ANNEXURE- A

SECOND YEAR ELECTRONICS AND TELECOMMUNICATION ENGINEERING PROGRAM

SCHEME OF INSTRUCTION AND EXAMINATION, REVISED COURSE (2019-2020)

SEMESTER – III

Course Code	Nomenclature of the Course	Scheme of Instruction Hrs/Week			Scheme of Examination						
		L	T	P#	Duration (Hrs)	Marks					Credits
						Th	IA	TW*	P	Total	
ET310	Mathematics- III	3	1	--	3	100	25	25	--	150	4
ET320	Circuit Analysis and Synthesis	3	--	--	3	100	25	--	--	125	3
ET330	Electronic Devices and Circuits	3	1	--	3	100	25	25	--	150	4
ET340	Digital System Design	3	1	--	3	100	25	25	--	150	4
ET350	Electromagnetic Field & Wave Theory	3	1	--	3	100	25	25	--	150	4
ET360	Electronic Devices and Circuits Lab	--	--	2	--	--	--	25	25	50	1
ET370	Digital System Design Lab	--	--	2	--	--	--	25	25	50	1
HM001	Technical Communication	2	--	--	--	--		75	--	75	2
AC390	Mathematics-I and II(Bridge Course*)	--	--	--	--						
	TOTAL	17	4	4	--	500	125	225	50	900	23

L-Lecture T-Tutorial P-Practical Th-Theory TW-Term Work IA-Internal Assessment

A candidate is considered to have sucessfully fulfilled the requirement of a semester, provided he/ she submits to the department a certified journal reporting the experiments conducted during the semester.

*Term Work marks are to be awarded through continuous evaluation

SECOND YEAR ELECTRONICS AND TELECOMMUNICATION ENGINEERING PROGRAM
SCHEME OF INSTRUCTION AND EXAMINATION, REVISED COURSE (2019-2020)

SEMESTER – IV

Course Code	Nomenclature of the Course	Scheme of Instruction Hrs/Week			Scheme of Examination						
		L	T	P#	Duration (Hrs)	Marks					Credits
						Th	IA	TW*	P	Total	
ET410	Signals and Systems	3	1	--	3	100	25	25	--	150	4
ET420	Microprocessors and Interfacing	4	--	--	3	100	25	--	--	125	4
ET430	Linear Integrated Circuits	4	--	--	3	100	25	--	--	125	4
ET440	Transmission Lines and Antennas	3	--	--	3	100	25	--	--	125	3
ET450	Statistical Communication Theory	3	1	--	3	100	25	25	--	150	4
ET460	Microprocessors and Interfacing Lab	--	--	2	--	--	--	25	50	75	1
ET470	Linear Integrated Circuits Lab	--	--	2	--	--	--	25	50	75	1
HM008	Engineering Economics and Management	3	--	--	3	100	25	--	--	125	3
	TOTAL	20	2	4	--	600	150	100	100	950	24

L-Lecture T-Tutorial P-Practical Th-Theory TW-Term Work IA-Internal Assessment

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*Term Work marks are to be awarded through continuous evaluation

THIRD YEAR ELECTRONICS AND TELECOMMUNICATION ENGINEERING PROGRAM
SCHEME OF INSTRUCTION AND EXAMINATION, REVISED COURSE (2019-2020)
SEMESTER – V

Course Code	Nomenclature of the Course	Scheme of Instruction Hrs/Week			Scheme of Examination						
		L	T	P#	Duration (Hrs)	Marks					Credits
						Th	IA	TW*	O	Total	
ET510	Analog and Digital Communication	3	1	--	3	100	25	25	--	150	4
ET520	Digital Signal Processing	3	1	--	3	100	25	25	--	150	4
ET531	Embedded Systems	3	--	--	3	100	25	--	--	125	3
ET532	Power Electronics										
ET533	Soft Computing										
ET534	Numerical Methods and Approximations										
ET535	Solid State Devices and Technology										
ET541	Microwave Engineering	3	--	--	3	100	25	--	--	125	3
ET542	Electromagnetic Compatibility Engineering										
ET543	Digital Image Processing										
ET544	Electronic Instrumentation and Automation										
ET545	Information Theory and Coding										
ET550	Communication Engineering Lab	--	--	2	--	--	--	25	25	50	1
ET560	Electronic Measurement Lab	--	--	2	--	--	--	25	25	50	1
**	**Open Elective**	3	--	--	3	100	25	--	--	125	3
HM009	Ethics and Entrepreneurship	3	--	--	3	100	25	--	--	125	3
	TOTAL	18	2	4	--	600	150	100	50	900	22

L-Lecture T-Tutorial P-Practical O-Oral Th-Theory TW-Term Work IA-Internal Assessment

A candidate is considered to have successfully fulfilled the requirement of a semester, provided he/ she submits to the department a certified journal reporting the experiments conducted during the semester.

*Term Work marks are to be awarded through continuous evaluation

THIRD YEAR ELECTRONICS AND TELECOMMUNICATION ENGINEERING PROGRAM
SCHEME OF INSTRUCTION AND EXAMINATION, REVISED COURSE (2019-2020)

SEMESTER – VI

Course Code	Nomenclature of the Course	Scheme of Instruction Hrs/Week			Scheme of Examination						
		L	T	P#	Duration (Hrs)	Marks					Credits
						Th	IA	TW*	O	Total	
ET610	Control System Engineering	3	1	--	3	100	25	25	--	150	4
ET620	VLSI Technology and Design	3	1	--	3	100	25	25	--	150	4
ET631	Real Time Operating Systems	3	--	--	3	100	25	--	--	125	3
ET632	Radar System Engineering										
ET633	Artificial Neural Networks										
ET634	Nanoelectronics										
ET635	Wireless Sensor Networks										
ET641	Motor Control and Applications	3	--	--	3	100	25	--	--	125	3
ET642	Adaptive Signal Processing										
ET643	Bio-medical Electronics and Instrumentation										
ET644	Mobile Communication										
ET645	Error Control Coding										
ET650	VLSI Lab	--	--	2	--	--	--	25	25	50	1
ET660	Electronic System Design Laboratory	--	--	2	--	--	--	25	25	50	1
**	Open Elective	3	--	--	3	100	25	--	--	125	3
HM006	Cyber Law and IPR	3	--	--	3	100	25	--	--	125	3
	TOTAL	18	2	4	--	600	150	100	50	900	22

L-Lecture T-Tutorial P-Practical O-Oral Th-Theory TW-Term Work IA-Internal Assessment

A candidate is considered to have successfully fulfilled the requirement of a semester, provided he/ she submits to the department a certified journal reporting the experiments conducted during the semester.

*Term Work marks are to be awarded through continuous evaluation

FOURTH YEAR ELECTRONICS AND TELECOMMUNICATION ENGINEERING PROGRAM
SCHEME OF INSTRUCTION AND EXAMINATION, REVISED COURSE (2019-2020)

SEMESTER – VII

<table>
<tr><th rowspan="3">Course Code</th><th rowspan="3">Nomenclature of the Course</th><th colspan="3">Scheme of Instruction Hrs/Week</th><th colspan="7">Scheme of Examination</th></tr>
<tr><th rowspan="2">L</th><th rowspan="2">T</th><th rowspan="2">P#</th><th rowspan="2">Duration (Hrs)</th><th colspan="5">Marks</th><th rowspan="2">Credits</th></tr>
<tr><th>Th</th><th>IA</th><th>TW*</th><th>O</th><th>Total</th></tr>
<tr><td>ET710</td><td>Data Communication</td><td>3</td><td>1</td><td>--</td><td>3</td><td>100</td><td>25</td><td>25</td><td>--</td><td>150</td><td>4</td></tr>
<tr><td>ET721</td><td>Robotics</td><td rowspan="5">3</td><td rowspan="5">--</td><td rowspan="5">--</td><td rowspan="5">3</td><td rowspan="5">100</td><td rowspan="5">25</td><td rowspan="5">--</td><td rowspan="5">--</td><td rowspan="5">125</td><td rowspan="5">3</td></tr>
<tr><td>ET722</td><td>Machine Learning</td></tr>
<tr><td>ET723</td><td>Wavelets and Multirate Signal Processing</td></tr>
<tr><td>ET724</td><td>Consumer Electronics</td></tr>
<tr><td>ET725</td><td>Hardware Description Language</td></tr>
<tr><td>ET730</td><td>Data Communication Lab</td><td>--</td><td>--</td><td>2</td><td>--</td><td>--</td><td>--</td><td>25</td><td>25</td><td>50</td><td>1</td></tr>
<tr><td>**</td><td>Open Elective</td><td>3</td><td>--</td><td>--</td><td>3</td><td>100</td><td>25</td><td>--</td><td>--</td><td>125</td><td>3</td></tr>
<tr><td>ET740</td><td>Internship</td><td>--</td><td>--</td><td>6</td><td>3</td><td>--</td><td>--</td><td>50</td><td>50</td><td>100</td><td>3</td></tr>
<tr><td>ET750</td><td>Project Work - Phase I</td><td>--</td><td>--</td><td>6</td><td>3</td><td>--</td><td>--</td><td>50</td><td>75</td><td>125</td><td>3</td></tr>
<tr><td></td><td>TOTAL</td><td>9</td><td>1</td><td>14</td><td>--</td><td>300</td><td>75</td><td>150</td><td>150</td><td>675</td><td>17</td></tr>
</table>

L-Lecture T-Tutorial P-Practical O-Oral Th-Theory TW-Term Work IA-Internal Assessment

A candidate is considered to have successfully fulfilled the requirement of a semester, provided he/ she submits to the department a certified journal /report reporting the experiments conducted/ work done during the semester.

*Term Work marks are to be awarded through continuous evaluation

SEMESTER – VIII

Course Code	Nomenclature of the Course	Scheme of Instruction Hrs/Week			Scheme of Examination						
		L	T	P#	Duration (Hrs)	Marks					Credits
						Th	IA	TW	O	Total	
ET810	Advanced Communication Engineering	3	--	--	3	100	25	--	--	125	3
ET821	Process Control Instrumentation	3	--	--	3	100	25	--	--	125	3
ET822	RF Design										
ET823	High Performance Computer Architecture										
ET824	Secure Communication										
ET825	System Verification and Validation										
ET830	Elective - NPTEL / MOOC / SWAYAM	3	--	--	--	--	--	50	50	100	3
ET840	Project Work - Phase II	--	--	18	--	--	--	200	200	400	9
	TOTAL	9	0	18	--	200	50	250	250	750	18

L-Lecture T-Tutorial P-Practical O-Oral Th-Theory TW-Term Work IA-Internal Assessment

A candidate is considered to have successfully fulfilled the requirement of a semester, provided he/ she submits to the department a certified project report of the work done during the semester.

*Term Work marks are to be awarded through continuous evaluation

ANNEXURE- B

THIRD YEAR ELECTRONICS AND TELECOMMUNICATION ENGINEERING PROGRAM
SYLLABUS, REVISED COURSE (2019-2020)

SEMESTER – V

<table>
<tr><th colspan="7">ANALOG and DIGITAL COMMUNICATION</th></tr>
<tr><td>Course Code</td><td colspan="2">ET510</td><td>Credits</td><td colspan="3">4</td></tr>
<tr><td rowspan="2">Scheme of Instruction
Hours/ Week</td><td>L</td><td>T</td><td>P</td><td colspan="3">TOTAL</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td colspan="3">40hrs/sem</td></tr>
<tr><td rowspan="2">Scheme of Examination
TOTAL = 150 marks</td><td>IA</td><td>TW</td><td>TM</td><td>P</td><td colspan="2">O</td></tr>
<tr><td>25</td><td>25</td><td>100</td><td>0</td><td colspan="2">0</td></tr>
</table>

Course Objectives:

The course aims to provide the student with:

1. An understanding of fundamental concepts of analog and digital modulation techniques.
2. Knowledge about the sampling process, pulse modulation and multiplexing.
3. An introduction to noise theory and its impact on performance of modulation schemes.
4. An understanding of the functions of a communication transmitter and receiver.
5. An introduction to the underlying theory behind optimum receiver design.

Course Outcomes:

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

CO1	Explain fundamental concepts of analog and digital communication
CO2	Classify and compare different analog and digital modulation schemes.
CO3	Analyze the performance of a communication system in presence of noise and impairments
CO4	Model and design basic sub-systems of a typical analog and digital communication link.

UNIT -1	
An Overview of Electronic Communication Systems: Block Diagram Representation, Analog vs. Digital Communication, Need for Frequency Translation - Modulation and Multiplexing, Types of Transmission Media. **Analog Modulation:** Amplitude Modulation (AM) – Mathematical Representation of AM signal, Modulation Index, Double Side-band Suppressed Carrier (DSB-SC)-Balanced Modulator, Coherent detection, DSB with Carrier (DSB-C)-Envelope Detector, Single Sideband Suppressed Carrier (SSB-SC) Generation: Filter Method, Phase Shift Method, The Third Method, Coherent Detection, Comparison based on Spectrum (Modulation Bandwidth) and Power Efficiency, Concept of Frequency Division Multiplexing. Noise in AM – Calculation of Signal-to-Noise ratio (SNR) for DSB-SC, SSB-SC and AM.	10hrs
UNIT -2	
Angle Modulation: Frequency Modulation (FM) - Mathematical Representation of FM signal, Modulation Index, Tone Modulated FM Signal, FM Spectrum, Bandwidth, Carson's Rule, Narrowband and Wideband FM (Classification). Phase Modulation (PM) – Mathematical Representation, Relationship between FM and PM. Noise in FM – Calculation of SNR, Comparison with AM. **Pulse Modulation:** Sampling – The Low Pass Sampling Theorem, Mathematical Analysis of Instantaneous Sampling. Pulse Amplitude Modulation (PAM) and Concept of Time Division Multiplexing, Pulse Code Modulation: Block Diagram Representation, Quantization of Signals – Derivation of Quantization Error, PCM Encoder and Decoder.	10hrs
UNIT -3	
Digital Modulation: Keying Techniques – Mathematical Representation, Generation and Reception Scheme (Block Level), and Spectrum (Nominal Bandwidth) of: Amplitude Shift Keying (ASK), Binary Phase Shift Keying (BPSK), Differential PSK (DPSK), Offset Quadrature Phase Shift Keying (QPSK), M-ary PSK, Binary Frequency Shift Keying (BFSK), Quadrature Amplitude Shift Keying: 16-QASK.	10hrs
UNIT -4	
Principle and block level representation of Superheterodyne Receiver, Choice of Intermediate Frequency, Image Frequency and its rejection. **Optimum Receiver:** Baseband Signal Receiver (Integrate-and-Dump) –Peak SNR, Probability of Error, Maximum Likelihood Detector and Bayes' Receiver, Optimum Receiver for Baseband and Passband, Calculation of Optimum Filter Transfer Function, Realization using Matched Filter and Correlator.	10 hrs

TEXTBOOKS	
1	Herbert Taub, Donald Schilling, and Goutam Saha, Principles of Communication Systems , Third Edition, Tata McGraw Hill.
2	R.P.Singh and S.D.Sapre,Communication Systems: Analog and Digital , Third Edition, Tata McGraw Hill.

REFERENCES	
1	George Kennedy, Bernard Davis, and S. R. M. Prasanna,Electronic Communication Systems , Fifth Edition, Tata Mcgraw Hill.
2	Simon Haykin,Communication Systems , Fourth Edition, John Wiley & Sons.
3	John Proakis and Masoud Salehi, Fundamentals of Communication Systems , Pearson Education, 2007.

DIGITAL SIGNAL PROCESSING					
Course Code	**ET520**		**Credits**	**4**	
Scheme of Instruction Hours/ Week	**L**	**T**	**P**	**TOTAL**	
	3	**1**	**0**	**40hrs/sem**	
Scheme of Examination TOTAL = 150 marks	**IA**	**TW**	**TM**	**P**	**O**
	25	**25**	**100**	**0**	**0**

Course Objectives:

The course aims to provide the student with:

1. An understanding of sampling, multirate signal processing and its applications.
2. Ability to compute Discrete Fourier Transform and Fast Fourier Transform of a timedomain signal.
3. An understanding of the design techniques for FIR and IIR digital filters.
4. Knowledge of applications of multirate digital signal processing

Course Outcomes:

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

CO1	Explain the need and applications of multirate systems.
CO2	Compute discrete Fourier transform and its inverse transform of a sequence.
CO3	Design finite impulse response (FIR) and infinite impulse response (IIR) discrete-time filters
CO4	Implement digital filters.

UNIT -1	
Sampling of continuous time signals: Periodic sampling, Frequency domain representation ofsampling, Reconstruction of a Band limited Signal from its samples, Discrete-time processing ofContinuous time signals.Changing the sampling rate using discrete time processing - Sample rate reduction by aninteger factor, increasing the sampling rate by an integer factor. **Multirate Signal Processing:** Interchange filtering and down sampling/Up sampling,multistage decimation and interpolation.Polyphase decompositions, Polyphase implementationof decimation filters, Polyphase implementation of interpolation filters. Multirate filter banks.	10 hrs
UNIT -2	
The Discrete Fourier transform: Introduction, Representation of Periodic Sequences: TheFourier transform of periodic signals; sampling the Fourier transform, the Discrete Fouriertransform (DFT), Properties of Discrete Fourier Transform, Linear Convolution and circularconvolution using the DFT. Computation of the Discrete Fourier transform. **Fast Fourier Transform:** Efficient computation of DFT, Decimation-in-time FFT (in-placecomputations), Decimation-in-Frequency FFT (in-place computations)	10hrs
UNIT -3	
Structures for discrete-time systems: Block diagram representation of linear constant-coefficient difference equations, Signal flow graph representation.Basic structures of IIR systems: Direct, cascade, parallel and Transposed Forms.Basic network structures for FIR systems: Direct and Cascade Structures for linear-phase FIRsystems. **IIR Filter design techniques:** Design of Discrete-time IIR filters from continuous-time filters. IIR Filter design by impulse invariant method and bilinear transformation. **Design of IIR Filters:** Butterworth and Chebyshev Type-1 low pass filter design using impulseinvariance and bilinear transformation.	10hrs
UNIT -4	
FIR filters: Magnitude and phase response of digital filters, frequency response of linear phaseFIR filters. **Design techniques for FIR filters:** Frequency Sampling Method, Window techniques(Rectangular, Hanning, Hamming, Blackman and Bartlett). **Applications of Multirate signal processing:** Design of Phase shifters, interfacing of digitalsystems with different sampling rates, Sub band coding of speech signals.	10hrs

TEXTBOOKS	
1	A. V. Oppenheim and R. W. Schafer; Discrete-Time Signal Processing; 3 rd Ed.; Pearson.
2	S. Salivahanan; Digital Signal Processing, 3 rd Ed.; McGraw Hill Education.

