2. Explain and design different linear applications of operational amplifiers such as filters.
3. Demonstrate the function of waveforms generator using op-Amp.
4. Construct multivibrator and oscillator circuits using IC555 and IC566 and perform measurements of frequency and time.
5. Design and practically demonstrate the applications based on IC555 and IC566.

	MICROPROCESSOR & MICROCONTROLLER LAB	**0L:0T:2P**	**1 Credit**

SUGGESTIVE LIST OF EXPERIMENTS:

1. Write a program using 8085 Microprocessor for Decimal, Hexadecimal addition and subtraction of two Numbers. ***(Through Virtual Lab Link)***
2. Write a program using 8085 Microprocessor for addition and subtraction of two BCD numbers. ***(Through Virtual Lab Link)***
3. To perform multiplication and division of two 8 bit numbers using 8085. ***(Through Virtual Lab Link)***
4. To find the largest and smallest number in an array of data using 8085 instruction set.
5. To write a program using 8086 to arrange an array of data in ascending and descending order. ***(Through Virtual Lab Link)***
6. To convert given Hexadecimal number into its equivalent ASCII number and vice versa using 8086 instruction set.
7. To convert given Hexadecimal number into its equivalent BCD number and vice versa using 8086 instruction set.
8. To interface 8253 programmable interval timer and verify the operation of 8253 in six different modes.
9. To write a program to initiate 8251 and to check the transmission and reception of character.
10. Serial communication between two 8085 through RS-232 C port.
11. Write a program of Flashing LED connected to port 1 of the 8051 Micro Controller
12. Write a program to generate 10 kHz square wave using 8051.
13. Write a program to show the use of INT0 and INT1 of 8051.
14. Write a program for temperature & to display on intelligent LCD display.

Virtual Lab Link: http://vlabs.iitb.ac.in/vlabs-dev/labs_local/microprocessor/labs/explist.php

Available on: http://www.vlab.co.in/broad-area-electronics-and-communications

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

1. Use techniques, skills, modern engineering tools, instrumentation and software/hardware appropriately to list and demonstrate arithmetic and logical operations on 8 bit data using microprocessor 8085.
2. Examine 8085 & 8086 microprocessor and its interfacing with peripheral devices.
3. State various conversion techniques using 8085 & 8086 and generate waveforms using 8085.
4. Implement programming concept of 8051 Microcontroller.
5. Design concepts to Interface peripheral devices with Microcontroller so as to design Microcontroller based projects.

	INSTRUMENTATION & MEASUREMENTS LAB	0L:0T:2P	1 Credit

SUGGESTIVE LIST OF EXPERIMENTS:

1. Study of semiconductor diode voltmeter and its use as DC average responding AC Voltmeter.
2. Study of L.C.R. Bridge and determination of the value of the given components.
3. Characteristics of Thermocouples and RTD.
4. Study of the following transducer (i) PT-100 Transducer (ii) J-Type Transducer (iii) K-Type Transducer (iv) Pressure Transducer
5. Measurement of phase difference and frequency using CRO (Lissajous Figure)
6. Characteristics of LDR, Photo Diode, and Phototransistor:
   (i) Variable Illumination.
   (ii) Linear Displacement
7. Characteristics of LVDT.
8. Study of the transistor tester and determination of the parameters of the given transistors
9. Design and Test a signal conditioning circuit for any transducer.
10. Implementation of Color Sensor for differentiating frequencies

Through Virtual Lab:

11. Measurement of low resistance Kelvin's double bridge.
12. To measure unknown capacitance of small capacitors by using Schering's bridge.
13. To measure unknown Inductance using Hay's bridge.
14. Measurement of capacitance by De Sauty Bridge.