REFERENCES	
1	J. G. Proakis and D. G. Manolakis, *"Digital SignalProcessing: Principles,* Algorithms and Applications, 4th Ed., Pearson, 2007.
2	Sanjit K. Mitra; Digital Signal Processing - A computer based approach, 2 nd Ed.; McGraw HillEducation.

EMBEDDED SYSTEMS					
Course Code	**ET531**		**Credits**	**3**	
Scheme of Instruction Hours/ Week	**L**	**T**	**P**	**TOTAL**	
	3	**0**	**0**	**40hrs/sem**	
Scheme of Examination TOTAL = 125 marks	**IA**	**TW**	**TM**	**P**	**O**
	25	**0**	**100**	**0**	**0**

Course Objectives:

The course aims to provide the student with:

1. An understanding of the architecture and operation of typical microcontrollers.
2. An ability to interface external devices with the microcontrollers.
3. An understanding of programming the microcontrollers.
4. An ability to design real world applications using microcontrollers.

Course Outcomes:

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

CO1	Understand the architecture of 8051 and PIC18 microcontroller
CO2	Analyse the instruction set of 8051 and PIC18 microcontroller.
CO3	Interface the microcontroller with the hardware for a given application.
CO4	Create Assembly language programs for 8051 and PIC 18.

UNIT -1	
8051 architecture: Overview of 8051 Family, Data types and directives , Flag bits, PSW register, Register banks and stacks, Addressing modes, Assembly language programming ,JUMP ,LOOP and CALL instructions, Arithmetic instructions, Logic instruction ,Bit instructions , I/O port programming , Bit manipulation instructions.	10 hrs
UNIT -2	
Interrupts and Interfacing: Timer/Counter basics and programming , Serial communication basics and programming , basics of interrupts and programming timer interrupts, external hardware interrupts and serial communication interrupts, Interrupt Priority , Interfacing of LCD,ADC, Stepper motor, Keyboard, DAC and External memory to 8051 .	10hrs
UNIT -3	
PIC 18 Architecture: Block diagram, WREG, PIC File Register, Using Instructions with the default Access bank, PIC Status Register, PIC Data Format and Directives, Introduction to PIC Assembly language Programming, The Program Counter and Program ROM space in the PIC, Harvard and RISC Architecture in the PIC, Branch Instructions and Looping, Call Instructions and Stack.	10hrs
UNIT -4	
Arithmetic, Logic Instructions and Programs, Bank Switching: Addressing Modes, PIC 18 Timer Programming in Assembly: Programming Timers 0,1,2 and 3, PIC18 Interrupts, PortB-Change Interrupt, CCP Programming: Compare Mode Programming, Capture Mode Programming, PWM Programming, SPI Bus Protocol.	10hrs

TEXTBOOKS	
1	Muhammad Ali Mazidi, Janice Gillispie Mazidi; The 8051 Microcontroller and Embedded systems; Pearson Education
2	Muhammad Ali Mazidi, Rolind D. Mckinlay, Danny Causey; PIC Microcontroller and Embedded Systems Using Assembly & C for PIC18; Pearson Education
3	Kenneth J. Ayala; The 8051 Microcontroller, Architecture, Programming & applications, second edition; Penram International.

REFERENCES	
1	Barry B. Brey; Applying PIC18 Microcontrollers: Architecture, Programming, and Interfacing using C and Assembly; Prentice Hall

<table>
<tr><th colspan="6">POWER ELECTRONICS</th></tr>
<tr><td>Course Code</td><td colspan="2">ET532</td><td>Credits</td><td colspan="2">3</td></tr>
<tr><td rowspan="2">Scheme of Instruction
Hours/ Week</td><td>L</td><td>T</td><td>P</td><td colspan="2">TOTAL</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td colspan="2">40hrs/sem</td></tr>
<tr><td rowspan="2">Scheme of Examination
TOTAL = 125 marks</td><td>IA</td><td>TW</td><td>TM</td><td>P</td><td>O</td></tr>
<tr><td>25</td><td>0</td><td>100</td><td>0</td><td>0</td></tr>
</table>

Course Objectives:

The course aims to provide the student with:

1. An introduction to various power semiconductor devices, their characteristicsandoperation.
2. An understanding of Thyristor protection, Thyristor firing circuits andThyristorcommutation techniques.
3. Ability to analyze and explain AC-DC converters, DC-DC converters and their operation.
4.An understanding of inverter types, AC voltage controllers and Cycloconverters.

Course Outcomes:

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

CO1	Explain the construction and characteristics of power semiconductor devices.
CO2	Discuss the thyristor turn on methods, thyristor protection and applications of power electronics. different triggering circuits for Thyristor and their applications.
CO3	Explain and analyze thyristor firing circuits, commutation circuits and connections of SCR.
CO4	Analyze and explain the AC-DC converters, DC-DC converters, inverters, AC voltage controllers and Cycloconverters.

UNIT 1	
Power Semiconductor Devices: Construction and characteristics of Power diodes, Power Transistors, Power MOSFET, Insulated Gate Bipolar transistors (IGBTs).Classification of Power electronic converters. **Introduction to Thyristor family:** Structure, Symbol, V.I. Characteristics of SCR. Two transistor analogy, Thyristor Turn-on methods, switching characteristics of Thyristor during Turn on & Turn OFF, Thyristor Gate characteristics. Mounting of Thyristors Series and parallel operation of Thyristor and equalization circuits. String efficiency problems on series, parallel operation of Thyristors. Other members of Thyristor Family: DIAC, TRIAC, SUS, SCS, RCT & GTO: structure, characteristics, applications. Operation and characteristics of devices used in firing circuits: UJT and PUT.	10hrs
UNIT -2	
Thyristor trigger circuits: R and RC firing circuits (half wave & Full wave), Ramp triggering, Ramp and pedestal trigging. **Thyristor commutations:** Class A, B, C, D, E and F **Thyristor protection:** Over voltage protection, suppression of over voltages, over current protection, di/dt protection, dv/dt protection, Crowbar protection, gate protection, snubber circuit. **AC to DC converters:** Principle of phase control, single phase half-wave Thyristor rectifier with R load, RL load and RLE load. Effect of Free-wheeling diode. Single phase full-wave mid-point & bridge Thyristor converters.	10hrs
UNIT -3	
DC to DC converters (choppers): principle of operation, Step down, step up choppers. Control Schemes: Constant frequency scheme, variable frequency scheme, Current limit control. Operation of Class A, B, C, D, & E Choppers. Problems on basic Choppers **Flyback converters (Switching regulators):** Principles of operation of Step-down (Buck), Step-up (Boost), Step up/down (Buck- Boost) Switch Mode regulators **AC Voltage Controllers:** Types, Single Phase Voltage controllers with R and RL Load.	10 hrs
UNIT -4	
Inverters: Classification, Basic and modified parallel inverters, Basic and modifiedSeries inverters, Single phase voltage source inverters: half bridge & full bridge(mathematical analysis) Three phase inverter for 180° and 120° mode operations. **Cycloconverters:** Principle of cycloconverter operation. Single phase to single phasecycloconverter **Some Applications:** (only block diagrams) Switched mode Power supply, UPS,HVDC transmission.	10 hrs

TEXTBOOKS	
1	P. S. Bhimbra; Power Electronics; Khanna Publications
2	M. D. Singh, K. B. Khanchandani; Power electronics, 2 nd Ed.; TMH
3	V. Jagannathan; Introduction to Power Electronics; Prentice Hall of India

REFERENCES	
1	Mohammed H. Rashid; Power Electronics circuits, Devices & applications; Prentice Hall
2	M. S. Berde; Thysistor Engineering; Khanna Publications
3	P.C. Sen; Power Electronics; McGraw-Hill Education
4	Vedam Subramanyam; Power Electronics –Devices, Converters and Applications, 2nd Ed.; New Age International Publishers Pvt. Ltd

SOFT COMPUTING					
Course Code	ET533		Credits	3	
Scheme of Instruction Hours/ Week	L	T	P	TOTAL	
	3	0	0	40hrs/sem	
Scheme of Examination TOTAL = 125 marks	IA	TW	TM	P	O
	25	0	100	0	0

Course Objectives:

The course aims to provide the student with:

1. An introduction to soft computing techniques and their applications.
2. An introduction to Neural Networks and its training methodologies.
3. An understanding of Fuzzy Logic and Fuzzy Inference Systems.
4. An understanding of Genetic Algorithms and Evolutionary Algorithms.
5. An introduction to Deep Learning and Hybrid Systems.

Course Outcomes:

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

CO1	Explain different types of soft computing techniques and its applications.
CO2	Apply evolutionary algorithms to a given problem.
CO3	Compare different supervised and unsupervised learning rules.
CO4	Design artificial neural networks, fuzzy inference systems to solve real-life

UNIT 1	
Introduction to Soft Computing: Soft Computing versus Hard Computing, Soft-Computing Techniques: Artificial Neural Networks, Fuzzy Systems, Evolutionary Algorithm. **Expert Systems:** Expert System Design. Types of Problems: Classification, Functional Approximations, Optimizations. **Neural Networks:** Mc-Culloch Pitt's neuron model, Activation functions, Basic gates, Neural learning. Training algorithms- Hebbian learning rule, perceptron learning rule, Delta learning rule, Widrow-Hoff learning rule related problems. Error back propagation algorithm or generalized delta rule. Setting of parameter values and design considerations (Initialization of weights, Frequency of weight updates, Choice of learning rate, Momentum, Generalizability, Network size, Sample size, Non-numeric inputs).	10 hrs
UNIT -2	
Fuzzy Logic: Introduction, Classical Set Theory (Crisp Set): Operations & Properties, Fuzzy Set Theory: Operations & Properties, Membership Functions and types, Fuzzy v/s Crisp Sets, Classical relations (Cartesian product) and Fuzzy relations: Cardinality, Operations, Properties and Composition, Tolerance and Equivalence Relations. Crisp Logic vs Fuzzy logic, Fuzzy logic operations: AND, OR, NOT, Implication,Aggregation and Deffuzification, Lambda-cuts or Alpha-cuts for fuzzy, Types of defuzzification. Fuzzy Inference Systems and its design, Fuzzy Process, Type-2 fuzzy sets, Sugeno Fuzzy System.	10hrs
UNIT -3	
Genetic Algorithms: Concept, Solution, Initial Population, Genetic Operators, Fitness Function, Stopping Condition. Fitness Scaling, Selection, Mutation, Crossover, Other Genetic Operators, Algorithm Working, Diversity. **Other Evolutionary Algorithms:** Particle Swarm Optimization, Ant Colony Optimizations, Traveling Salesman Problem.	10 hrs
UNIT -4	
Deep Neural Networks: Introduction & Necessity of deep neural networks (DNN),Example: Auto encoder DNN, Convolutional neural networks: Convolution operation,Motivation and Pooling. **Hybrid Systems:** Sequential, Auxiliary and Embedded Hybrid Systems, Neuro-FuzzyHybrid System: Comparison, Characteristics & Classification, Neuro-Genetic Hybrid:Properties, GA based Back Propagation Network and its advantages, Genetic- Fuzzy andFuzzy-Genetic Hybrid systems: Tuning, Learning, Advantages.	10 hrs

TEXTBOOKS	
1	Rajasekaran, G. A. Vijayalakshmi Pai; Neural Networks, Fuzzy Logic and GenericAlgorithm, PHI Learning Pvt. Ltd.
2	Anupam Shukla, Ritu Tiwari, Rahul Kala; Real Life Applications of Soft Computing;CRC Press
3	S. N. Sivanandan and S. N. Deepa, Principles of Soft Computing, 2 nd Edition, WileyIndia.
4	Kishan Mehrotra, Chilukuri Mohan, Sanjay Ranka; Elements of Artificial Neural Network;Penram Publications.

REFERENCES	
1	J. Zurada; Introduction to Artificial neural network; Jaico Publications.
2	Ian Goodfellow, Yoshua Bengio, Aaron Courville, Deep Learning, MIT Press.
3	Charu C. Aggarwal, Neural Networks and Deep learning, Springer Publications.
4	Timothy J. Ross; Fuzzy Logic with Engineering Applications, 3 rd Ed.; Wiley-India

NUMERICAL METHODS AND APPROXIMATIONS					
Course Code	ET534		Credits	3	
Scheme of Instruction Hours/ Week	L	T	P	TOTAL	
	3	0	0	40hrs/sem	
Scheme of Examination TOTAL = 125marks	IA	TW	TM	P	O
	25	0	100	0	0

Course Objectives: The course aims to provide the student with:

1. An understanding of sources of errors and problems in computation for very large data set.
2. An understanding of different numerical methods used for the solution of engineering problems.
3. An ability to develop algorithm for the numerical methods.
4. An ability to implement a particular method for a realistic engineering problem.

Course Outcomes:

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

CO1	Explain sources and types of errors and approximations and its problems in computation.
CO2	Solve non-linear equations, simultaneous linear algebraic equations, ordinary and partial differential equations using appropriate numerical methods.
CO3	Apply various numerical methods to perform interpolation, numerical differentiation and integration.
CO4	Compute the solutions of engineering problems using appropriate numerical methods.

UNIT 1	
Introduction, Approximation and errors of computation: sources of errors, problems in computations, safeguards against errors, floating point arithmetic, absolute error, relative error, percentage error-calculations, Taylor's series, Newton's finite differences (forward, backward, central and divided differences) Difference, shift, differential operators. **Solutions of Algebraic & Transcendental Equations:** Introduction, Bisection method, Newton Raphson method, Regula Falsi method, Secant method, fixed point iteration method, Rate of convergence and comparisons of these methods.	10 hrs
UNIT -2	
Solution of system of linear algebraic equations: Direct Methods,Gauss elimination method with pivoting strategies, Gauss Jordan method, LU Factorization. Iterative methods (Jacobi, Gauss Seidal method), Eigen value and Eigen vector using Power method. **Interpolation:** Newton's Interpolation(forward, backward), Central difference interpolation: Stirling's Formula, Bessel's formula, Interpolation with unequal intervals, Lagrange's interpolation, Least square method of fitting linear and non-linear curve for discrete data and continuous function, Spline interpolation(cubic spline).	10hrs
UNIT -3	
Numerical Differentiation and Integration: Numerical differentiation formulae, Numerical Integration, Newton-Cote general Quadrature formula, Trapezoidal, Simpson's 1/3, 3/8 rule, Romberg's method, Gaussian integration (Gaussian- Legendre Formula 2 point and 3 point) **Numerical Solution of ordinary differential equations:** Picard's method ,Taylor series method, Euler's and modified Euler's method, Runge Kutta methods for 1^{st} and 2^{nd} order ordinary differential equations, solution of boundary value problem by finite difference method and shooting method	10 hrs
UNIT -4	
Numerical solution of partial differential equation: Classification of partial differential equation (Elliptic, parabolic and Hyperbolic), Solution of Laplace equation (standard five point formula with iterative method), Solution of Poisson equation (finite difference approximation), Solution of Elliptic equation by Relaxation method. **Data Approximation of Function:** Weierstrass theorem, Types of Norm, Types of approximation, Use of orthogonal functions, Gram-Schmitt orthogonalizing process, Legendre & Chebyshev polynomials, Uniform approximation.	10 hrs

TEXTBOOKS	
1	E. Balaguruswamy,Numerical Methods – TMH. ,1st Edition, 2012
2	Dr. B. S. Grewal, Numerical methods in Engineering & Science - Khanna Publication, 9th Edition, 2012
3	Dr. Sudhir K. Pundir, Numerical Methods in Science and Engineering -CBS Publishers & Distributors Pvt. Ltd., 1st Edition, 2017

REFERENCES	
1	S. S. Sastry; Introduction methods of numerical analysis; PHI
2	Robert J. Schilling, Sandra I. Harries; Applied Numerical Methods for Engineers using MATLAB and C, 3rd Edition; Thomson Brooks
3	John H. Mathews, Kurtis Fink; Numerical Methods Using MATLAB, 3rd Edition; Prentice Hall publication

<table>
<tr><th colspan="6">SOLID STATE DEVICES AND TECHNOLOGY</th></tr>
<tr><td>Course Code</td><td colspan="2">ET535</td><td>Credits</td><td colspan="2">3</td></tr>
<tr><td rowspan="2">Scheme of Instruction
Hours/ Week</td><td>L</td><td>T</td><td>P</td><td colspan="2">TOTAL</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td colspan="2">40hrs/sem</td></tr>
<tr><td rowspan="2">Scheme of Examination
TOTAL = 150 marks</td><td>IA</td><td>TW</td><td>TM</td><td>P</td><td>O</td></tr>
<tr><td>25</td><td>0</td><td>100</td><td>0</td><td>0</td></tr>
</table>

Course Objectives:

The course aims to provide the student with:

1. An understanding ofthe physical concepts underlying the operation of semiconductor devices so as to be able to analyze carrier flow associated with PN junction due to drift, diffusion, generation, and recombination and to draw and interpret energy band diagrams.

2. An understanding of the behavior of BJT including device physics, device operation, and device characteristics and how device design affects performance

3. An understanding of the behavior of Metal oxide semiconductor field effect transistor including device physics, device operation, modelling and device characteristics.

4. A sound understanding of current semiconductor devices and technology to appreciate its applications to Nano-electronics and microminiaturization.

Course Outcomes:

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

CO1	Understand the key concepts involved in semiconductor device operation and their characteristics.
CO2	Apply the effect of device design variations on device performance.
CO3	Develop analytical approaches to understanding semiconductor devices
CO4	Evaluate and demonstrate an understanding of the technologies used in solid state devices and the impact of these technologies on device design and performance

UNIT 1	
Introduction to Quantum Mechanics (Schrodinger's wave equation and it's application) and Statistical Mechanics (The Fermi-Dirac and Maxwell-Boltzmann probability distribution function) p-n junction: Energy Band Diagram; zero bias analysis, Forward and Reverse Bias; Linearly graded junction; Abrupt pn junction; Transient Response of P-n junction; Forward bias Diode current (minority and majority carrier current); Generation and recombination current ; Small signal model of the pn junction; Hetero p-n junction, Hetero junction diode current; Reverse bias Diode breakdown.	10 hrs
UNIT -2	
Bipolar junction transistors:Principle of Operation; Minority Carrier Profiles in a Bipolar Junction Transistor; Current Components and Current Gain; Bias modes and operation of bipolar transistor; Non-ideal effects; Base width modulation; High injection effects; emitter band-gap narrowing and emitter current crowding; Breakdown mechanisms in BJTs; BJT small signal equivalent circuit model- Ebers-Moll Model; MOS Capacitors: Surface Charge in Metal Oxide Semiconductor Capacitors; Capacitance-Voltage Characteristics of a MIS Structure; Low frequency capacitance; High frequency capacitance .	10hrs
UNIT -3	
Metal Oxide Semiconductor Field Effect Transistors (MOSFETs): Gradual Channel Approximation and Constant Mobility Model; Charge sheet approximation; Threshold Voltage; Onset of Pinch-off and Current Saturation; Sub-Threshold Characteristics; Substrate Bias Effects; Temperature effects; Effective Mobility concept in MOSFETs; Short Channel MOSFETs: Charge Sharing Model; Drain induced Barrier lowering (DIBL); Velocity Saturation, Channel length modulation and narrow channel effect. MOSFET Scaling; Constant field scaling; Generalized scaling, Constant voltage scaling; Channel Dopant Engineering; Series Resistance in scaled MOSFETs; Effective Channel Length.	10 hrs
UNIT -4	
Solid state devices: junction diode, zener diode, tunnel diode, Schottky diode, switching diode, UJT, SCR, JFET – characteristics, parameters, equipment circuits and application circuits. Introduction to Nano-electronics: Technological processes for microminiaturization; Methods and limits of microminiaturization in silicon.	10 hrs

TEXTBOOKS	
1	B. Streetman and S. K. Banerjee,Solid-State Electronic Devices, 7th edition Pearson, 2014
2	Jacob Millman, Christos C Halkias and Satyabrata Jit,Electronic Devices & Circuits, 4 edition (2015),McGraw Hill Education.
3	Donald A. Neaman, Semiconductor Physics and Devices, 4thedition, Tata McGraw-Hill) 2012.
4	K. Goser, P. Glosekotter and J. Dienstuhl , Nanoelectronics and Nanosystems, Springer International Edition, 2004.

REFERENCES	
1	Yuan Taur and Tak H. Ning, Fundamentals of Modern VLSI Devices, 2nd Edition, Cambridge University Press , 2018.
2	J B Gupta, Electronic Devices and Circuits, 6th Edition, Katson Publication, 2013.
3	M. Ratner and D. Tatner,Nanotechnology , Pearson Education, 2003.
4	R. Booker, E. Boysen, Nanotechnology , Wiley-dreamtech Pvt. Ltd, 2006

MICROWAVE ENGINEERING					
Course Code	ET541		Credits	3	
Scheme of Instruction Hours/ Week	L	T	P	TOTAL	
	3	0	0	40hrs/sem	
Scheme of Examination TOTAL = 150 marks	IA	TW	TM	P	O
	25	0	100	0	0

Course Objectives:

The course aims to provide the student with:

1. An understanding of the concepts of Microwave Network parameters, passive and activemicrowave devices, microwave amplifiers and oscillators and microwavemeasurement
2. An ability to apply the concepts of semiconductor physics to microwave devices,amplifiers, oscillators and measurements
3. An ability to analyze the working of microwave networks, devices, sources andmeasurements
4. An ability to evaluate the microwave network parameters, microwave passive devices,microwave sources and microwave parameters

Course Outcomes:

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

CO1	Explain the Microwave Network parameters, passive and active microwave devices,microwave amplifiers and oscillators and microwave measurement
CO2	Apply the concepts of semiconductor physics to microwave devices, amplifiers,oscillators and measurements.
CO3	Analyze the working of microwave networks, devices, sources and measurements.
CO4	Evaluate the microwave network parameters, microwave passive devices,microwave sources and microwave parameters.

UNIT 1	
Two Port Network Theory: Introduction, Microwave Spectrum and Bands, Applications of Microwaves. Review of Low frequency parameters: Impedance, Admittance, Hybrid and ABCD parameters, Different types of interconnection of Two port networks, High Frequency parameters, Formulation of S parameters, Properties of S parameters, Reciprocal and lossless Network. **Waveguides:** General solutions for TEM, TE and TM Waves, Rectangular waveguides- modes of propagation. Introduction to stripline and micro stripline-Construction and Field configurations	10hrs
UNIT -2	
Passive and Active Microwave Devices: Terminations, Attenuators, Phase shifters, Directional couplers, Hybrid Junctions, Circulator, Isolator, Power dividers-E plane, H plane, Magic Tee, Wilkinson, quadrature Hybrid-	10hrs

Construction and S parameter, **Construction, working and applications**-FET-MESFET, MOSFFET and HEMT, PIN diode, Gunn diode (two valley model), IMPATT diode, Varactor diode.	
UNIT -3	
Microwave Generation: Limitations and Losses of conventional tubes at microwave frequencies. Microwave tubes – O type and M type classifications. O-type tubes, Construction, Operation and applications of Two cavity Klystron Amplifier-transit time, Reflex Klystron oscillator, Traveling wave tube amplifier-Slow wave structures, Magnetron- pi mode operation, strapping.	10 hrs
UNIT -4	
Microwave Measurements: Low Frequency versus Microwave measurements,Measurement of power- low, medium and High, Measurement of Frequency, Phase shift,VSWR-low and High, Impedance, Noise factor, Q-factor Vector Network analyzer-Architecture	10 hrs

TEXTBOOKS	
1	D. M. Pozar; Microwave Engineering, 3rd Ed.; John Wiley & Sons Inc
2	S. M. Liao; Microwave devices and Circuits, 3rd Ed.; Prentice Hall of India

REFERENCES	
1	M. Kulkarni,Microwave and Radar Engineering, Umesh publications
2	Ananjan Basu, An Introduction to Microwave Measurements; CRC Press

<table>
<tr><th colspan="6">ELECTROMAGNETIC COMPATIBILITY ENGINEERING</th></tr>
<tr><td>Course Code</td><td colspan="2">ET542</td><td>Credits</td><td colspan="2">3</td></tr>
<tr><td rowspan="2">Scheme of Instruction Hours/ Week</td><td>L</td><td>T</td><td>P</td><td colspan="2">TOTAL</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td colspan="2">40hrs/sem</td></tr>
<tr><td rowspan="2">Scheme of Examination TOTAL = 150 marks</td><td>IA</td><td>TW</td><td>TM</td><td>P</td><td>O</td></tr>
<tr><td>25</td><td>0</td><td>100</td><td>0</td><td>0</td></tr>
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Course Objectives:

The course aims to provide the student with:

1. An understanding of basics of electromagnetic interference and electromagneticcompatibility.
2. An understanding of methods of grounding and cabling.
3. An understanding of types and effects of noise on circuits.
4. An understanding of EMI/EMC standards.

Course Outcomes:

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

CO1	Explain electromagnetic interference and electromagnetic compatibility.
CO2	Analyze the methods of grounding, cabling, shielding, balancing and filtering.
CO3	Explain the types and effects of noise.
CO4	Analyze the Standards and Laboratory Techniques for EMI EMC.

UNIT 1	
Introduction to EMI/EMC: Sources of EMI, Conducted and radiated interference, designing for electromagnetic compatibility (EMC). United States' EMC Regulations, European Union's EMC Requirements, Military Standards, typical noise path, use of network theory, methods of eliminating interferences.	10 hrs
UNIT -2	
Cabling: Method of hardening Cabling, capacitive coupling, inductive coupling-shielding to prevent magnetic radiation, shield transfer impedance. **Grounding:** safety grounds, signal grounds, single point and multipoint ground systems, hybrid grounds, ground loops, guard shields. **Balancing and filtering:** Balancing, filtering, Power supply decoupling. **Shielding:** near and far fields, shielding effectiveness, absorption and reflection loss, Shielding with magnetic materials, conductive gaskets, windows and coatings, grounding of shields.	10hrs
UNIT -3	
Intrinsic Noise Sources: Thermal Noise, Shot Noise, Contact Noise, Popcorn Noise, **Active Device Noise:** Noise Factor, Measurement of Noise Factor. **Digital circuit Grounding:** Frequency versus time domain, analog versus digital circuits, digital logic noise, internal noise sources, digital circuit ground noise.	10 hrs
UNIT -4	
Electrostatic discharge: Static Generation, human body model, static discharges, ESDprotection in equipment design, ESD grounding. ESD versus EMC, **Standards and Laboratory Techniques:** Industrial and Government standards, FCCrequirements, CISPR recommendations, Laboratory techniques- Measurement methods forfield strength-EMI.	10 hrs

TEXTBOOKS	
1	Henry W. Ott, "Noise reduction techniques in electronic systems", John Wiley & Sons, 1989.
2	V. Prasad Kodali, "Engineering Electromagnetic Compatibility - Principles, Measurements and Technologies", IEEE Press.

REFERENCES	
1	Bernhard Keiser, “Principles of Electro-magnetic Compatibility”, Artech House, Inc. (685 Canton street, Norwood, MA 020062 USA) 1987.
2	Clayton R. Paul, “Introduction to Electromagnetic Compatibility”, John Wiley & Sons , Second Edition, 2006.
3	L. W. Ricketts, J. E. Bridges, J. Miletta, “EMP Radiation and Protective techniques”, John Wiley and sons, 1976.

DIGITAL IMAGE PROCESSING					
Course Code	**ET543**		**Credits**	**3**	
Scheme of Instruction Hours/ Week	**L**	**T**	**P**	**TOTAL**	
	3	**0**	**0**	**40hrs/sem**	
Scheme of Examination TOTAL = 150 marks	**IA**	**TW**	**TM**	**P**	**O**
	25	**0**	**100**	**0**	**0**

Course Objectives:

The course aims to provide the student with:

1. An understanding of basics of visual perception, effects of imagesampling and quantization
2. An ability to apply relevant filters for enhancing images
3. An understanding of image degradation and restoration process
4. An ability to apply various morphological operations on the imagesfor the high level applications and compression techniques on images
5. An ability to apply the various edge detection algorithms to segmentimage into different regions

Course Outcomes:

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

CO1	Explain general terminology of digital image processing and its applications.
CO2	Apply image enhancement algorithms in practical applications and have the ability to design system using it.
CO3	Apply restoration and compression techniques
CO4	Design and implement algorithms for advanced image analysis using morphological, segmentation and representation techniques

UNIT 1	
Introduction to image processing: Example of fields that uses image processing, Steps of image processing, Components, Applications, Image sensors and image formats, Brightness adaptation and discrimination, Image sampling and quantization, Zooming, Shrinking, Basic relationships between pixels **Spatial Domain Enhancement:**Introduction, Some basic intensity transformation functions (thresholding, Contrast stretching, Gray level slicing, Log, Power-law,Negation, Bit plane slicing), Histogram equalization, matching, stretching, Enhancement using arithmetic and logical operations **Spatial filtering:**Fundamentals of spatial filtering, Smoothing and Sharpening spatial filters, Point, Line, and Edge detection	10hrs
UNIT -2	
Enhancement in Frequency domain: Introduction, 2-D Discrete Fourier Transform, Properties of Fourier transform, Basic filtering in the frequency domain, Smoothing and Sharpening filters, Homomorphic filtering **Different Image Transforms:**Discrete cosine transform (DCT), HADAMARD, WALSH, KL (PCT), transform, DWT **Colour image processing:**Colour fundamentals, Colour models (RGB, CMYK, HSI)	10hrs
UNIT -3	
Image Restoration: Image degradation Model, Image restoration Techniques, Noise models, Mean Filters, Order Statistics, Adaptive filters, Inverse Filtering, Wiener filtering **Image Compression:** Fundamentals, Image Compression Models, Error free compression (VLC, LZW, Bit-Plane, Lossless Predictive Coding), Lossy compression techniques (Lossy predictive coding, IGS and Vector quantization, Transform coding)	10 hrs
UNIT -4	
Morphological Image Processing: Introduction, Erosion and Dilation, Opening and Closing, The Hit-or-Miss transformation, Gray scale morphology. **Segmentation:** Fundamentals, Edge linking and Boundary detection (Local and GlobalProcessing via Hough transform) and Thresholding, Region basedsegmentation **Representation and Description:** Representation (chain codes) , Boundary	10 hrs

Descriptors (Shape number,Fourier Descriptor)	

TEXTBOOKS	
1	Rafael C. Gonzalez, Richard E. Woods, “Digital Image Processing”,Pearson, Fourth Edition, 2017
2	Anil K. Jain, “Fundamentals of Digital Image Processing”, PearsonEducation India; First edition (2015)

REFERENCES	
1	Rafael C. Gonzalez, Richard E. Woods, Steven Eddins, “Digital Image Processing using MATLAB”, McGraw Hill Education; 2 edition , 2017
2	William K. Pratt, “Digital Image Processing”, John Wiley, New York,2002
3	Milan Sonka et al, “Image processing, analysis and machine vision”,Brookes/Cole, Vikas Publishing House, 2nd edition, 1999
4	S. Jayaraman, S. Esakkirajan and T. Veerakumar, “Digital ImageProcessing”, TataMcGraw Hill Education (India) Private Ltd. Eleventhreprint 2013
5	S. Sridhar, “Digital Image Processing”, Oxford University Press India (2011)

ELECTRONIC INSTRUMENTATION AND AUTOMATION					
Course Code	**ET544**		**Credits**	**3**	
Scheme of Instruction Hours/ Week	**L**	**T**	**P**	**TOTAL**	
	3	**0**	**0**	**40hrs/sem**	
Scheme of Examination TOTAL = 150 marks	**IA**	**TW**	**TM**	**P**	**O**
	25	**0**	**100**	**0**	**0**

Course Objectives:

The course aims to provide the student with:

1. An understanding of the principle and working of digital voltmeters,oscilloscopes, SCADA systems, Data Loggers.
2. An introduction to Virtual Instruments and Real time data acquisition systems.
3. An understanding of the different types of transducers .
4. An introduction to the automation systems using the programmable logiccontrollers.

Course Outcomes:

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

CO1	Explain the principle and working of the digital voltmeters, oscilloscopes, SCADA systems, Data Loggers, transducers and PLC.
CO2	Construct PLC ladder diagrams and Virtual Instruments and Real time data acquisition system using appropriate hardware and software
CO3	Analyze the different types of transducers, voltmeters, oscilloscopes and PLC logics for a given application.
CO4	Design and simulate various industrial control applications using the programmable logic controllers.

UNIT 1	
Electronic Voltmeter: Non-integrating type: Ramp type, Staircase Ramp, Continuous balance. Integrating type: Potentiometer Integrating, Dual Slope Integrating Voltmeter. **Block diagram of Digital multimeter**, Sensitivity & Resolution of a DMM. **Oscilloscope:** Cathode ray tube, block diagram, delay lines , Time base circuits, CRT control circuits, Dual beam and Dual trace CRO, CRO probes: Active & Passive probes, Compensation for probes. Digital storage oscilloscope. **Virtual Instrumentation:** Block diagram of Virtual Instrumentation ,Advantages **LabVIEW**: Introduction to the terms :Front Panel, Block diagram, VI, sub VI, Functions ,Tools and Control Palettes	10hrs
UNIT -2	
Factors in selecting a transducer, Classification of transducers, Temperature Measurement Transducers: Resistance Temperature Detectors, Thermistors, Thermocouples. Pressure Transducers: Potentiometric, Capacitive, Inductive, Piezoelectric , Strain Gauge, Linear Variable Differential Transformer Optical transducers: Photo resistor, Photodiode, Phototransistor. Flow measurement transducers: Turbo magnetic Flow meter, Electromagnetic Flow meter. Data Acquisition systems (DAS):Basic block diagram of DAS, Objective of DAS SCADA systems: Introduction and brief history of SCADA, modern SCADA systems ,SCADA software, Remote terminal units Data Logger: Advantages of data loggers, Block diagram of a data logger, Types of data loggers, factors to be considered in selecting a data logger	10hrs
UNIT -3	
Programmable Logic Controllers (PLC): PLC Advantages & Disadvantages, Overall PLC System, CPU & Programmable Monitors, PLC input & Output Modules (Interfaces). General PLC Programming Procedure: Proper Construction of PLC Ladder diagrams, Process Scanning considerations. Selecting a PLC: Factors to be considered while selecting a PLC. Basic PLC Programming: Programming ON-OFF inputs to produce ON-OFF outputs, Concepts of latching, interlocking, jogging outputs via ladder programming.	10 hrs
UNIT -4	
PLC Timer Functions: PLC timer functions, Examples of timers and Industrial process timing applications. PLC Counter functions: PLC Counters, Examples of Counter Functions, Industrial applications PLC data handling instructions: Move, Conditional Jump, Call Subroutine instructions.	10 hrs

TEXTBOOKS	
1	H. S. Kalsi; Electronic Instrumentation; Tata McGraw Hill.
2	Robert H. Bishop; Learning with LABVIEW 7 Express; Pearson Education.
3	John Webb, Ronal Weiss; Programmable Logic Controllers: Principles & Applications, 5th Edition; Prentice Hall of India.
4	Clarke, G., Reynders, D., Wright, E.; Practical Modern SCADA Protocols DNP3, 60870.5 and Related Systems, 1st Edition, Newnes , An imprint of Elsevier

REFERENCES	
1	A.K.Sawhney , Electrical and Electronic Measurements and Instrumentation, Dhanpat Rai & Co.

INFORMATION THEORY AND CODING					
Course Code	**ET545**		**Credits**	**3**	
Scheme of Instruction Hours/ Week	**L**	**T**	**P**	**TOTAL**	
	3	**0**	**0**	**40hrs/sem**	
Scheme of Examination TOTAL = 150 marks	**IA**	**TW**	**TM**	**P**	**O**
	25	**0**	**100**	**0**	**0**

Course Objectives:

The course aims to provide the student with:

1. An understanding of information theoretic behavior of a communication system.
2. A perspective of problems associated with channel capacity of the different typesof the communication channels**.**
3. An ability to calculate the efficiency of the source using the various source codingtechniques.
4. An understanding of various channel coding techniques.