Virtual Lab Link: http://vlabs.iitkgp.ernet.in/asnm/#

Available on: http://www.vlab.co.in/broad-area-electronics-and-communications

Course Outcomes:

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

1. Demonstrate voltage measurement using AC voltmeter and semiconductor diode voltmeter.
2. Measure the unknown resistance, capacitance and inductance using LCR Bridge, Kelvin double bridge, Schering bridge, Hay's bridge, De sauty bridge.
3. Practically demonstrate the different types of transducers like J-type, K-type, PT-100 and RTD.
4. Interpret frequency and phase difference from Lissajous figure.
5. Interpret hybrid parameters of transistor and demonstrate different transducer like LDR and LVDT.

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B.Tech 3rd Year
VI Semester
Syllabus

	EMBEDDED SYSTEMS DESIGN	3L:1T:0P	4 Credits

Unit	Topics	Lectures
I	**Advanced concepts in 8051 architecture:** Review of 8051 architecture, concept of synchronous serial communication, SPI and I2C communication protocols, study of SPI port on 89LP 51RD2, study of SAR ADC/DAC MCP3304 / MCP 33, interfacing concepts for SPI based ADC/DAC, study of watchdog timer, study of PCA timer in different modes like capture mode, PWM generation mode, High speed output toggle mode Embedded 'C' programming for the above peripherals.	8
II	**MSP430x5x Microcontroller:** series block diagram, address space, on-chip peripherals (analog and digital), and Register sets. Instruction set, instruction formats, and various addressing modes of 16-bit microcontroller; Sample embedded system on MSP430 microcontroller. Memory Mapped Peripherals, programming System registers, I/O pin multiplexing, pull up/down registers, GPIO control. Interrupts and interrupt programming.	8
III	**Introduction to Embedded Systems:** Describe what an embedded system is and its main components, Outline the different options available for building embedded systems,Explain the benefits, functions, and attributes of embedded systems, Examine the constraints specific to embedded systems and their impact **Introduction to the Arm Cortex-M4 Processor** Architecture, Identify key features of Arm architectures and processors, Explain the features and layout of the Arm Cortex-M4 processor. Explain the structure and purpose of specific registers in the Arm Cortex-M4 processor **Introduction to Arm Cortex-M4 Programming**, Compare the C and Assembly programming languages, Explain program-generation flow, including compilation and program images , Describe and compare different data formats and how they are stored in memory, Explain how mixed assembly and C programming can be performed, Introduction to the Mbed Platform and CMSIS.	8
IV	**Digital Input and Output (IO):** Explain the relationship between electrical voltages and logic values , Describe the key features of GPIOs (General Purpose I/O pins) and how they can be used to control peripherals, Explain the key elements of GPIO design in relation to microcontrollers. Compare register-level GPIO programming to GPIO programming with the Mbed API. Interrupts and Low Power Features: Interrupts and Low Power Features, Serial Communication **Introduction to the Internet of Things (IoT):** Describe the concepts of IoT and understand the key elements of an IoT device, Outline the evolution of IoT, Describe the main technologies that enable IoT, Identify the key challenges facing IoT systems, and Evaluate the opportunities and risks that emerge with IoT adoption.	8
V	**Hardware Platforms for IoT:** Identify the concepts of hardware platform and the factors influencing its design,Differentiate between various types of memory, Explain the principles of sensors and the role of I/O **IoT Connectivity:** Identify the concept of Bluetooth technology,Identify key features of the Bluetooth and Bluetooth Low Energy protocols,Explain how a Bluetooth connection is secured,Outline the new features that are introduced in the Bluetooth 5 specification, Explain the architecture and protocol stack used in ZigBee.	8

Text Books:

1. Mazidi Ali Muhammad, Mazidi Gillispie Janice, and Mc Kinlay Rolin D "The 8051 Microcontroller and Embedded Systems using Assembly and C", Pearson Publication,2006
2. John H Davies, "MSP430 Microcontroller Basics" Newnes Publication,2008.
3. Embedded Systems Fundamentals on Arm Cortex-M based Microcontrollers: A Practical Approach by Alexander G. Dean https://www.arm.com/resources/education/textbooks/efficient-embedded-systems

Reference Books:

1. TI MSP430x5xx and MSP430x6xx Family User's Guide , Revised 2018.
2. The Definitive Guide to ARM® Cortex®-M3 and Cortex®-M4 Processors, Third Edition by Joseph Yiu
3. Cortex-A Series Programmer's Guide for ARMv7-A by Arm from http://infocenter. arm.com/ help/topic/com.arm.doc.den0013d/index.html
4. White Paper: Cortex-M for Beginners - An overview of the Arm Cortex-M processor family and comparison:https://community.arm.com/developer/ip-products/processors/b/processors-ip-blog/posts/white-paper-cortex-m-for-beginners-an-overview-of-the-arm-cortex-m-processor-family-and-comparison.

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

1. Explain the advance concept of 8051 architectures and AVR family architecture and compare them for different applications.
2. To demonstrate the basics of MSP430x5x Microcontroller
3. To execute the I/O interfacing and peripheral devices associated with Microcontroller SoC (system on chip).
4. Explain the advance concept Arm Cortex-M4 Processor Architecture.
5. Demonstrate the ability to do Demonstrate the basics of Embedded Systems, IoT and its application and design IoT based projects on Arm based development boards

	CONTROL SYSTEM	3L:1T:0P	4 Credits

Unit	Topics	Lectures
I	**Introduction to Control Systems:** Basic Components of a control system, Feedback and its effect, types of feedback control systems. Block diagrams Reduction and signal flow graphs, Modeling of Physical systems: electrical networks, mechanical systems elements, free body diagram, analogous Systems, sensors and encoders in control systems, modeling of armature controlled and field controlled DC servomotor.	8
II	**State-Variable Analysis:** Introduction, vector matrix representation of state equation, state transition matrix, state-transition equation, relationship between state equations and high-order differential equations, relationship between state equations and transfer functions, Decomposition of transfer functions, Controllability and observability, Eigen Value and Eigen Vector, Diagonalization.	8
III	**Time domain Analysis of Control Systems:** Time response of continuous data systems, typical test signals for the time response of control systems, unit step response and time-domain specifications, time response of a first order system, transient response of a prototype second order system, Steady-State error, Static and dynamic error coefficients, error analysis for different types of systems.	8
IV	**Stability of Linear Control Systems:** Bounded-input bounded-output stability continuous data systems, zero-input and asymptotic stability of continuous data systems, Routh Hurwitz criterion, Root-Locus Technique: Introduction, Properties of the Root Loci, Design aspects of the Root Loci.	8
V	**Frequency Domain Analysis:** Resonant peak and Resonant frequency, Bandwidth of the prototype Second order system, effects of adding a zero to the forward path, effects of adding a pole to the forward path, polar plot, Nyquist stability criterion, stability analysis with the Bode plot, relative stability: gain margin and phase margin.	8

Text Book:

1. I. J. Nagrath & M. Gopal, “Control System Engineering”, 6th Ed. New Age International Publishers, 2018
2. B.C. Kuo & Farid Golnaraghi, “Automatic Control Systems”, 9th Edition, John Wiley India, 2008

Reference Books:

1. (Schaums Outlines Series) Joseph J. Distefano III, Allen R. Stubberud, Ivan J. Williams, “Control Systems”, 3rd Edition, TMH, Special Indian Edition, 2010.
2. A. Anand Kumar, “Control Systems”, Second Edition, PHI Learning private limited, 2014.
3. William A. Wolovich, “Automatic Control Systems”, Oxford University Press, 2011.

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

1. Describe the basics of control systems along with different types of feedback and its effect. Additionally they will also be able to explain the techniques such as block diagrams reduction, signal flow graph and modelling of various physical systems along with modelling of DC servomotor.
2. Explain the concept of state variables for the representation of LTI system.
3. Interpret the time domain response analysis for various types of inputs along with the time domain specifications.
4. Distinguish the concepts of absolute and relative stability for continuous data systems along with different methods.
5. Interpret the concept of frequency domain response analysis and their specifications.