Course Outcomes:

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

CO1	**Understand information, mutual information, channel capacity, source and channel coding, and comparison of error rates.**
CO2	**Apply concepts of information theory, probability to source coding; and concepts of linear algebra to block codes.**
CO3	Analyze binary sources, communication channels, types of coding techniques
CO4	**Evaluate channel capacity, and various coding/decoding schemes.**

UNIT 1	
Information Theory: Information content, unit of information, entropy, entropy of a binary source, rate of information, joint entropy and conditional entropy. **Mutual Information and Channel Capacity:** Noise free channel, channel with independent input and output, symmetric channel, binary symmetric channel (BSC), binary erasure channel (BEC), cascaded channels, repetition of signals, extension of the zero memory sources. **Sources with Finite Memory:** Markov sources, extension of binary channels.	10 hrs
UNIT -2	
Shannon's theorem, Capacity of a Gaussian Channel: Shannon - Hartley theorem, bandwidth–S/N tradeoff, Shannon limit. **Source Coding:** Coding efficiency, Shannon's first fundamental theorem, Lossless coding algorithm, Kraft's inequality. Variable length source coding: Shannon–Fano coding, Huffman coding, (d-ary compact codes), Lempel-Ziv (LZ) coding,Lossy data compression: Rate distortion theory	10hrs
UNIT -3	
Error Control Coding: Types of codes, error probability with repetition in the binary symmetric channel, parity check bit for error detection, Hamming distance. Linear block codes, syndrome and error detection, standard array and syndrome decoding for error correction, probability of undetected error for linear block codes. Single parity check bit code, repeated codes, Hadamard code, Hamming codes, Reed-Muller codes, dual codes. **Cyclic Codes:** Algebraic structure of cyclic codes, binary cyclic code properties, encoding in systematic form, circuit for dividing polynomials, systematic encoding with an (n−k) stage shift register, error detection with an (n−k) stage shift register, Golay code, BCH codes.	10 hrs
UNIT -4	
Burst Error Correction: Block interleaving, convolutional interleaving,Reed-Solomon (RS) code, concatenated codes. **Convolutional Coding:** Code generation, generator matrix, code tree, stateand trellis diagrams for convolutional codes, types of convolutional codes,their realizations, catastrophic encoders. **Decoding Convolutional Codes:** using a code tree, decoding in the presence ofnoise, sequential decoding, the Viterbi algorithm. Comparison of error rates in coded and uncoded transmission, introductionto Turbo codes, Turbo decoding, automatic repeat request (ARQ),performance of ARQ systems.	10 hrs

TEXTBOOKS	
1	Herbert Taub, Donald Schilling, Goutam Saha; Principles of Communication Systems; 4 th Ed.; Tata-McGraw Hill.
2	Ranjan Bose; Information Theory, Coding & Cryptography, 2nd edition; Tata-McGraw Hill, 2008.
3	Salvatore Gravano; Introduction to Error Control Codes, 1 st Ed., Oxford University Press, 2001

REFERENCES	
1	R. P. Singh, S. Sapre; Communication systems: Analog and Digital, 3 rd ed.; Tata-McGraw Hill.
2	J. Das, S. K. Mullick, P. K. Chatterjee; Principles of Digital Communication; John Wiley, 1986.
3	Bernard Sklar; Digital Communications : Fundamental & Applications, 2nd Edition; Pearson Education, 2009.

COMMUNICATION ENGINEERING LAB					
Course Code	ET550		Credits	1	
Scheme of Instruction	L	T	P	TOTAL	
Hours/ Week	0	0	2	30 hrs/sem	
Scheme of Examination	IA	TW	TM	P	O
TOTAL = 150 marks	0	25	0	0	25

Course Objectives:

The course aims to provide the student with:

1.Hands-on experience to design and conduct experiments to analyze the characteristics of various communication systems.

Course Outcomes:

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

CO1	Classify and compare various modulation schemes based on time and frequency domain observations.
CO2	Apply the theory of modulation and demodulation to generate and detect signals.
CO3	Design experiments to verify theoretical concepts in analog and digital communications.
CO4	Interpret experimental observations based on individual and team work to reinforce the fundamental theory of analog and digital communications.

A minimum of 10 experiments to be conducted from the following list of titles:

1. Amplitude Modulation & Demodulation.
2. Frequency Modulation & Demodulation.
3. Sampling and Reconstruction.
4. Pulse Amplitude Modulation.
5. Pulse Code Modulation.
6. Binary Phase Shift Keying.
7. Binary Frequency Shift Keying.
8. Quadrature Phase Shift Keying.
9. Quadrature Amplitude Modulation.
10. Time Division Multiplexing.
11. Frequency Division Multiplexing.
12. Noise in Analog Communication.
13. Noise in Digital Communication.
14. Line Encoding.
15. Pre-emphasis & De-emphasis.

ELECTRONIC MEASUREMENT LAB					
Course Code	**ET550**		**Credits**	**1**	
Scheme of Instruction Hours/ Week	**L**	**T**	**P**	**TOTAL**	
	0	**0**	**2**	**30 hrs/sem**	
Scheme of Examination TOTAL = 150 marks	**IA**	**TW**	**TM**	**P**	**O**
	0	**25**	**0**	**0**	**25**

Course Objectives:

The course aims to provide the student with:

1. An understanding of the working of the digital multimeter trainer and the CROtrainer .
2. An ability to determine the characteristics of the different types of the transducers.
3. An ability to construct the virtual instruments using the LABVIEW .
4. An ability to develop PLC ladder diagrams for industrial control mechanisms.

Course Outcomes:

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

CO1	Demonstrate the working of the digital multimeter trainer and the CRO trainer.
CO2	Determine the characteristics of the different types of the transducers.
CO3	Construct virtual instruments using LABVIEW .
CO4	Develop PLC ladder diagrams for industrial control mechanisms.

A minimum of 10 experiments to be conducted from the following list of titles:

1. Fault simulation using CRO trainer
2. Virtual Instruments using LABVIEW
3. Displacement Transducers
4. Pressure Transducers
5. Flow Transducers
6. Temperature Transducers
7. Optical transducers
8. Linear variable differential transducers
9. Data Acquisition using LABVIEW
10. Ladder program to implement latching, jogging
11. Ladder program to implement Interlocking
12. Ladder program to implement timing applications
13. Ladder program to implement counting applications

ETHICS AND ENTREPRENEURSHIP					
Course Code	HM009		Credits	3	
Scheme of Instruction	L	T	P	TOTAL	
Hours/ Week	3	0	0	40hrs/sem	
Scheme of Examination	IA	TW	TM	P	O
TOTAL = 75 marks	25	0	100	0	0

Course Objectives:

The course aims to provide the student with:

1. Acquaint to standard concepts of ethics that they will find useful in their professional life.

2.An understanding of the various concepts in Ethics.

3.Familiarization to the basic principles of entrepreneurship.

4.Acquaint to standard concepts of entrepreneurship that they will find useful in their profession or during the process of starting their own enterprise.

Course Outcomes:

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

CO1	Appreciate and assimilate ethics and interpersonal behaviour. Also to understand the use of ethical theories.
CO2	Understand code of ethics in various fields, safety responsibility and rights as an engineer.
CO3	Understand the concept of entrepreneurship and demonstrate the skills for project identification, development and implementation.
CO4	Understand the basics of financing a project. From the options of choosing the project and source of finance, to finding ways of sustaining the project.

UNIT -1	
What is Ethics? Ethics and Rights, Ethics and Responsibility, Why Study Ethics, Attributes of an ethical personality, Case Study Work Ethics, Integrity, Honesty Engineering Ethics – History, Engineering Ethics Professional Roles to be played by an engineer, Functions of an Engineer, Self-Interest, Customs and Religion, Profession al Ethics, Types of Inquiry, Engineering and Ethics, Kohlberg's Theory Theories of Ethics – Moral issues, Moral dilemmas, Theories, Uses of Ethical Theories, Factors influencing Ethical Behaviour	10hrs
UNIT -2	
Code of Ethics Safety Responsibility and Rights: Responsibility of Engineers, Risk-Benefit Analysis, Ethical issues in Cost-benefit Analysis, Ethics and Risk Management, Reducing Risk., Conflict of Interest, Occupational Crime, Intellectual property Environmental Ethics – Introduction, Affecting Environment, Engineers as Managers, Role of Engineers, IEEE code of Ethics Rights of Engineers –Professional Rights, Employees Rights Whistle –blowing	10hrs
UNIT -3	
Definition and clarification of concept of entrepreneurship: Qualities and skills required for entrepreneurship, Functions of an entrepreneur, Importance of entrepreneur in economic development. Theories of Entrepreneurship: Economic theory, Sociological theory, Psychological theory. Types of entrepreneurs: Based on type of business, Based on use of technology, Based on motivation, Based on stages of development, Based on motive, Based on capital ownership, Danhof's classification. Project identification: External environment analysis, Meaning and characteristics of a project, Classification of projects, Project life-cycle, Sources and screening of project ideas.	10hrs

Project formulation: Meaning and significance, Feasibility analysis, Techno-economic analysis, Input analysis, Financial analysis, Social cost benefit analysis. Project feasibility. Pre-feasibility study: Project feasibility report - Meaning, Importance and Contents.	
UNIT -4	
Project financing and institutional finance: Classification of capital – Fixed capital -Meaning, Factors governing fixed capital requirements, Working capital – Meaning and concepts, Types, Factors determining working capital requirements. Sources of finance – Share capital, Debenture capital, Lease finance and term loans from commercial banks. Financial aspects: Break even analysis, Income statement, Balance sheet, Fund flow statement, Ratio analysis – Liquidity, leverage and profitability ratios. Capital budgeting – Need, Importance, Process, methods of project evaluation: Payback period, Net Present Value Index.	10 hrs

TEXTBOOKS	
1	A. Alavudeen, R. Kalil Rahman, M. Jayakumaran; Professional Ethics andHuman Values, Firewall Media, 2008.
2	Jayshree Suresh, B. Raghavan; Professional Ethics: Values and Ethics of Profession, S. Chand Co. Ltd (2005)
3	C.B.Gupta and N.P.Srinivasan ; Entrepreneurship; Sultan Chand and Sons,4/e, 1997
4	Prassanna Chandra; Fundamentals of Financial Management; Tata McGraw Hill 3/e.; 2001.

REFERENCES	
1	Charles B. Fleddermann; Engineering Ethics,Pearson; 4 edition (August 2011)
2	C.B. Gupta and S.S. Khanka; Entrepreneurship and Small Business Management; Sultan Chand and Sons; 1997,2/e.
4	Richard M. Lynch, Robert W. Williamson; Accounting for Management, Planning and Control; Third Edition, Tata McGraw-Hill, New Delhi.

SEMESTER – VI

CONTROL SYSTEM ENGINEERING					
Course Code	**ET610**		**Credits**	**4**	
Scheme of Instruction Hours/ Week	**L**	**T**	**P**	**TOTAL**	
	3	**1**	**0**	**40hrs/sem**	
Scheme of Examination TOTAL = 150 marks	**IA**	**TW**	**TM**	**P**	**O**
	25	**25**	**100**	**0**	**0**

Course Objectives:

The course aims to provide the student with:

1. An understanding of basic control system components, signal flow graphs and transfer functions.
2. An ability to evaluate stability of any given system model
3. An ability to perform frequency domain stability analysis.
4. An ability to design compensators and controllers for a given application

Course Outcomes:

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

CO1	Explain the types and applications of control systems and approaches towards their time , frequency,stability analysis and design.
CO2	Apply mathematical modeling and stability analysis techniques to mechanical and electrical systems.
CO3	Analyse performance and stability of mechanical and electrical systems using time and frequency domaintechniques.
CO4	Design compensators and controllers for mechanical and electrical systems.

UNIT -1	
Introduction to control systems: Types of control systems, Examples of Control systems,basic concept of open-loop and closed-loop control systems; Mathematical modeling and representation of mechanical (translational & rotational) and electrical systems. Conversion ofmechanical to analogous electrical systems (force-voltage and force- current analogy); Blockdiagrams; Signal flow graphs and transfer functions.	10hrs
UNIT -2	
Standard Test Inputs, Transient response of first and second order systems; Type -0, -1 and –2 control systems. Steady state error and error co-efficient; Effects of proportional, derivative and integral systems. Stability: Stability concept, Routh-Hurwitz criteria; Root-locus techniques.	10hrs
UNIT -3	
State space variable Analysis: Concept of state, state variable and state model. State space representation of continuous time LTI system. Frequency-domain analysis: Correlation between time and frequency response, Polar-plots, Bode-plots, Nyquist-plots; Relative stability using Nyquist-plot.	10hrs
UNIT -4	
Compensators: Concept of compensators; types of compensators; Design of Cascade compensator in time domain- Lead, Lag and Lead-Lag compensation; Design of Cascade compensator in frequency; domain -Lead, Lag and Lead-Lag compensation. Introduction to Controllers: PI, PD and PID controllers. Ziegler–Nichols rules for tuning PID Controllers.	10 hrs

TEXTBOOKS	
1	M. Gopal; Control Systems-Principles and Design; Tata Mc Graw Hill
2	I. J. Nagrath and M. Gopal; Control Systems Engineering; The New Age International.

REFERENCES	
1	K. Ogata; Modern Control Engineering; 5th edition, Pearson, 2015.
2	A. Nagoor Kani; Control Systems; RBA Publications, Chennai
3	D. Roy Choudhry; Modern Control Engineering; PHI
4	Salivahanan S.; Control Systems Engineering; Pearson Education

VLSI TECHNOLOGY AND DESIGN					
Course Code	**ET620**		**Credits**	**4**	
Scheme of Instruction Hours/ Week	**L**	**T**	**P**	**TOTAL**	
	3	**1**	**0**	**40hrs/sem**	
Scheme of Examination TOTAL = 125 marks	**IA**	**TW**	**TM**	**P**	**O**
	25	**25**	**100**	**0**	**0**

Course Objectives:

The course aims to provide the student with:

1. An in depth knowledge of the MOSFET operation and the ability to derive the thresholdvoltage & current equations.
2. An understanding of the theory of CMOS Inverter and Switching characteristics and thecapability to write SPICE programs for various circuits.
3. The capability to design combinational circuits in CMOS logic and draw Layouts for the same.
4. An understanding of the various processes involved in VLSI technology and chip fabricationand design circuits using VHDL.

Course Outcomes:

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

CO1	Explain the MOSFET operation, Current Voltage Equations, and CMOS Inverter Theory and to solve numerical based on MOSFET and CMOS inverter.
CO2	Explain the various MOSFET fabrication processes.
CO3	Write the SPICE programs for modeling MOSFET circuits and to implement complex combinational functions in CMOS logic and draw the layout for the same.
CO4	Design simple combinational and sequential circuits using VHDL.

UNIT -1	
Introduction to VLSI: VLSI Design Flow. **MOS transistors**: Structures, MOS system under external bias, operation of MOS transistor (MOSFET), MOS transistors: Threshold voltage MOSFET current-voltage characteristics (CGA), channel length modulation, substrate bias effect. **Measurements of parameters –** K_N, V_{T0}& γ. Overview of MOSFET capacitances.	10 hrs
UNIT -2	
CMOS inverter design: operation, DC characteristics, calculation of VIL, VIH, VTH, VOH and VOL. Noise margins power and area considerations. Latch up and its prevention. **Switching Circuit Characteristics:** Rise, fall and delay time, gate delays, transistor sizing, static and dynamic power dissipations CMOS logic gate design: Fan in and fan out. **Modeling of MOS transistor circuits using SPICE.** (Level 1 model equations).	10hrs
UNIT -3	
MOS transistor switches: CMOS logic- Inverter, NOR, NAND and combinational logic, Compound gates, Multiplexers, Transmission gates, Latches and Registers. Implementation of Boolean Expressions using transmission gates and CMOS logic. Stick diagrams and Layout of Inverter, NOR and NAND. Complex logic gates and their layouts (Euler paths). MOSIS layout design rules (full-custom mask layout designs.	10hrs
UNIT -4	
Silicon semiconductor technology: Wafer processing, oxidation, epitaxy, deposition, etching, Photolithography, Ion-implantation and diffusion. Silicon gate process. Chemical Vapor Deposition. **Basic CMOS technology**: n-well and p-well CMOS process. Silicon on insulator. **Introduction to VHDL language**. VHDL Programs and test benches for Adder, Subtractor, Decoder, Encoder, Multiplexer, Demultiplexer, Flip Flops, Registers and Counters.	10hrs

TEXTBOOKS	
1	Sung-Mo (Steve) Kang, Yusuf Leblebici; CMOS Digital Integrated Circuits Analysis & Design; McGraw-Hill Education
2	Neil Weste, David Harris; CMOS VLSI Design: A Circuits and Systems Perspective;Pearson
3	Bhaskar; VHDL Primer; PHI
4	Stephen Brown, Zvonco Vranesic; Fundamentals of Digital logic with VHDL design;McGraw-Hill Education

REFERENCES	
1	Wayne Wolf; Modern VLSI design (Systems on Silicon); PHI
2	Jan M. Rabaey; Digital Integrated Circuits – A Design perspective; Pearson Education

REAL TIME OPERATING SYSTEMS					
Course Code	**ET631**		**Credits**	**3**	
Scheme of Instruction Hours/ Week	**L**	**T**	**P**	**TOTAL**	
	3	**0**	**0**	**40hrs/sem**	
Scheme of Examination TOTAL = 125 marks	**IA**	**TW**	**TM**	**P**	**O**
	25	**0**	**100**	**0**	**0**

Course Objectives:

The course aims to provide the student with:

1. An introduction to Real Time System, Resources,RTOS.
2. Illustration of Real Time Task Scheduling and Protocols.
3. An Understanding of Scheduling Real Time task in multiprocessing system.
4. Knowledge of Real Time communication and database.

Course Outcomes:

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

CO1	Identify the principles and characteristics of various applications of real time systems.
CO2	Distinguish and demonstrate performance of various task scheduling algorithms in RTOS
CO3	Illustrate the features of RTOS, its protocols and concepts of commercial real time operating system.
CO4	Illustrate the scheduling operation of real time tasks in multiprocessor and the concepts of real time communication and database.

UNIT -1	
Introduction to Real-Time Systems and Resources: Definition of Real Time, Applications of Real-Time Systems, Basic Model of Real-Time Systems, Timing Constraints, and Modeling Timing Constraints. **Real Time Operating Systems:** Operating System basics: Kernel Architecture, Types of operating system, Task, process and Threads, Multi-Processing and Multitasking, Resource, Types of Real Time Tasks and their Characteristics.	10 hrs
UNIT -2	
Real-Time Task Scheduling: Task Scheduling, Task states, Non-Preemptive scheduling, Preemptive Scheduling, Round Robin Scheduling, Idle Task, Task Communication, Task Synchronization, Thread Safe Reentrant Functions. Clock-Driven Scheduling, Hybrid Schedulers, Event-Driven Scheduling, Earliest Deadline First (EDF) Scheduling, Rate Monotonic Algorithm, Some Issues associated With RMA.	10hrs
UNIT -3	
Handling Resource Sharing and Dependencies Among Real Time Tasks: Resource Sharing among Real Time Tasks, Priority Inversion, Priority Inheritance Protocol, Highest Locker Protocol, Priority Ceiling Protocol, Different Types of Priority Inversions Under PCP, Important Features of PCP. **Scheduling Real-Time Tasks In Multiprocessor:** Multiprocessor Task Allocation, Dynamic Allocation of Tasks, Fault-Tolerant Scheduling of Tasks, Clocks In Distributed Real-Time Systems, Centralized Clock Synchronization, Distributed Clock Synchronization.	10hrs
UNIT -4	
Commercial Real Time Operating Systems: Time Services, Features of Real-Time Operating System, Unix as a Real-Time Operating System, Unix - Based Real-Time Operating Systems, Windows as Real-Time Operating System, POSIX, A Survey of Contemporary Real Time Operating Systems, Benchmarking Real-Time Systems. **Real-Time Communication:** Examples of Applications Requiring, Real Time Communication, Basic Concepts, Real-Time Communication In a LAN, Real-Time Communication over Packet Switched Networks, QOs Framework, Routing, Resource Reservation, Tate Control, QOs Models. **Real-Time Databases:** Example Applications of Real-Time Databases, Review of Basic Database Concepts, Real-Time Databases.	10hrs

TEXTBOOKS	
1	Rajib Mall, "Real Time System Theory & Practice", Pearson Education Asia.
2	Abraham Silberschatz, P. B. Galvin "Operating System Concepts" , 9th Edition, Wiley , 2018.

REFERENCES	
1	Jane W.S. Liu "Real time system", Pearson Education Asia, 2001.
2	R. Bennett, "Real time computer control", Prentice Hall, 1994.
3	Shem Toy Levi, Ashok K. Agrawala, "Real time system design", McGraw Hill Publishing Company, 1990.
4	C.M. Krishna and Kang Shin, "Real Time Systems", McGraw Hill Publishing Company inc., 1997.
5	Rajkamal, "Embedded Systems- Architecture, Programming, and Design", 2007, TMH.

RADAR SYSTEM ENGINEERING					
Course Code	**ET632**		**Credits**	**3**	
Scheme of Instruction Hours/ Week	**L**	**T**	**P**	**TOTAL**	
	3	**0**	**0**	**40 hrs/sem**	
Scheme of Examination TOTAL = 125 marks	**IA**	**TW**	**TM**	**P**	**O**
	25	**0**	**100**	**0**	**0**

Course Objectives:

The course aims to provide the student with:

1. An understanding of Working of different types of Radar
2. Ability to Apply the concepts of radar theory to target detection and tracking
3. Ability to Analyze the working of different types of radars
4. Ability to Evaluate the radar parameters

Course Outcomes:

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

CO1	Explain the Working of different types of Radar and radar tracking
CO2	Apply the concepts of radar theory to target detection and tracking
CO3	Analyze the working of different types of radars
CO4	Evaluate the radar parameters

UNIT 1	
The radar range equation: Introduction to RADAR, Range to a target, maximum unambiguous range, Derivation of range equation, Radar block diagram, radar frequencies and applications of radar, Detection of signal in Noise, Probability of Detection & False Alarm, Integration of Radar Pulses, Radar Cross Section of Targets, PRF.	10 hrs
UNIT -2	
Doppler Effect, pulsed Doppler, Continuous Wave and Frequency Modulated CW Radar, Moving Target Indicator Radar- Principle of operation, block diagram, single & double delay line cancellers, clutter attenuation, blind speeds, staggered PRF's, limitations to MTI performance, non- coherent MTI.	10hrs
UNIT -3	
Different types of tracking techniques. Sequential lobing, Conical Scanning, amplitude & phase comparison Monopulse Radar, Limitation of Tracking Accuracy-low angle tracking, Tracking in range-split gates	10 hrs
UNIT -4	
Introduction to radar clutter, Pulse compression, FM pulse compression radar, Radomes androtodomes, Secondary Surveillance Radar (SSR): Principle of operation, problems with SSR, SyntheticAperture Radar (SAR), concept of bistatic & multistatic radar, Radar Displays-PPI, A,B, C and D scopes.	10 hrs

TEXTBOOKS	
1	Merill Skolnik, Introduction to Radar Systems , McGraw Hill Education, 3rd edition ,2017.

REFERENCES	
1	David K. Barton; Modern radar system analysis; Artech house
2	Fred E. Nathanson; Radar Design Principles; McGraw Hill
3	Cook C. E., Bernfield M.; Radar signals; Academic press
4	Simon Kingsley & Shaun Quegan , Understanding Radar Systems , StandardPublisher Distributors, New Delhi.

<table>
<tr><td colspan="6">ARTIFICIAL NEURAL NETWORKS</td></tr>
<tr><td>Course Code</td><td colspan="2">ET633</td><td>Credits</td><td colspan="2">3</td></tr>
<tr><td rowspan="2">Scheme of Instruction
Hours/ Week</td><td>L</td><td>T</td><td>P</td><td colspan="2">TOTAL</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td colspan="2">40hrs/sem</td></tr>
<tr><td rowspan="2">Scheme of Examination
TOTAL = 125 marks</td><td>IA</td><td>TW</td><td>TM</td><td>P</td><td>O</td></tr>
<tr><td>25</td><td>0</td><td>100</td><td>0</td><td>0</td></tr>
</table>

Course Objectives:

The course aims to provide the student with:

1. An introduction to important neural processing paradigms, and learning rules.
2. An introduction to foundations of trainable decision making networks forclassification of linearly separable and linearly non-separable classes of patterns.
3. An understanding of different artificial neural networks that use Unsupervised Learning algorithms to extract features from available data.
4. The basic knowledge of associative models of artificial neural networks.

Course Outcomes:

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

CO1	Explain the structure, working and related parameters of artificial neural networks.
CO2	Apply various learning rules to train artificial neural networks.
CO3	Analyze the working of artificial neural networks using graphical methods.
CO4	Design artificial neural networks for their use in applications such as Classification and Clustering

UNIT 1	
Introduction: Introduction to neural networks, structure of biological neuron, Mc-Culloch Pitts neuron model. Logic network realization by using Mc-Culloch Pitts neuron model, Neuron modelling for artificial neuron systems, Neural learning. Hebbian learning rule, perceptron learning rule, Delta learning rule, Widrow-Hoff learning rule (ADALINE), co-relation learning rules, winner take all and outstar learning rules, and related problems. **Single layer network:** Concept of linear separability and non-linear separability, training algorithms, Discriminant functions, Minimum distance classification, Non-parametric Training Concept	10 hrs
UNIT -2	
Single layer Discrete Perceptron, Single layer Continuous Perceptron, Multi-class classification **Multilayer network I:** Error back propagation algorithm or generalized delta rule. Setting of parameter values and design considerations (Initialization of weights, Frequency of weight updates, Choice of learning rate, Momentum, Generalizability, Network size, Sample size, Non-numeric inputs). R-Prop Algorithm **Multilayer network II:** Adaptive multilayer network, network pruning algorithm. Marchands algorithm, neural tree, tiling algorithm & problems related to adaptive multiplayer network. Radial basis function and its applications, polynomial network.	10hrs
UNIT -3	
Winner-Take-All network, Hamming Distance classifier, MAXNET. Clustering, simple competitive learning algorithm, LQV algorithm. Adaptive resonance theory. **Topologically organized network:** Self Organizing Feature Map, Distance based learning, **Deep Neural Networks:** Introduction & Necessity of deep neural networks (DNN),Example: Auto encoder DNN, Convolutional neural networks: Convolution operation, Motivation and Pooling.	10 hrs
UNIT -4	
Hopfield network: Non-iterative procedures for association, Matrix Association memories,Least square procedures.Discrete Hopfield networks, Continuous Hopfield networks, Energy functions, Energyminimization, Storage capacity of Hopfield networks.Brain-state-in-a-box network, Bi-directional associative memory and problems. Applicationsof neural network.	10 hrs

TEXTBOOKS

1	Jacek M. Zurada; Introduction to Artificial Neural Systems; Jaico Publishing House, Jan 1994
2	Kishan Mehrotra, Chilukuri Mohan, Sanjay Ranka; Elements of artificial neural network;Penram International Publishing Pvt. Ltd., Jan 2009
3	Ian Goodfellow, Yoshua Bengio, Aaron Courville, Deep Learning, MIT Press, Jan 2017

REFERENCES	
1	D. Patterson; Artificial neural networks; Prentice Hall, April 1994
2	Satish Kumar; Neural Networks, A Classroom Approach; Mc Graw Hill Education, July 2017
3	Charu C. Aggarwal, Neural Networks and Deep learning, Springer Publications, 1st edition, Aug 2018

NANOELECTRONICS					
Course Code	**ET634**		**Credits**	**3**	
Scheme of Instruction Hours/ Week	**L**	**T**	**P**	**TOTAL**	
	3	**0**	**0**	**39hrs/sem**	
Scheme of Examination TOTAL = 125 marks	**IA**	**TW**	**TM**	**P**	**O**
	25	**0**	**100**	**0**	**0**

Course Objectives:

The course aims to provide the student with:

1. Technical knowledge of Nanoelectronics, its necessity, challenges and applications.
2. An introduction to quantum mechanics of electron.
3. An introduction to Nanotransistor, single electron and few electron phenomena.
4. An understanding of fabrication techniques in Nanoelectronics and various nanostructures of carbon.

Course Outcomes:

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

CO1	Explain the approaches to nanotechnology, classical and quantum mechanics, theory of Graphene, Carbon nanotubes, nanodevices and fabrication techniques for nanostructures
CO2	Apply quantum mechanics to understand the electrostatics at nano dimensions and use nanodevices for various applications
CO3	Analyse behaviour of carriers in nanostructures and their transport mechanisms in classical, ballistic, CNT and nanowires.
CO4	Evaluate carrier electrostatics at material and device level with nano dimensions

UNIT 1	
Introduction: Need for Nanotechnology & Nanoelectronics, Nanostructures & its classification, Nanoscale architecture, Effects of the nanometre length scale, Effect of Nanoscale dimensions on its properties, Top down and bottom up approaches in Nanoelectronics. **Principles of Quantum Mechanics:** Energy Quanta, Wave-Particle Duality, The Uncertainty Principle **Schrodingers Wave Equation:** The Wave Equation, Physical Meaning of the Wave Function, Boundary Conditions. **Applications of Schrodingers Wave Equation:** Electron in Free Space, The Infinite Potential Well, The Step Potential Function, The Potential Barrier.	10 hrs
UNIT -2	
Introduction to the Quantum Theory of Solids: Allowed and Forbidden Energy Bands, Formation of Energy Bands, The Kronig-Penney Model, The k-Space Diagram **Electrical Conduction in Solids:** The Energy Band and the Bond Model, Drift Current, Electron Effective Mass, Concept of the Hole, Metals, Insulators, and Semiconductors **Extension to Three Dimensions:** The k-Space Diagrams of Si and GaAs, Additional Effective Mass Concepts. Electron in Quantum dots, wires and wells, Introduction to Graphene and carbon Nanotubes	10hrs
UNIT -3	
Tunnel junction: Tunneling through a Potential barrier, Potential energy profiles for material interfaces, Applications of Tunneling. **Coulomb Blockade:** Coulomb Blockade in a Nano capacitor, Tunnel junction. **Nanotransistors:** Single-Electron transistor logic, Carbon Nanotube Transistors (FETs & SETs), Semiconductor Nanowire FETs & SETs, Molecular SETs & Molecular Electronics.	10 hrs
UNIT -4	
Fabrication Techniques: Lithography, Nanoimprint Lithography, Split-Gate Technology,Self-Assembly. **Nanowires, Ballistic transport, and spin transport:** Classical and semi classicaltransport, Concept of Ballistic channels & sub-bands, Carbon nanotubes and nanowires,Transport of spin and Spintronic.	10 hrs

TEXTBOOKS	
1	George W. Hanson; Fundamentals of Nanoelectronics; Pearson Education.
2	Donald A. Neaman ; Semiconductor Physics and Devices, Tata McGraw-Hill

REFERENCE BOOKS	
1.	Karl Goser, Peter Glösekötter, Jan Dienstuhl; Nanoelectronics and Nanosystems; Springer International Edition.
2.	Robert W. Kelsall, Ian W. Hamley, Mark Geoghegan Nanoscale Science and Technology, John Wiley & Sons Ltd.
3.	R. Booker, E. Boysen; Nanotechnology; Wiley-Dreamtech India Pvt. Ltd.

WIRELESS SENSOR NETWORKS					
Course Code	ET635		Credits	3	
Scheme of Instruction Hours/ Week	L	T	P	TOTAL	
	3	0	0	39hrs/sem	
Scheme of Examination TOTAL = 125 marks	IA	TW	TM	P	O
	25	0	100	0	0

Course Objectives:

The course aims to provide the student with:

1.An understanding of wireless sensor network technology and its application.
2. An ability to understand the MAC and Routing protocols for WSN
3. An ability to understand the Transport layer protocols for WSN
4. An understanding of network Management and Operating Systems for WSN.

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

CO1	Explain the basic theory of Wireless Sensor Network technology
CO2	Explain different MAC, Routing and Transport Layer protocols for WSN
CO3	Explain Network management and various Operating Systems for WSN
CO4	Identify the various applications of WSN.

UNIT 1	
Introduction and Overview of Wireless Sensor Networks : Background of Sensor Network Technology, Basic Overview of the Technology, Basic Sensor Network Architectural Elements, Challenges and Hurdles. Applications of Wireless Sensor Networks. **Basic Wireless Sensor Technology :** Sensor Node Technology, Hardware and Software, Sensor Taxonomy, WN Operating Environment, WN Trends.	10 hrs
UNIT -2	
Medium Access Control Protocols for Wireless Sensor Networks : Fundamentals of MAC Protocols, Performance Requirements, Common Protocols, MAC Protocols for WSNs, Schedule-Based Protocols, Random Access-Based Protocols. **Routing Protocols for Wireless Sensor Networks :** Data Dissemination and Gathering, Routing Challenges and Design Issues in Wireless Sensor Networks, WSN Routing Techniques, Flooding and Its Variants, Sensor Protocols for Information via Negotiation, Low-Energy Adaptive Clustering Hierarchy, Power-Efficient Gathering in Sensor Information Systems, Directed Diffusion, Geographical Routing.	10hrs
UNIT -3	
Transport Control Protocols for Wireless Sensor Networks : Traditional Transport Control Protocols, 1 TCP (RFC 793), UDP (RFC 768), Feasibility of Using TCP or UDP for WSNs, Transport Protocol Design Issues, Examples of Existing Transport Control Protocols, CODA (Congestion Detection and Avoidance), ESRT (Event-to-Sink Reliable Transport), GARUDA, ATP (Ad Hoc Transport Protocol), Congestion, Packet Loss Recovery. **Middleware for Wireless Sensor Networks :**WSN Middleware Principles, Middleware Architecture, Data-Related Functions, Architectures, Existing Middleware: MiLAN (Middleware Linking Applications and Networks), IrisNet (Internet-Scale Resource-Intensive Sensor Networks Services), Middleware), SensorWare.	10 hrs
UNIT -4	
Network Management for Wireless Sensor Networks : NetworkManagement Requirements, Simple Network Management Protocol, Network Management Design Issues, Example of Management Architecture: MANNA. **Operating Systems for Wireless Sensor Networks :** Operating System Design Issues, Examples of Operating Systems, TinyOS, MANTIS, SenOS, CONTIKI OS. Performance and Traffic Management, Performance Modeling of WSNs, performance Metrics.	10 hrs

TEXTBOOKS	
1	Taieb, Znati Kazem Sohraby, Daniel Minoli, Wireless Sensor Networks: Technology, Protocols and Applications, Wiley, 2010.
2	Jun Zheng, AbbasJamalipour, Wireless Sensor Networks A Networking Perspective, Wiley ,2014
3	Edgar H. Callaway, Jr.,Wireless Sensor Networks: Architectures and Protocols , Auerbach Publications, 1st Edition,2003

REFERENCES	
1	Feng Zhao, Wireless Sensor Networks: An Information Processing Approach, Elsevier, 2005.

<table>
<tr><th colspan="6">MOTOR CONTROL AND APPLICATIONS</th></tr>
<tr><td>Course Code</td><td colspan="2">ET641</td><td>Credits</td><td colspan="2">3</td></tr>
<tr><td rowspan="2">Scheme of Instruction
Hours/ Week</td><td>L</td><td>T</td><td>P</td><td colspan="2">TOTAL</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td colspan="2">39hrs/sem</td></tr>
<tr><td rowspan="2">Scheme of Examination
TOTAL = 125 marks</td><td>IA</td><td>TW</td><td>TM</td><td>P</td><td>O</td></tr>
<tr><td>25</td><td>0</td><td>100</td><td>0</td><td>0</td></tr>
</table>

Course Objectives:

The course aims to provide the student with:

1.An understanding of construction and working of DC and AC motors.
2. An introduction to the drive system and its characteristics.
3. An understanding of control strategies used for starting, braking andspeed control of different AC and DC motors.
4.An ability to analyse the speed control strategies using power converters.