	INDUSTRIAL MEASURING INSTRUMENTS	3L:1T:0P	4 Credits

Unit	Topics	Lectures
I	**Generalized configurations, functional descriptions and performance characteristics of measuring instruments:** General concepts and terminology of measurement systems, transducer classification, general input-output configuration, static and dynamic characteristics of a measurement system, Statistical analysis of measurement data. Standards and Calibration. **Displacement measurement:** Resistive potentiometers, Digital displacement transducers, Mechanical fly ball angular velocity sensor, Mechanical revolution counters and timers, stroboscopic method	8
II	**Force and Pressure Measurement:** Standards & calibration; basic methods of force measurement; Characteristics of elastic force transducer-Bonded strain gauge, differential transformer, Piezo electric transducer. Units of pressure; dead weight gauges & manometer and its types, Bellows and force balance type sensors, Bourden guage, Piezoelectric, Capacitive and Inductive Pressure pickups.	8
III	**Flow measurement:** Differential pressure flowmeters: Bernoulli’s theorem: pitot tube, orifice, venturi, flow nozzle, Hot wire and hot film anemometers, variable area meters (rotameter), meters, Electromagnetic flowmeters, Ultrasonic flowmeters, Drag force flow meter, Vortex shedding flow meters. Measurement of level, Float type gauge, purge method, differential pressure method, conductive and capacitive method; electromechanical method.	8
IV	**Temperature measurements:** Standards and calibration, thermal expansion methods, bimetallic thermometer, thermocouple, reference junction considerations, special materials, configuration & techniques, Measurement of thermocouple output, Electrical resistance sensors and thermistors, Radiation thermometers.	8
V	**Miscellaneous Measurements: Viscosity, Density and Vacuum:** **Measurement of Viscosity:** Definitions, units, Newtonian and Newtonian behaviour, measurement of viscosity using laboratory viscometers, industrial viscometers. Viscometer selection and application. **Measurement of Density:** Definitions, units, liquid density measurement, gas densitometers, its application and selection, **Measurement of Vacuum:** Mcleod gauge, Pirani gauge, Knudsen gauge and Ionization gauge	8

Text Books:

1. E. O. Doebelin, “Measurements systems: Applications and Design”, 4th Edition, Tata McGraw Hill.
2. B. C. Nakra and K. K. Chaudhry, “Instrumentation: Measurements & Analysis” Tata McGraw Hill
3. J.G. Joshi, Electronics Measurement and Instrumentation, Khanna Publishing House, Delhi.

Reference Books:

1. A.K. Sawhney, “A Course in Electrical and Electronic Measurements and Instrumentation” Dhanpat Rai Publications., 19th Edition.
2. Bela G. Liptak, "Process Measurement and Analysis, Vol. 1”, CRC Press

Course Outcomes: At the end of this course, Students will be able to

1. Describe the basic fundamentals, terms, and characteristics of measurement system.
2. Explain the working principle of various transducers used for the measurement of force and pressure.
3. Recognize the physics of pressure, temperature, level and flow measurement used to control dynamics of processes.
4. Assemble commonly used temperature measurement devices through proper selection, identification, design, installation and principle of operation in industries.
5. Develop critical and creative thinking to bring the technology, problem-solving skills in trouble shooting problems with the measurement and control of industrial instrumentation work.

	OPTO-ELECTRONICS	3L:0T:0P	3 Credits

Unit	Topics	Lectures
I	**Introduction to optical waveguide, Photo sources and detectors**: Optical wave guide modes-Theory of Dielectrics lab waveguides-Symmetric and Asymmetric Slab waveguide, Channel waveguide Light emitting diode (LED), materials, constructions, Drive circuitry, Fundamentals of lasers and its applications	8
II	**Electro Optic Effects**: Birefringence phenomenon EO Retardation, EO Amplitude and Phase Modulator, Electro optic Intensity Modulators, Beam deflection, Acousto-optics, A-O Modulators, Integrated optic spectrum analyzer.	8
III	**Optical Fiber Sensors:** Multi mode fiber Sensors-Displacement, pressure, stress, strain. Intensity modulated sensors, Active multimode FO sensors, Micro-bend optical fiber sensor, Current sensors, Magnetic sensors, Single mode FO sensors, Phase modulated, Polarization modulated, Fibre Optic Gyroscope	8
IV	**Optical detection principles**: Absorption Quantum efficiency Responsivity, Long wavelength cutoff, Photon detectors: Photodiodes, PIN photodiode, APD, photomultipliers, Thermal detector: Bolometers and thermisters, Pyroelectric detector	8
V	**Optical Computing:** Analog arithmetic operation- addition/subtraction, multiplication, division, averaging, differentiation and integration. Digital logic: modified signed digit number system, residue number system, logarithmic number system. Arithmetic operations: MSD, residue, signed logarithmic arithmetic, threshold logic, threshold devices, spatial light modulators.	8

Text Books:

1. J.Wilson and J.Hawkes,“Optoelectronics-AnIntroduction”,PHI. (2002)
2. M.A.Karim,“OpticalComputing–Anintroduction”,WileyIndia. (1997)
3. Optical fiber communications: principles and practice, John. M. Senior (2005)

Reference Books:

1. A.Yariv, P.Yeh,“Photonics”,6th Ed.,OxfordUniversityPress. 2011
2. Emmanuel Rosencher and BorgeVinter, "Optoelectronics", Cambridge University Press. 2012

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

1. Explain the basic learning of Optical waveguides, photo source and detectors.
2. Demonstrate the concept of Electro Optic effects.
3. Analyze the working of optical fiber sensor.
4. Interpret the basics of optical detection principles
5. Express the basics of optical computing.

1.

	DIGITAL MEASUREMENT TECHNIQUES	3L:0T:0P	3 Credits

Unit	Topics	Lectures
I	Philosophy of digital measurements. Digital Time Measurement Techniques: Measurement of time interval between two events, Error in time interval measurement, Vernier technique for small time measurement, Measurement of time interval with constraints, Measurement of periodic time, phase, Time interval between two events defined by voltage levels, Capacitance, Quality factor of ringing circuit, Decibel meter	8
II	Digital Frequency Measurement Techniques: Measurement of frequency, Ratio of two frequencies, Product of two frequencies, High frequency, average Frequency difference, Deviation of power frequency, Peak frequency. Fast low-frequency measurement.	6
III	Digitally Programmable Circuits: Single mode switching, Group mode switching, Resistors, Potentiometers, Amplifiers, Schmitt trigger, Dual polarity gain amplifiers. Programmable gain amplifier with dual output, Two stage programming, Programmable Biquads.	9
IV	Digital to Analog Converters: Output Input relation, DACs derived from programmable gain amplifiers, Weighted-resistor DAC, Weighted current DAC, Weighted reference voltage DAC, Ladder DAC, Switches.	9
V	Digital Voltage Measurement Techniques: Sampling theorem, Time-division multiplexing, Quantization, Indirect type A/D converters, Direct type A/D converters, Input circuitry of a digital voltmeter.	8

Text Books:

1. "Digital Measurement Techniques", T. S. Rathore, by Narosa Publishing House, 1996

Reference Books:

1. A.K. Maini, All in One Electronics Simplified, Khanna Publishing House, Delhi

Course Outcomes: At the end of this course students will demonstrate the ability:

1. To describe the basic knowledge of Digital Measurement Technique.
2. To demonstrate the concepts of DMT involved in term of frequency.
3. To explain the concepts of programmable circuits.
4. To analyze the performance of digital to analog converters.
5. To apply the concept of voltage measurement in DMT.