Course Outcomes:

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

CO1	Explain the construction, working and characteristics of electrical machines.
CO2	Analyse and explain the starting, braking and speed control methods for DC and AC motors.
CO3	Analyse and discuss phase controlled and chopper controlled DC drives.
CO4	Analyse and discuss control strategies used to control speed of AC drives.

UNIT 1	
DC Motors: Construction, working and types of DC Motors, Speed and Torque expressions, Characteristics of DC motors. Speed Control methods of DC motors DC Drives: Concept of DC drives, Four quadrant operation. Electric Braking of dc motors – Plugging, Dynamic, and Regenerative Braking operations.	10hrs
UNIT -2	
Control of DC drives: Operation of Single and three phase half wave converter, semi- converter, full-converter and dual converter drives. Chopper Drives: Power control or motoring control, Regenerative Braking Control, Two quadrant Chopper drives, Four quadrant Chopper drives A typical thyristor converter controlled dc motor drive system.	10hrs
UNIT -3	
Three phase induction Motor: Construction, working and types, Speed torque characteristics, Starting methods, methods of speed control Stepper motor: Working of Variable Reluctance Stepper motor, Permanent Magnet Stepper motor, Hybrid stepper motor	10 hrs
UNIT -4	
Control of AC Drives: Speed control of three phase induction motors: StatorVoltage, Stator Frequency, Stator voltage and frequency control, Cyclo-converter control, PWM control. Comparison of VSI and CSI operations. Rotor Side Control of Induction Motor: Static rotor resistance control and Slippower recovery scheme: Static Scherbius drive, Static Kramer Drive-theirperformance and speed torque characteristics, advantages, applications.	10 hrs

TEXTBOOKS	
1	P. S. Bhimbra, Power Electronics , Khanna Publishers.
2	B. L. Theraja, A. K.Theraja, A Textbook of Electrical Technology, Volume II, S. Chand Publication
3	G K Dubey, Fundamentals of Electric Drives, CRC Press, 2002.
4	M. D. Singh, K. B. Khanchandani; Power electronics, 2nd Ed., TMH
5	V. K. Mehta, Rohit Mehta, Principles of Electrical Machines , S. Chand Publication.

REFERENCES	
1	Vedam Subramanyam, Thyristor Control of Electric drives, Tata McGraw Hill Publications, 1987.
2	S K Pillai, A First course on Electrical Drives, New Age International (P) Ltd. 2nd Edition. 1989
3	P. C. Sen, Thyristor DC Drives, Wiley-Blackwell, 1981
4	B. K. Bose, Modern Power Electronics, and AC Drives, Pearson 2015.
5	R. Krishnan, Electric motor drives - modeling, Analysis and control, Prentice Hall PTR, 2001

<table>
<tr><th colspan="6">ADAPTIVE SIGNAL PROCESSING</th></tr>
<tr><td>Course Code</td><td colspan="2">ET642</td><td>Credits</td><td colspan="2">3</td></tr>
<tr><td rowspan="2">Scheme of Instruction
Hours/ Week</td><td>L</td><td>T</td><td>P</td><td colspan="2">TOTAL</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td colspan="2">40hrs/sem</td></tr>
<tr><td rowspan="2">Scheme of Examination
TOTAL = 125 marks</td><td>IA</td><td>TW</td><td>TM</td><td>P</td><td>O</td></tr>
<tr><td>25</td><td>0</td><td>100</td><td>0</td><td>0</td></tr>
</table>

Course Objectives:

The course aims to provide the student with:

1.An understanding of statistical characterization of random variables and processes.
2. An introduction to the modeling of random processes.
3. The ability to derive Weiner-Hopf Equations for application in Wiener filtering problems.
4. The knowledge of different nonparametric models of spectral estimation.

Course Outcomes:

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

CO1	Characterize random variables and processes using their ensemble averages and/or joint moments.
CO2	Describe different methods of modeling random processes.
CO3	Compare different methods for estimating the power spectrum of wide sense stationary random processes.
CO4	Develop FIR adaptive filters based on the method of steepest descent and compare their performance

UNIT 1	
Random Variables: Definitions, Ensemble Averages, Jointly Distributed Random Variables, Joint Moments, Independent, Uncorrelated andOrthogonal Random Variables, Linear Mean Square Estimation, Parameter Estimation: Bias and Consistency Random Processes: Definitions, Ensemble Averages, Stationary Processes, the Autocovariance and Autocorrelation Matrices, Ergodicity, White Noise, The Power Spectrum.	10 hrs
UNIT -2	
Filtering Random Processes, Spectral factorization, Special Types of Random Processes: ARMA processes, AR processes, MA processes. Stochastic Signal Modelling: ARMA models, AR and MA models, Applications in Power Spectrum Estimation.	10hrs
UNIT -3	
Wiener Filtering: Introduction, the FIR Wiener filter, Filtering, Linear Prediction, Noise Cancellation. Spectrum Estimation: Nonparametric models – The Periodogram, Performance of the Periodogram, The Modified Periodogram, Periodogram Averaging (Bartletts Method).	10 hrs
UNIT -4	
Adaptive Filtering: FIR Adaptive Filters – The Steepest Descent Adaptive Filter, The LMS Algorithm and its convergence, Normalized LMS, Application: Noise Cancellation, Channel Equalization.	10 hrs

TEXTBOOKS	
1	Monson H. Hayes; Statistical Digital Signal Processing and Modeling; Wiley India
2	Simon Haykin; Adaptive Filter Theory; Prentice Hall

REFERENCES	
1	Dmitris Manolakis, Vinay Ingle, Stephen Kogon; Statistical and Adaptive Signal Processing; Artech House
2	B. Widrow; S. Stearns; Adaptive Signal Processing; Prentice Hall

BIO-MEDICAL ELECTRONICS AND INSTRUMENTATION					
Course Code	**ET643**		**Credits**	**3**	
Scheme of Instruction Hours/ Week	**L**	**T**	**P**	**TOTAL**	
	3	**0**	**0**	**40hrs/sem**	
Scheme of Examination TOTAL = 125 marks	**IA**	**TW**	**TM**	**P**	**O**
	25	**0**	**100**	**0**	**0**

Course Objectives:

The course aims to provide the student with:

1.An introduction to human physiological system which is very important with respect to electronic design considerations.
2. The knowledge of the principles of operation and design of biomedical electronics & instruments.
3. An understanding of medical diagnosis and therapy techniques.
4. An ability to solve electronic engineering problems related to medical field.

Course Outcomes:

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

CO1	Describe physiology of human body and nervous system, generation of bio-potentials and bio-potential electrodes.
CO2	Define safety parameters and measures to be taken while designing biomedical equipment.
CO3	Explain different measuring, monitoring and therapeutic equipment.
CO4	Categorize different imaging systems based on their application, advantages and disadvantages for a given problem.

UNIT 1	
Cell and its structure: Resting and action potential, Bioelectric potentials: ECG, EEG, EMG, Nervous system: Nerve fibers, neuron system, Basics of cardiovascular system, respiratory system. Electrodes: basic electrode theory, Nernst equation, Bio-potential electrodes,biochemical transducers. Patient safety: Intensive care system, Electric shock hazards, Leakage currents;Testing instruments for checking safety parameters of biomedical electronic equipment.	10 hrs
UNIT -2	
Measuring and monitoring systems: EEG, ECG, EMG with block diagrams, Artifacts in bio-potential recordings. Pacemakers: Pacing modes, Lead wires and electrodes, Synchronous pacemaker, Rate responsive pacing. AC and DC Defibrillators, Blood pressure monitoring: Direct and Indirect measurement.	10hrs
UNIT -3	
Spirometry, Audiometers, Block diagram of heart-lung machine, Endoscopy. Surgical diathermy; Physiotherapy equipment: Microwave diathermy; Laser therapy, Ultrasonic therapy unit, Cryotherapy. Telemedicine Technology: Essential parameters for telemedicine, Overview of Telemedicine system, Clinical Data Interchange/Exchange Standards: DICOM.	10 hrs
UNIT -4	
X-Rays: X ray diagnostic methods, Production of X-ray, Use of X-ray imaging. Computed Tomography, Magnetic resonance imaging: Basic principles, functionalblock diagram, Medical applications and safety precautions. Ultrasound: Functional block diagram of basic pulse echo system for diagnosticpurposes, A-SCAN, M-SCAN, B-SCAN, Application of ultrasound imaging. Nuclear medical imaging: Positron emission tomography(PET), Single positronemission computed tomography (SPECT), Medical applications, safety precautions.	10 hrs

TEXTBOOKS	
1	R.S Khandpur, Handbook of Biomedical instrumentation , Tata McGraw-Hill Education, 2003
2	Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, Biomedical instrumentation and Measurements , PHI, 2nd edition, 2018
3	John.G Webster, Medical instrumentation – Application & Design, John Wiley, 4th Edition, 2014.
4	W.Blesser, Systems approach to Biomedicine, McGraw Hill

REFERENCES	
1	Tatsuo Togawa,Toshiyo Tamura, Ake Oberg. Biomedical Transducers and Instruments, CRC Press,2nd edition, 2011
2	S.K Guha, Introduction to medical electronics-Bharati Bhavan
3	C.A Caceres, Biomedical telemetry- (Academic press)
4	Principles of applied biomedical instrumentation-L. Graddes and L. Baker
5	A Guide to Patient Care Technology: A Review of Medical Equipment (Hardcover)By Laurence J Street, Publisher: Taylor & Francis

MOBILE COMMUNICATION					
Course Code	ET644		Credits	3	
Scheme of Instruction Hours/ Week	L	T	P	TOTAL	
	3	0	0	40hrs/sem	
Scheme of Examination TOTAL = 125 marks	IA	TW	TM	P	O
	25	0	100	0	0

Course Objectives:

The course aims to provide the student with:

1. An understanding of the cell theory and the different types of handoffs
2. An ability to calculate the Co-channel Interference reduction factor, received power at the mobile using the different types of propagation models, parameters of the mobile multipath channels and classify the different types of fading channels
3. An understanding of the different types of equalization and diversity techniques.
4. An understanding of the GSM and CDMA standards for mobile communication

Course Outcomes:

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

CO1	Design a cellular system for a given channel capacity
CO2	Determine the Co-channel Interference reduction factor in a cellular system and calculate the received power using the different types of propagation models
CO3	Evaluate the parameters of the mobile multipath channels and classify the different types of fading channels.

UNIT 1	
The Cellular Concept: Introduction, Block diagram of Cellular System, Concept of Frequency Reuse, Hexagonal shaped cells. **Handoff Strategies**: Handoffs, Types of handoff, handoff initiation, delaying handoff, forced handoff, Power Difference Handoffs, Mobile assisted Handoff (MAHO) and Soft Handoff, Cellsite Handoff, Intersystem handoff . Co-channel Interference reduction factor, Desired C/I for a normal case in a Omnidirectional Antenna System. Reduction of Co-Channel interference by means of a notch in the tilted antenna pattern. **Mobile Radio Propagation,Large -Scale Path Loss**: Introduction to Radio Wave Propagation, Free Space Propagation Model, The Three Basic Propagation Mechanisms, Reflection, Ground Reflection (Two Ray) Model, Diffraction, Scattering: Radar cross section model.	10 hrs
UNIT -2	
Mobile Radio Propagation: Small -Scale Fading and Multipath: Small- Scale Multipath Propagation, Impulse Response Model of a Multipath Channel: Relationship between bandwidth and received power, Small-scale multipath measurements Parameters of Mobile Multipath Channels, Types of Small -Scale Fading, Rayleigh and Ricean Distribution. Statistical models for multipath fading channels: Clarke's model for flat fading, Level crossing and fading statistics, Two Ray-Rayleigh fading model.	10hrs
UNIT -3	
Equalization: Introduction, Fundamentals of Equalization, Training A Generic Adaptive Equalizer, Equalizers in a communications Receiver, Linear Equalizers, Non linear Equalization ,Algorithms for adaptive equalization: Zero Forcing Algorithm, Least Mean Square Algorithm, Recursive least squares algorithm. **Diversity Techniques**: Practical Space Diversity Considerations, Polarization Diversity, Frequency Diversity, Time Diversity, RAKE Receiver. **MIMO Systems**: Multiple Input Multiple Output Antenna Systems, Alamouti Space Time Codes for MIMO Wireless Communications.	10 hrs
UNIT -4	
Global System for Mobile Communication (GSM) : GSM Services and Features, GSM System Architecture, GSM Radio Subsystem, GSM Channel Types, Example of a GSM Call, Frame Structure for GSM. Spread Spectrum techniques & CDMA: Advantages, Process Gain, Jam Margin, J/S ratio, Multipath Fading and its avoidance, PN Sequences, Techniques: Direct Sequence (DSSS) & Frequency Hopping (FHSS), The Near Far Problem ,DS-CDMA & FH-SS CDMA CDMA Digital Cellular Standard (IS-95) : Frequency and Channel Specifications, Forward CDMA Channel, Reverse CDMA Channel.	10 hrs

CO4	Explain the different types of diversity techniques , GSM and CDMA technology.

TEXTBOOKS	
1	Mobile Communications by Jochen Schiller, 2nd Edition, Addison Wesley
2	Mobile Cellular Telecommunications by William Lee, Tata McGraw Hill
3	Wireless Communication : Principles and Practice by Theodore Rappaport
4	Space Time Codes and MIMO Systems by Mohinder Janakiraman, Artech House

REFERENCES	
1	Principles of communication systems by Taub, Schilling,Saha, Third edition ,Tata McGraw hill publishing company
2	Fundamentals of Wireless Communications by David Tse and Pramod Vishwanathan.

ERROR CONTROL CODING					
Course Code	**ET645**		**Credits**	**3**	
Scheme of Instruction	**L**	**T**	**P**	**TOTAL**	
Hours/ Week	**3**	**0**	**0**	**40hrs/sem**	
Scheme of Examination	**IA**	**TW**	**TM**	**P**	**O**
TOTAL = 125 marks	**25**	**0**	**100**	**0**	**0**

Course Objectives:

The course aims to provide the student with:

1.An understating of Concepts of Galois Fields.
2. Knowledge of various coding techniques.
3. Mathematical and computational skills required in coding theory.
4. Ability to decode and correct the errors in the communication systems.

Course Outcomes:

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

CO1	Discuss the concepts related to elementary aspects of linear algebra.
CO2	Design and generate codes using the knowledge of Galois field.
CO3	Encode the data using various coding techniques.
CO4	Decode and correct the errors in the received code.

UNIT 1	
Introduction to Algebra: Groups, Fields, Construction of fields, Binary field arithmetic. Basic properties of a Galois field, Primitive field elements. Minimal polynomial, Computations using Galois field GF (2^m) Arithmetic, Vector spaces, matrices. **Revisiting linear block codes:** Generator and parity check matrices, Implementation of encoder and decoder. Hamming codes. Weight enumerators and the MacWilliams identities.	9 hrs
UNIT -2	
Introduction to BCH codes: Encoding and decoding of BCH codes, error location polynomial, Implementation of Galois field arithmetic,Implementation of error correction. **Non-binary BCH codes:** Reed-Solomon codes, Berlekamp's decoding algorithm, decoding with Euclidean Algorithm.	10hrs
UNIT -3	
Convolution codes: Viterbi decoding algorithm, Stack algorithm-ZJ algorithm method, Fano sequential decoding algorithm, **Trellis Coded Modulation**: Introduction to TCM, concept of coded	10 hrs

modulation, mapping by set partitioning, Ungerboeck's TCM design rules, TCM example.	
UNIT -4	
Low-Density Parity-Check Codes: Introduction to LDPC Codes, tanner graphs for linear block codes, Geometric construction of LDPC codes, Decoding of LDPC Codes, Code construction by row and column Splitting, breaking cycles in Tanner graphs, Construction of Gallager LDPC Codes, Random LDPC Codes, Irregular LDPC Codes.	10 hrs

TEXTBOOKS	
1	Shu Lin, Daniel J. Costello; Error Control Coding- Fundamentals and Applications, 2 ndEd., Pearson/Prentice Hall
2	Ranjan Bose; Information Theory, Coding & Cryptography, 2 nd Edition; Tata McGrawHill Publishing Company Limited.

REFERENCES	
1	F. J. MacWilliams, N. J. A. Sloane; The theory of error correcting codes; North Holland
2	R.E. Blahut; Theory and Practice of Error Control Codes, Addison Wesley
3	Alvatore Gravano; Introduction to Error Control Codes; Oxford University Press
4	W. Cary Huffman, Vera Pless; Fundamentals of Error Correcting Codes; Cambridge University Press
5	Paul Garrett; Mathematics of Coding Theory: Information, Compression, Error Correction, and Finite Fields; Prentice Hall
6	Bernard Sklar; Digital Communications : Fundamental & Applications, 2 nd Edition; Pearson Education
7	Peter Sweeney; Error Control Coding: From Theory to Practice; John Wiley & SonsLtd.

VLSI LAB					
Course Code	ET650		Credits	1	
Scheme of Instruction	L	T	P	TOTAL	
Hours/ Week	0	0	2	30hrs/sem	
Scheme of Examination	IA	TW	TM	P	O
TOTAL = 50 marks	0	25	0	0	25

Course Objectives: The course aims to provide the student with:

1. An ability to understand SPICE programming.
2. An ability to understand VHDL programming.
3. An ability to Draw Layouts for combinational circuits
4. An understanding of designing using FPGAs.

Course Outcomes:

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

CO1	Write the SPICE programs for modeling MOSFET circuits
CO2	Implement and verify Layouts for combinational circuits.
CO3	Simulate combinational and sequential circuits using VHDL.
CO4	Implement digital circuits using FPGA's.

A minimum of 10 experiments to be conducted from the following list of titles:

1. SPICE program for NMOS and PMOS Characteristics;
2. SPICE program for channel length modulation in MOSFET
3. SPICE program for CMOS Inverter VTC.
4. SPICE program for Transmission Gate.
5. VHDL programs for Combinational circuits. Verify with Test benches
6. VHDL programs for sequential circuits. Verify with Test benches
7. Layout for Inverter and parameter extraction in SPICE.
8. Layout for NAND & NOR and parameter extraction in SPICE.
9. Layout for XOR & XNOR and parameter extraction in SPICE.
10. Layout for Boolean function and parameter extraction in SPICE .
11. Layout for 2x1 MUX in Transmission Gates.
12. Sequential / Combinational circuit design using FPGA

REFERENCES	
1	SPICE (The Oxford Series in Electrical and Computer Engineering) Paperback –Gordon W. Roberts , Adel S. Sedra .
2	VHDL Primer, Bhasker
3	Circuit Design and Simulation with VHDL (The MIT Press) , 2010, Volnei Pedroni.