	DATA COMMUNICATION NETWORKS	3L:0T:0P	3 Credits

Unit	Topics	Lectures
I	**Introduction to Networks & Data Communications:** Goals and Applications of Networks ,The Internet, Protocols & Standards, Layered Tasks, OSI reference Model, TCP / IP, Addressing, Line Coding Review.	8
II	**Physical Layer**: Transmission Media- Guided and unguided, Network Topology Design, **Data Link Layer**: Error detection and Correction, Framing, Flow and Error Control Protocols, Noiseless Channel and Noisy Channel Protocol, HDLC, Point-to-Point Protocol	8
III	**Multiple Access:** RANDOH, CDMA, CSMA/CD, CSMA/CA, Controlled Access, Channelization Wired LANs: IEEE Standards, Standard Ethernet, Fast Ethernet, Gigabit Ethernet, Wireless LAN IEEE 802.11, Bluetooth IEEE 802.16.	8
IV	**Network Layer:** Design Issues. Routing Algorithms. Congestion control Algorithms. Internetworking –TCP/IP, IP Packet, IPv4 and IPv6 Protocols, IPV4 Addresses, Connecting Devices, Virtual LAN IPV6 Addresses.	8
V	**Transport Layer Protocol:** UDP and TCP, ATM, Cryptography, Network Security**,** Session Layer-Design issues. **Application Layer:** File Transfer, Electronic mail, HTTP, WWW, SMTP, Cryptography, Network Security.	8

Text Books:

1. B. A. Forouzan, “Data Communications and Networking”, 5th Edition, TMH, 2017.

Reference Books:

1. S. Tanenbaum, “Computer Networks”, 4th Edition, Pearson, 2013.
2. W. Stallings, “Data and Computer Communication”, 8th Edition, Pearson, 2007.

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

1. Identify the issues and challenges in the architecture of a network.
2. Analyze the services and features of various protocol layers in data layer.
3. Demonstrate the knowledge of multiple access to design a access technique for a particular application.
4. Realize protocols at different layers of a network hierarchy.
5. Recognize security issues in a network and various application of application layer.

	ANALOG SIGNAL PROCESSING	3L : 0T : 0P	3 Credits

Unit	Topics	Lectures
I	Introduction to domains and the analogue/digital trade off, Introduction to current conveyor, current feedback amplifier. Analog signal filtering: introduction to bilinear transfer functions and active realizations. Second-order filter realization, filter design parameters (Q and ω_0), frequency response, Three op-amp biquad, effect of finite gain of op-amp over filters, Sallen-Key biquad.	8
II	Ideal low-pass filter, Buttreworth and Chebyshev magnitude response, pole locations, low-pass filter specifications, comparison of Maximally flat and Equal ripple responses.	8
III	Delay equalization: equalization procedures, equalization with first-order and second order modules, strategies for equalization design. Definition of Bode sensitivity.	8
IV	The General Impedance Convertor (GIC), optimal design of the GIC, realization of simple ladders, Gorski-Popiel's Embedding Technique, Bruton's FDNR technique, Creating negative components.	8
V	Elementary transconductor building blocks, resistors, integrators, amplifiers, summers, Gyrator, First and second order filters, Higher order filters	**8**

Text Book:

1. R. Schaumann and M.E. Valkenberg, "Design of Analog Circuits", Oxford University Press

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

1. Describe and apply fundamentals of signal processing in analog domain and its associated concepts like OTA and current conveyor.
2. Introduction of filter and its designing parameters
3. Solve problems and design higher order filters like Butterworth and Chebyshev.
4. Understand and explain the reasons for delay in filter designing and its procedure to equalize.
5. Understand the principles of the inductor simulation like general impedance convertor (GIC), optimal design of the GIC, Gorski-Popiel's Embedding Technique, Bruton's FDNR technique which are used for placing equivalent inductor on integrated circuits.

	RANDOM VARIABLES & STOCHASTIC PROCESS	3L:0T:0P	3 Credits

Unit	Topics	Lectures
I	**Probability**: Introduction to set theory, experiments and sample spaces, joint probability, conditional probability, concept of total Probability, Bayes' Theorem, and independent events, Bernoulli's trials, combined experiments.	8
II	**Random Variables:** Introduction, types of random variables, cumulative distribution function and probability density functions, Standard distributions: Gaussian, exponential, Rayleigh, uniform, Bernoulli, binominal, Poisson, discrete uniform and conditional distributions. Functions of one random variable: distribution, mean, variance, moments and characteristics functions.	8
III	**Multiple Random Variables:** Joint distributions, joint density function and properties, marginal distribution and density functions, conditional distribution and density Functions, statistical independence, functions of two random variables, joint moments, Multiple random variables: multiple functions of multiple random variables, jointly Gaussian random variables, sums of random variable, Central limit theorem.	8
IV	**Stochastic Processes:** Definitions, Random process concept, Statistics of stochastic processes: Mean, Autocorrelation, Covariance Functions and its properties, Strict and Wide sense stationary, random processes, Time Averages and Ergodicity, Mean-Ergodic Processes.	8
V	**Stochastic Processes in Frequency Domain:** Power spectrum of stochastic processes, Properties of power spectral density, Relationship between Power Spectrum and Autocorrelation Function, the Cross-Power Density Spectrum and Properties, Relationship between Cross-Power Spectrum and Cross-Correlation Function, Transmission over LTI systems, Gaussian and White processes.	8

Text Books:

1. Probability, Random Variables And Stochastic Processes, Papoulis, TMH (2002)
2. Stochastic Processes, 2ed, Ross, Wiley.(1996)

Reference Books:

1. Devore – Probability and statistics for engineering and sciences, Cengage learning 2011
2. Mendenhall – Introduction to probability and statistics, Cengage learning 2012
3. Probability, Random Variables And Random Signal Principles, Peebles, TMH 2002
4. Probability Theory and Stochastic Processes for Engineers, Bhat, Pearson 2011
5. Probability and Random Processes with Application to Signal Processing, 3/e, Stark, Pearson 2002
6. Random Variables & Stochastic Processes, Gaur and Srivastava, Genius publications 2003
7. Random Processes: Filtering, Estimation and Detection, Ludeman, Wiley 2002
8. An Introduction to Probability Theory & Its App., Feller, Wiley 1969

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

1. Students will be able to explain the basic learning of Probability.
2. Students will be able to demonstrate the concept of Random Variables.
3. Students will be able to analyze Multiple Random Variables.
4. Students will be able to interpret the basics of Stochastic Processes.
5. Students will be able to express Stochastic Processes in Frequency domain.

	EMBEDDED SYSTEM DESIGN LAB	0L:0T:2P	1 Credit

SUGGESTIVE LIST OF EXPERIMENTS:

Part A: Based on ARM Process:

1. To develop and verify the interfacing ADC and DAC with LPC 2148 Arm Micro Controller.
2. Interfacing of LED and PWM with Micro Controller. (ARM-) using embedded C program.
3. Interfacing of serial port with Am processor using embedded C-program.
4. Interfacing of key board and LCD with Arm processor using embedded C-Program.
5. To develop and verify Embedded C program mailbox using ARM.
6. To implement zigbee protocol with ARM program.
7. Implement the lighting and winking LEDs of the ARM I/O port via programming.
8. ARM programming in C language using KEIL IDE.
9. Demonstrate the TIMING concept of real time application using RTOS on ARM microcontroller kit.
10. Demonstrate the Multi-Tasking concept of real time application using RTOs on ARM microcontroller.
11. Demonstrate the RS 232 serial communication using RTOS on ARM microcontroller kit.
12. ISR (Interrupt Service Routine) programming in ARM based system with I/O port.

Part B: Based on MSP 430

1. Write a program for temperature & to display on intelligent LCD display.
2. Write a program to generate a Ram waveform using DAC with micro controller.
3. Write a program to Interface GPIO port in C using MSP430 (blinking LEDs, push buttons)
4. Write a program Interface potentiometer with GPIO.
5. Write a program of PWM based Speed Controller of Motor controlled by potentiometer connected to GPIO.
6. Write a program of PWM generation using Timer on MSP430 GPIO.
7. Write a program to Interface an accelerometer.
8. Write a program using USB (Sending data back and forth across a bulk transfer-mode USB connection.)