ELECTRONIC SYSTEM DESIGN LABORATORY					
Course Code	ET660		Credits	1	
Scheme of Instruction	L	T	P	TOTAL	
Hours/ Week	0	0	2	30hrs/sem	
Scheme of Examination	IA	TW	TM	P	O
TOTAL = 50 marks	0	25	0	0	25

Course Objectives:

The course aims to provide the student with:

1. Knowledge to show their innovativeness and understanding of electroni systems through hardware and software based system design.
1. Enhancement of the learning experience of the students in different domains,
2. Help to learn how as a system designer they should reason out and select the right integrated circuit for the right application and also to take decisions to optimize system level cost or power or performance by trade-off of various design parameters.

Course Outcomes:

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

CO1	Understand the key concepts involved in electronic system design.	
CO2	Apply the device design considerations on device performance.	
CO3	Develop analytical approaches to understand electronic system design.	
CO4	Evaluate and demonstrate an understanding of the recent technologies used in electronic system design.	

List of Experiments: (At least 8 experiments should be conducted fromthe list of experiments.)

Students in batch-wise (maximum 4 in a group) should design, select the component based on understanding of the datasheets and according to design considerations, Layout the design (CAD Tool), Fabricate the PCB, Assemble the designed circuit, and solder it on PCB.

Minimum two working models from the following list (Not limited to) should be implemented and **minimum Six** experiments as simulation / study experiments should be performed

1. Design of full wave centered tapped rectifier circuit using a capacitor Filter to give a DC output of 12V at 100Ù load with ripple factor not exceeding 0.014.
2. Design of Regulated Power supply for fixed voltage using IC 7805
3. Design of Regulated Power supply for variable voltage using LM 317.
4. To design an Instrumentation Amplifier using IC 741
5. To Design variable gain (1-50) audio power amplifier using LM380.
6. Design a tone control circuit using IC LM 833.
7. Design a transistorized single stage negative feedback amplifier
8. Design of an ac/dc voltage regulator using SCR.
9. Design of AM/FM modulator and demodulator
10. Wireless data modem using FSK modulator and demodulator.
11. Arduino based applicative project.
12. Automatic street light switch
13. Automatic water tank overflow alarm
14. Any mini-project as suggested by course-coordinator

REFERENCES	
1	JeraldG.Graeme.ApplicationsofOperationalAmplifiers:ThirdGeneration Techniques
2	James K. Roberge. Operational Amplifiers: Theory and Practice. Wiley, New York
3	Electronic Devices & Circuits, Jacob Millman, Christos C Halkias and Satyabrata Jit, McGraw Hill Education; 4 edition (2015)
4	Analog Circuit Design, Peter D. Hiscocks, Second Edition, Syscomp Electronic Design Limited, 2010
5	Analog Circuit Design: A Tutorial Guide to Applications and Solutions, Bob Dobkin and Jim Williams, Elsevier, 2011
6	Online resources

<table>
<tr><th colspan="6">CYBER LAW AND IPR</th></tr>
<tr><td>Course Code</td><td colspan="2">HM006</td><td>Credits</td><td colspan="2">3</td></tr>
<tr><td rowspan="2">Scheme of Instruction
Hours/ Week</td><td>L</td><td>T</td><td>P</td><td colspan="2">TOTAL</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td colspan="2">40hrs/sem</td></tr>
<tr><td rowspan="2">Scheme of Examination
TOTAL = 125 marks</td><td>IA</td><td>TW</td><td>TM</td><td>P</td><td>O</td></tr>
<tr><td>25</td><td>0</td><td>100</td><td>0</td><td>0</td></tr>
</table>

Course Objectives:

The course aims to provide the student with:

1. An introduction to understanding the concept of cybercrime and the laws that deal with it.
2. An understanding of the legal issues related to defamation, harassment and E-mail abuse
3. An awareness regrading various aspects of copyright infringement.
4. An understanding of the fundamental aspects of Intellectual property Rights(IPR) and their role in development and management of innovative projects in industries.
5. An ability disseminate knowledge on copyrights, its related rights and registration aspects
6. An understanding of the issues related to trademarks and registration aspects of patents

Course Outcomes:

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

CO1	Describe and analyze cyber crime and understand jurisdictional aspects of cyber law
CO2	Explain the concept of copyright, protection , computer piracy and relevant laws to deal with aspects related to infringement on the issues
CO3	Explain the concept of Intellectual Property rights , principles of enforcement and methods of protection
CO4	Describe to the concept of patents and legal issues related to enforcement of Intellectual Property Rights

UNIT 1	
Power of Arrest without Warrant under the IT Act, 2000: A Critique: Section 80 of the IT Act 2000, Forgetting the line between Cognizable and Non-Cognizable Offences, Necessity of Arrest without warrant from any place, public or otherwise. Cyber Crime and Criminal Justice: Concept of Cyber Crime and the IT Act 2000, Hacking, Teenage web vandals, Cyber fraud and cyber cheating. Virus on the Internet. Defamation, harassment and E-mail abuse, Monetary penalties, adjudication and appeals under IT Act 2000, Nature of cyber criminality, strategies to tackle cyber crime and trends, Criminal justice in India and Implications on Cyber crime. Contracts in the Infotech World: Contracts in the Infotech world, Click-wrap and Shrink-wrap contracts, Contract formation under the Indian Contract Act 1872, Contract formation on the Internet, Terms and Conditions of Contracts, Software product license. Jurisdiction in the Cyber World: Civil law of Jurisdiction in India, Cause of action, Jurisdiction and the Information Technology Act 2000, Place of cause of action in contractual and IPR disputes, Exclusion clauses in Contracts, Abuse of exclusion clauses.	10hrs
UNIT -2	
Battling Cyber Squatters and Copyright Protection in the Cyber World: Concept of Domain name and reply to Cyber Squatters, Battle between freedom and control on the internet, Works in which copyright subsists and meaning of Copyright, Copyright Ownership and Assignment, License of Copyright, Copyright term and respect for foreign works, Copyright Infringement, Remedies and Offences, Copyright protection of content on the Internet, Copyright notice, disclaimer and acknowledgment, Napster and its Cousins, Computer Software Piracy. Digital signatures, Digital Signature Certificate, Certifying Authorities and Liability in the Event of Digital Signature Compromise, E-Governance in India. The Indian Evidence Act of 1872 v/s Information Technology Act, 2000: Status of Electronic Records as Evidence, Proof and Management of Electronic Records, Proving Digital Signature, Proof of Electronic Agreements, Proving Electronic Messages, Other Amendments in the Indian Evidence Act by the IT Act	10hrs
UNIT -3	
Intellectual Property: Introduction, Protection of Intellectual Property — Copyright, Related Rights, Patents, Industrial Designs, Trademark, Unfair Competition Information Technology Related Intellectual Property Rights Computer Software and Intellectual Property — Objective, Copyright Protection, Reproducing, Defences, Patent Protection. Database and Data Protection-Objective, Need for Protection, UK Data Protection Act, 1998, US Safe Harbor Principle, Enforcement. Protection of Semiconductor Chips-Objectives Justification of Protection, Criteria, Subject Matter of Protection, WIPO Treaty, TRIPs, SCPA. Domain Name Protection-Objectives, Domain Name and Intellectual Property, Registration of Domain Names, Disputes under Intellectual Property Rights, Jurisdictional Issues, and International Perspective.	10hrs

UNIT -4	
Patents (Ownership and Enforcement of Intellectual Property) Patents — Objectives, Rights, Assignments, Defences in Case of Infringement Copyright-Objectives, Rights, Transfer of Copyright, Work of Employment Infringement, Defences for Infringement, Trademarks — Objectives, Rights, Protection of good will, Infringement, Passing off, Defences. Designs — Objectives, Rights, Assignments, Infringements, Defences of Design Infringement. Enforcement of Intellectual Property Rights — Civil Remedies, Criminal Remedies, Border Security Measures. Practical Aspects of Licencing — Benefits, Determinative Factors, Important Clauses, Licensing Clauses.	10hrs

TEXTBOOKS	
1	Vivek Sood, Cyber Law Simplified, Tata McGraw-Hill.
2	Nithyananda, K V. Intellectual Property Rights: Protection and Management. India, Cengage Learning India Private Limited(2019).
3	Neeraj, P., Khusdeep, D. . Intellectual Property Rights. India, IN: PHI learning Private Limited(2014)

REFERENCES	
1	IPR and Cyber Law , Sunil Shah, Himalaya Publishing house.
2	W. Cornish & Llewelyn – Intellectual Property: Patent, Copyrights, Trade Marks & Allied Rights", London Sweet & Maxwell.
3	Nard Madison- The Intellectual Property, Aspian Publication
4	Carlosm Correa- Oxford commentaries on GATT/ WTO Agreements trade related aspects of Intellectual Property Rights, Oxford University Press.
5	Ahuja, V K. (2017). Law relating to Intellectual Property Rights. India, IN: Lexis Nexis.

SEMESTER – VII

DATA COMMUNICATION					
Course Code	ET710		Credits	4	
Scheme of Instruction Hours/ Week	L	T	P	TOTAL	
	3	1	0	40hrs/sem	
Scheme of Examination TOTAL = 150 marks	IA	TW	TM	P	O
	25	25	100	0	0

Course Objectives:

The course aims to provide the student with:

1. An introduction to the concept of OSI model, TCP/IP , identifying different network topologies and Protocols.
2. An understanding of Data link layer protocols & technologies.
3. An understanding of the Routing algorithms, flow control & Congestion Control
4. An understanding of Internet Protocols & Transport Protocols
5. Familiarization with various Networking Devices & their functions within a network

Course Outcomes:

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

CO1	Explain the functions of the various layers of OSI Model, networking devices and protocols of data communication.
CO2	Apply the various line coding techniques, flow and error control techniques.
CO3	Classify and compare the services of the layers of the OSI model.
CO4	Analyze various networks based on their applications.

UNIT -1	
OSI Model: Layered architecture of OSI model, TCP/IP architecture. **Data communication concepts**: Parallel and Serial transmission, Asynchronous and Synchronous transmission, Line coding-NRZ, RZ, AMI, HDB3, B8ZS. **Modems**: Types of modems, Scrambler and Descrambler. **LAN systems**: Architecture: Bus, Ring, Tree, Star, Fast Ethernet, Token ring. Ethernet: Contention access, CSMA, CSMA/CD Physical Layer: Interface-RS232, DTE-DCE interface, Null Modems.	10hrs
UNIT -2	
Data Link Layer: Frame design consideration, flow control, error control (stop and wait mechanism, sliding window), sequence numbering of frames, piggybacking acknowledgement. **Data link protocols:** BISYNC, transmission frames, protocol operation, HDLC, Flow and error control in HDLC, framing in HDLC, transparency in HDLC, HDLC protocol operations, comparison of BISYNC and HDLC **Switching:** switching networks, circuits switching, space division switching, time division switching, packet switching (datagram and virtual circuit [SVC, PVC]), message switching.	10hrs
UNIT -3	
Networking Devices: Repeaters, Bridges, Routers, Firewall. **Network Layer:** Services, virtual circuits and datagram subnet, routing algorithms (shortest path, flooding, flow based, distance vector, link state), congestion control, choke packets, load shedding, jitter control, flow specifications, traffic shaping (leaky bucket and token bucket algorithm) **Internet protocols**: IPv4, CIDR, NAT, OSPF, BGP, IPv6	10hrs
UNIT -4	
Transport protocols: Transport service: Services provided to the upper layer, connection establishment, connection release, multiplexing, flow control and buffering, crash recovery, Comparison of internet transport protocols (TCP and UDP). **ATM**: ATM architecture- virtual connection, identifiers, cells, connection establishment and release. **ISDN**: IDN, ISDN, ISDN channels (B, D, H), ISDN interfaces (BRI and PRI). **Application Layer:** DNS, DHCP, Telnet,electronic mail, HTTP.	10 hrs

TEXTBOOKS	
1	Behrouz A. Forouzan,Data Communication & Networking- Tata Mc-Graw Hill, 2ed.
2	Prakash C. Gupta, Data Communication and computer networks- PHI.
3	Andrew S. Tanenbaum,Computer networks , PHI, 4ed.

REFERENCES

1	Achyut S Godbole,Data Communication and Networks , Tata McGraw.
2	William Stallings, Data and Computer Communications, Prentice Hall, 8ed

ROBOTICS					
Course Code	**ET721**		**Credits**	**3**	
Scheme of Instruction Hours/ Week	**L**	**T**	**P**	**TOTAL**	
	3	**0**	**0**	**40hrs/sem**	
Scheme of Examination TOTAL = 125marks	**IA**	**TW**	**TM**	**P**	**O**
	25	**0**	**100**	**0**	**0**

Course Objectives: The course aims to provide the student with:

1. An understanding of all the subsystems and components of a robot.
2. An ability to select appropriate sensors, actuators and end effectors for robots
3. An ability to analyze the kinematics and motion planning of robotic systems.
4. An understanding of control strategies employed in robot platforms

Course Outcomes:

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

CO1	Explain working principle behind various types of actuation systems and sensors, different robot architectures and applications and control techniques used in robotic systems	
CO2	Evaluate appropriate end effectors, sensors and motion strategies for given robotic application	
CO3	Solve problems related to robot specifications, actuators, robot kinematics and control.	
CO4	Propose robotic solutions for a given application	.

UNIT -1	
Basic Concepts in (Fundamentals of) robotics: Automation and robotics, Robot applications. **Different classifications of robot**: By application, by coordinate system, by actuation system, by control method and by programming method. **Robot anatomy**: links and joints, Joint notation scheme. Degree of Freedom. Robot resolution, accuracy and repeatability. Concept of workspace. **Drive systems**: Pneumatic and hydraulic systems. Electric: Relation between torque and voltage. AC and DC Servo motors, Stepper motors, BLDC motors. Electronic control of motors. **Robot End Effectors**: Grippers and Tools.	10hrs
UNIT -2	
Kinematics: Coordinate frames, mapping and transforms, description of objects in space, transformation of vectors, fundamental rotation matrices, **Direct Kinematic model**: Kinematic modelling of manipulator **Inverse Kinematics**: Solvability of inverse kinematic models, solution techniques, closed form solution **Trajectory planning**: Definitions and planning tasks, joint space techniques, cartesian space techniques, joint space v/s cartesian space.	10hrs
UNIT -3	
Manipulator Dynamics: Determination of Robotic Joint Torques, Langrage-Eulerformulation two approaches, Example with 2 link Manipulator. **Control Scheme:** Partitioned control Scheme. **Analysis of wheeled robots and Biped robots:** Introduction, Staircase Ascending (SSP),Power Consumption, Dynamic Balances. **Sensors:** Characteristics of a sensor, Classification of Sensors, Touch sensors, PositionSensors: Potentiometer, LVDT, Optical Encoders, Force/Moment sensors, Range Sensor,Proximity Sensors- Inductive sensor, capacitive sensor, Hall effect sensor, Passive Sensor:RCC	10hrs
UNIT -4	
Machine Vision: Introduction, Sensing & Digitizing function, Imaging devices, Lightingtechniques, Image storage, Image processing and analysis, Image Data reduction,Segmentation, Feature extraction, Object recognition, Training the vision system, Roboticapplications. **Motion planning:** Gross/Free Space Motion Planning **Find path problems using:** Visibility Graph, Voronoi diagram, Cell Decomposition,Tangent-Graph Technique. **Dynamic Motion Planning Problems:** Path Velocity Decomposition, Accessibility Graph,Relative velocity scheme, Incremental planning, Artificial Potential field approach, reactivecontrol scheme.	10 hrs

TEXTBOOKS	
1	John J. Craig; Introduction to Robotics, Mechanics & Control; Pearson Education Inc.
2	Roland Siegwart, Illah R. Nourbakhsh - Introduction to Autonomous Mobile Robots, MIT Press, 2ed.

REFERENCES	
1	S. K. Saha; Introduction to Robotics, 2nd Ed.; McGrawHill
2	Peter Corke; Robotics Vision and Control; Springer.
3	M. P. Groover, M. Weiss, R. N. Nagel, N. G. Odrey; Industrial Robotics Technology: programming and Applications; McGrawHill
4	Mittal & Nagrath; Robotics and Control; McGrawHill

MACHINE LEARNING					
Course Code	**ET722**		**Credits**	**3**	
Scheme of Instruction Hours/ Week	**L**	**T**	**P**	**TOTAL**	
	3	**0**	**0**	**40hrs/sem**	
Scheme of Examination TOTAL = 125marks	**IA**	**TW**	**TM**	**P**	**O**
	25	**0**	**100**	**0**	**0**

Course Objectives:

The course aims to provide the student with:

1. An understanding of the basic concepts of classification, clustering, predication and regression
2. Knowledge of the advanced methods of classification and clustering
3. An ability to compute the classification accuracy
4. An understanding of the concept of dimensionality reduction

Course Outcomes:

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

CO1	Explain the basic and advanced concepts of classification and clustering
CO2	Design and implement machine learning solutions to classification, regression, and clustering problems.
CO3	Evaluate and interpret the results of the algorithms
CO4	Compute the classification accuracy

UNIT -1	
Basic Concepts (Theory and Numerical): Data mining and Machine Learning, Supervised and Unsupervised Learning, Classification and Prediction, Issues Regarding Classification and Prediction, Bayesian Classification, Decision Tree induction, Rule-Based Classification, Model Evaluation and Selection, Techniques to improve Classification Accuracy, Techniques to Improve Classification Accuracy	10hrs
UNIT -2	
Classification: Advanced Methods (Theory and Numerical): Bayesian Belief Networks, Classification by Backpropagation, Support Vector Machines, Classification Using Frequent Patterns, Lazy Learners, Other classification Methods: Genetic Algorithms, Rough set and Fuzzy set Approach Prediction: Linear (Simple & Multiple), Non-Linear, Logistic Regression, Accuracy and Error Measure: Confusion Matrix, Precision and Recall	10hrs
UNIT -3	
Cluster Analysis: Basic Concepts and Methods (Theory and Numerical): Cluster Analysis, Partitioning Methods, Hierarchical Methods, Density-Based Methods, Grid-Based Methods, Evaluation of Clustering	10hrs
UNIT -4	
Advanced Cluster Analysis: Probabilistic Model-Based Clustering, Clustering High-Dimensional Data, Clustering Graph and Network Data, Clustering with Constraints Outlier Detection, Dimensionality Reduction (PCA & LDA with numerical)	10 hrs

TEXTBOOKS	
1	J. Han and M. Kamber, “Data Mining: Concepts and Techniques”, Third Edition, Elsevier

REFERENCES	
1	M. H. Dunham. Data Mining: Introductory and Advanced Topics, 1e, Pearson Education. 2010
2	Cios, K.J., Pedrycz, W., Swiniarski, R.W., Kurgan, L. “Data Mining A Knowledge Discovery Approach”, Springer, 2007
3	Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, “Introduction to Statistical Learning”, Springer, 2013.
4	Richard Duda, Peter Hart, David Stork, “Pattern Classification”, John Wiley & Sons,2nd Ed., 2001.