Part C: Virtual Lab Platform

https://www.soe.uoguelph.ca/webfiles/engg4420/EmbeddedSystemsAndLabsForARM-V1.1.pdf
https://profile.iiita.ac.in/bibhas.ghoshal/IEMB_2018/Lectures/ES_basics.pdf
https://nptel.ac.in/courses/108/102/108102045/

Practical Outcome The <u>Student able to:</u>

1. To understand the building blocks of embedded system.
2. To learn the concept of interfacing with different devices.
3. To relate the concept of memory map and memory interface.
4. To discover the characteristics of real time system and to validate the process using know input-output parameters.
5. To understand the basis work of microcontroller and learn the working.
6. Demonstrate knowledge of programs environment and executing variety of programs.

	CONTROL SYSTEMS LAB	**0L:0T:2P**	**1 Credit**

SUGGESTIVE LIST OF EXPERIMENTS:

1. Introduction to MATLAB Control System Toolbox.
2. Determine transpose, inverse values of given matrix.
3. Plot the pole-zero configuration in s-plane for the given transfer function.
4. Determine the transfer function for given closed loop system in block diagram representation.
5. Create the state space model of a linear continuous system.
6. Determine the State Space representations of the given transfer function.
7. Determine the time response of the given system subjected to any arbitrary input.
8. Plot unit step response of given transfer function and find delay time, rise time, peak time, peak overshoot and settling time.
9. Determine the steady state errors of a given transfer function.
10. Plot root locus of given transfer function, locate closed loop poles for different values of k.
11. Plot bode plot of given transfer function. Also determine gain and phase margins.
12. Plot Nyquist plot for given transfer function. Also determine the relative stability by measuring gain and phase margin.

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

1. Classify different tools in MATLAB along with the basic matrix operations used in MATLAB.
2. Evaluate the poles and zeros on s-plane along with transfer function of a given system.
3. Construct state space model of a linear continuous system.
4. Evaluate the various specifications of time domain response of a given system.
5. Appraise the steady state error of a given transfer function.
6. Examine the relative stability of a given transfer function using various methods such as root locus, Bode plot and Nyquist plot.

	INDUSTRIAL INSTRUMENTATION LAB	**0L:0T:2P**	**1 Credit**

SUGGESTIVE LIST OF EXPERIMENTS:

1. Instrumentation Amplifier: Design for specific gain and verification of CMRR.
2. Realization of PCM signal using ADC and reconstruction using DAC using 4-bit/8bit systems. Observe the Quantization noise in each case.
3. Study of low noise and low frequency amplifier for biomedical application.
4. Design of temperature transmitter using RTD.
5. Design of cold junction compensation circuit.
6. Design of Linearization circuit for thermistor.
7. Design of pressure transmitter.
8. Performance evaluation of pressure gauges using Dead weight tester.
9. Measurement of level using capacitance probe, differential pressure transmitter.
10. Measurement of flow using orifice, electromagnetic and positive displacement flowmeters.
11. Study of PID controllers in flow measurement.
12. Measurement of solar energy using sensor.
13. Experiment using PLC Trainer Kits
14. Simulate and analyze the frequency domain measurement of electrical signals using spectrum analyzer.
15. Range finding and object detection using detection sensor.
16. Measurement using various sensors and analyzing the output using Virtual Instrumentation Lab-VIEW software.

Course Outcomes: At the end of this course students will demonstrate the ability:

1. To design instrumentation amplifier.
2. To execute PCM technique and demonstrate the concept.
3. To design equipments related to temperature measurement.
4. To analyze the performance of various pressure gauges.
5. To conceptualize the principle of flow meters using various flow measurement instruments.