WAVELETS AND MULTIRATE SIGNAL PROCESSING					
Course Code	**ET723**		**Credits**	**3**	
Scheme of Instruction Hours/ Week	**L**	**T**	**P**	**TOTAL**	
	3	**0**	**0**	**40hrs/sem**	
Scheme of Examination TOTAL = 125marks	**IA**	**TW**	**TM**	**P**	**O**
	25	**0**	**100**	**0**	**0**

Course Objectives: The course aims to provide the student with:

1. An ability to analyze signal in time and frequency domain.
2. An understanding of orthonormality, sampling rate conversion and short time Fourier transform.
3. An ability to perform multi resolution analysis using filter banks.
4. An understanding of various continuous and discrete wavelet families.

Course Outcomes:

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

CO1	Explain the application of orthonormal basis in signal transformations.
CO2	Design a filter bank for analyzing signal.
CO3	Perform multiresolution analysis of a signal using Haar Wavelet.
CO4	Identify the importance of vanishing moments in construction of wavelets.

UNIT -1	
Introduction to Transformations: Need for Transformations, Inner Products, Orthogonal Transforms, Orthonormality, Basis: Orthogonal and Biorthogonal, Subspace, Span. **Overview of some basic transforms:** Z-Transform, Fourier series, Fourier Transform: Continuous and Discrete, Short Time Fourier Transform, Windowing Methods. **Introduction to Rate Converters:** Interpolator, Decimator, Properties, Effect of Interpolation and Decimation in frequency domain. **Disadvantage of:** Fourier Transform, STFT and Windowing Methods.	10hrs
UNIT -2	
Piecewise constant approximation: the Haar wavelet, Building up the concept of dyadic Multiresolution Analysis (MRA), Relating dyadic MRA to filter banks, Elements of multirate systems and two-band filter bank design for dyadic wavelets.	10hrs
UNIT -3	
Families of wavelets: Orthogonal and biorthogonal wavelets, Daubechies' family of wavelets in detail, vanishing moments and regularity. Conjugate Quadrature Filter Banks (CQF) and their design, Dyadic MRA more formally; Data compression - fingerprint compression standards, JPEG-2000 standards. **The Uncertainty Principle, and its implications:** the fundamental issue in this subject - the problem and the challenge that Nature imposes. The importance of the Gaussian function: the Gabor Transform and its generalization; time, frequency and scale - their interplay.	10hrs
UNIT -4	
The Continuous Wavelet Transform (CWT),Condition of admissibility and its implications, Application of the CWT in wideband correlation processing, Journey from the CWT to the DWT: Discretization in steps, Discretization of scale - generalized filter bank. Discretization of translation - generalized output sampling, Discretization of time/ space (independent variable) - sampled inputs.	10 hrs

TEXTBOOKS	
1	Raghuveer M.Rao , Ajit S. Bapardikar; Wavelet transforms- Introduction to theory and applications; Person Education.
2	P. P. Vaidyanathan; Multirate Systems and Filter Banks; Pearson Education.
3	L. Prasad, S.S. Iyengar; Wavelet Analysis with Applications to Image Processing.; CRC Press

REFERENCES	
1	Howard L. Resnikoff, Raymond O. Wells; Wavelet Analysis: The Scalable Structure of Information; Springer
2	G. Strang, T. Nguyen; Wavelets and filter banks; Wellesley-Cambridge Press.
3	K.P. Soman and K.L. Ramchandran; Insight into Wavelets from theory to practice; Prentice Hall.

CONSUMER ELECTRONICS					
Course Code	ET724		Credits	3	
Scheme of Instruction Hours/ Week	L	T	P	TOTAL	
	3	0	0	40hrs/sem	
Scheme of Examination TOTAL = 125marks	IA	TW	TM	P	O
	25	0	100	0	0

Course Objectives:

The course aims to provide the student with:

1.An understanding of basic characteristics of sound, microphones, loudspeakers, sound recording with its reproduction and public address systems.

2. An understanding of signal generation to test various sections of TV receiver.

3. An introduction to various electronic household and office appliances.

4. An understanding of the concepts and techniques in marketing.

Course Outcomes:

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

CO1	Explain the concepts related to sound recording and reproduction, TV systems, electrical appliances, marketing planning and strategy.
CO2	Demonstrate safety awareness and take precautionary measures while

	handling electronic equipments.
CO3	Analyze consumer electronic circuits for fault and performance degradation.
CO4	Design sound recording and reproduction circuits and formulate a marketing plan including marketing objectives, marketing mix, strategies.

UNIT -1	
Electro acoustical Transducers: Microphones, Loudspeakers, Pick-up characteristics, specifications and applications. **Sound Recording and Reproduction**: Principle and Block schematic of disc recording system, magnetic recording system, optical recording system, compact disc and video recording. **Audio Amplifier and subsystems**: Audio mixers, tone controls, Graphic equalizers, Features of Hi-Fi and stereo systems, Dolby system, Public Address systems.	10hrs
UNIT -2	
Testing, Alignment and Servicing of Television Receivers: Testing and Alignment of TV receivers, TV Wobbuloscope, Video Pattern Generators, Colour bar generator, Vectroscope, Tuners. **Cable Television**: Modern cable TV system, cable TV converter, Cable systems, Satellite Television, Direct to home TV, LED TV. **Digital television**: Digital Television Systems, Digital TV Signals, Digitized video parameters. **Projection Television**: Basic projection television systems, front and rear projection, LCD & Laser Projection system. **High Definition television systems**: HDTV Systems, HDTV standards and compatibility.	10hrs
UNIT -3	
Modern home appliances with electronic control: Microwave oven, washing machine, Air-conditioner, DVD, Digital Camera, Remote control, Refrigerator, Iron. Working principle of photocopying, fax machine, risograph, solar water heater and solar cooling. **Maintenance and safety measures**: Electricity in home: electric lighting, electric heating. Dangers of Electricity and Safety Precautions.	10hrs
UNIT -4	
Marketing planning: Importance of marketing planning, steps involved in marketing planning process scanning the marketing environment and spotting the business opportunities, setting the market objectives. **Marketing strategy**: the meaning and significance of marketing strategy, formulating the marketing strategy. Techniques and Practices for mass production for reliable production. **Costing**: Overview of costing and marketing communication. Entrepreneurship Awareness. **Patents**: Introduction to patents.	10 hrs

TEXTBOOKS	
1	B.R.Gupta, V. Singhal, Consumer Electronics, S. K. Kataria & Sons, 5ed,2006
2	R G Gupta, Audio and video systems,Tata McGraw-Hill Education, 2ed, 2010
3	S.P. Bali, Consumer Electronics , Pearson Educatio, India, 1ed,2004.

REFERENCES	
1	V S Ramaswamy, J Namakumari, Marketing management planning, implementation and control, Macmillan (2007)
2	Tom Duncan, Electronics for Today and Tomorrow,Trans-Atlantic Publications, Inc.; 2 edition .
3	R G Gupta, Television engineering and video systems , Tata McGraw-Hill Education,2005
4	H S Kalsi, Electronic Instrumentation, TMH, Sixth reprint,2006

HARDWARE DESCRIPTION LANGUAGE					
Course Code	ET725		Credits	3	
Scheme of Instruction Hours/ Week	L	T	P	TOTAL	
	3	0	0	40hrs/sem	
Scheme of Examination TOTAL = 125marks	IA	TW	TM	P	O
	25	0	100	0	0

Course Objectives: The course aims to provide the student with:

1. Learn the Syntax of Verilog HDL and System C.
2. Learn to write Verilog Hardware Description Language programs.
3. Learn to write System C programs.
4. Learn the general architecture of FPGAs.

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

CO1	Explain the syntax and semantics of Verilog HDL and System C.
CO2	Explain the general architecture of FPGA's.
CO3	Write programs to design circuits using Verilog Hardware Description Language.
CO4	Write programs in System C language.

UNIT -1	
Emergence of HDLs, Design Flow using HDLs, Importance of HDLs. Hierarchical ModelingConcepts: Modules, Instances. Data Types: Nets, Registers, Vectors, Arrays, Integer, Real, and Time, Memories, Parameters, Strings.Modules and Ports.Gate Level Modeling: Design of Ripple Carry Adder, Shift Register using DFF, Multiplexer,Demultiplexer, Decoder, Encoder. Test benches to verify the Functionality.	10hrs
UNIT -2	
Dataflow Modeling: Continuous assignment (assign) statement, assignment delay, implicit assignmentdelay, and net declaration delay for continuous assignment statements. Define expressions, operators,and operands. Operator types for all possible operations—arithmetic, logical, relational, equality,bitwise, reduction, shift, concatenation, and conditional.	10hrs
UNIT -3	
Behavioral Modeling: Structured procedures, always and initial. Blocking and	

non-blocking procedural assignments. Conditional statements using if and else. Multiway branching, using case, casex, and casez statements, Loopingstatements such as while, for, repeat, and forever. Definition of sequential and parallel blocks.	10hrs
UNIT -4	
Tasks and functions in Verilog, Finite State Machine using Verilog. Examples of design using Verilog HDL. System C Design Methodology. Syntax and semantics of System C. Data Types in SystemC.Examples of Design in System C FPGA's: Design Flow for Designing with FPGA, General Architecture of FPGAs.	10 hrs

TEXTBOOKS	
1	S. Palnitkar, "Verilog HDL: A Guide to Digital Design and Synthesis",Prentice Hall (NJ,USA), 1996.
2	J. Bhasker, "Verilog HDL Synthesis - A Practical Primer", Star Galaxy Publishing, Allentown,PA) 1998..
3	J Bhasker, System C primer ,Star Galaxy Publishing ,2 ed, 2010.

REFERENCES	
1	"IEEE std 1364-95, Verilog Language Reference Manual", IEEE Press (NY,USA), 1995.
2	Grötker, Liao, Swan, and Martin "System Design with SystemC"; by ISBN 1-4010-7072-1
3	System C Version 2.0 User's Guide

DATA COMMUNICATION LAB					
Course Code	**ET730**		**Credits**	**1**	
Scheme of Instruction	**L**	**T**	**P**	**TOTAL**	
Hours/ Week	**0**	**0**	**2**	**30hrs/sem**	
Scheme of Examination	**IA**	**TW**	**TM**	**P**	**O**
TOTAL = 50 marks	**0**	**25**	**0**	**0**	**25**

Course Objectives:

The course aims to provide the student with:

1. An understanding of the working principle of various communication protocols.
2. Analysis of the various routing algorithms.
3. An understanding of the concept of data transfer between nodes.

Course Outcomes:

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

CO1	Explain details and functionality of layered network architecture.
CO2	Apply mathematical foundations to solve computational problems in data communication between nodes
CO3	Analyze performance of various communication protocols.
CO4	Practice packet /file transmission between nodes.

List of experiments to be conducted

1, Study of NRZ-L encoding method of serial communication.

2. Study of NRZ-I encoding method of serial communication.

3. Study of RZ encoding method of serial communication.

4. Study of MANCHESTER encoding method of serial communication.

5. Study of DIFFERENTIAL MANCHESTER encoding method of serial communication.

6. Study of AMI encoding method of serial communication.

7.To create, name a VLAN in a switch and to transfer port of time to verify its functionality and delete the VLAN.

8. To create, name a VLAN using switch and to transfer range of ports at a time to verify its functionality and delete the VLAN.

9. To connect two switches to increase the number of ports in a vlan using trunking.

10. To create a network to exchange data between two PC's working on different networks using router.

FOURTH YEAR ELECTRONICS AND TELECOMMUNICATION ENGINEERING PROGRAM
SYLLABUS, REVISED COURSE (2019-2020)

SEMESTER – VIII

<table>
<tr><th colspan="6">ADVANCED COMMUNICATION ENGINEERING</th></tr>
<tr><td>Course Code</td><td colspan="2">ET810</td><td>Credits</td><td colspan="2">3</td></tr>
<tr><td rowspan="2">Scheme of Instruction
Hours/ Week</td><td>L</td><td>T</td><td>P</td><td colspan="2">TOTAL</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td colspan="2">40hrs/sem</td></tr>
<tr><td rowspan="2">Scheme of Examination
TOTAL = 125marks</td><td>IA</td><td>TW</td><td>TM</td><td>P</td><td>O</td></tr>
<tr><td>25</td><td>0</td><td>100</td><td>0</td><td>0</td></tr>
</table>

Course Objectives: The course aims to provide the student with:

1. An understanding of orbiting satellites, satellite orbital mechanics and their parameters, satellite subsystems and earth station equipment.
2. Conceptual knowledge of factors affecting the satellite link design, multiple access schemes, Global Positioning systems and VSAT systems.
3. An understanding of basic concepts of ray and mode theory of light propagation through optical fibers, fiber impairments and fiber joints.
4. Knowledge of construction and working of Optical Sources and Photo-detectors, WDM concepts.

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

CO1	Explain the theoretical and mathematical concepts of satellite and optical communication.
CO2	Analyze performance of satellite and optical communication under different scenarios.
CO3	Analyze efficacy of modulation and multiple access methods for maximum user access in optical and satellite communication.
CO4	Design satellite and optical link taking into consideration power budget for efficient performance in terms of BER and SNR.

UNIT -1	
Satellite Orbits: Satellite Communication System basics, Types of orbits, location of satellite with respect to earth, orbital parameters , Look angles, earth coverage and slant range, eclipse effects, orbital perturbations, satellite placement in geostationary orbit, Station keeping and Satellite Stabilization. **Satellite Subsystems:** Electric power supply, Altitude and Orbit Control, Propulsion Subsystem, Communication Subsystem (Repeaters/Transponders), Antenna Subsystems, Telemetry-TrackingCommand and Monitoring, Thermal Control Subsystem, Structure Subsystem. **Earth Station:** Types of Earth Station, Design Considerations and Earth system subsystems.	10hrs
UNIT -2	
Satellite Link Design: Link design equations, system noise temperature, C/N and G/T Ratio, Uplink design, complete Link design, Frequency considerations, Propagation Considerations , interference related problems, earth station parameters. **Multiple Access:** Frequency Division Multiple access, Time Division Multiple access, TDMA Frame, Burst and Superframe structure, FDMA v/s TDMA, Satellite switched TDMA, Beam Hopping TDMA, Space division Multiple Access. **VSAT satellite systems:** VSAT concept, VSAT/ Wireless local loop networks. VSAT network architectures, multiple access methods, Applications of VSAT networks. **Global positioning Satellite systems:** GPS segments, Working principle, GPS signal structure, GPS Positioning services and positioning modes, Trilateration method.	10hrs
UNIT -3	
Overview of optical fiber communication: Key elements of optical fiber systems. **Transmission Theory:** Ray theory transmission- Snell's law, skew rays. Optical fiber modes and configurations, single mode fibers, graded index fiber structures, cut-off wavelength, mode-field diameter, mode theory(derivations), basic concepts and classification of attenuation and dispersion (no derivation for intramodal dispersion). **Optical fiber joints:** Fiber to fiber joints, fiber misalignments, Fiber splicing.	10hrs
UNIT -4	
Optical Sources: Energy bands, direct and indirect bandgap. **LED structures:** edge emitter LEDs and surface emitter LEDs, Quantum efficiency and LED power, modulation of LED. **Laser diodes:** absorption, emission of radiation, population inversion, laser diode modes and threshold conditions, Fabry-Perot Laser diode, distributed feedback Laser diode. **Photo-detectors:** PN photodiode, PIN photodiode, Avalanche Photodiode, Quantum efficiency, responsivity, cut-off wavelength. **WDM concepts and components:** Operational principles and standards	10 hrs

of WDM.	

TEXTBOOKS	
1	D. C. Agarwal; Satellite Communications, 6th Edition, Khanna Publishers
2	Timothy Pratt, Charles Bostian, Jeremy Allnutt; Satellite Communications, 2nd Edition,Wiley Publications
3	Anil K Maini, Varsha Agarwal; Satellite Communications; Wiley Publications.

REFERENCES	
1	Gerd Keiser; Optical Fiber Communication, 4th Edition, McGraw Hill Publications.
2	John M Senior; Optical Fiber Communications, 5th Edition, Pearson Education.

PROCESS CONTROL INSTRUMENTATION					
Course Code	**ET821**		**Credits**	**3**	
Scheme of Instruction Hours/ Week	**L**	**T**	**P**	**TOTAL**	
	3	**0**	**0**	**40hrs/sem**	
Scheme of Examination TOTAL = 125marks	**IA**	**TW**	**TM**	**P**	**O**
	25	**0**	**100**	**0**	**0**

Course Objectives: The course aims to provide the student with:

1. An understanding of various Industrial Process Control Mechanisms.
2. Theoretical and practical training in the operation and maintenance of automated process control.
3. An understanding of various devices to measure physical processes in Industries.
4. An overview of Industrial Controller modes

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

CO1	Explain Process Control Instruments used in Industry.
CO2	Evaluate appropriate sensor for given application.
CO3	Design at block system level a complete instrumentation system for a given application
CO4	Evaluate Actuators and controllers for an instrumentation system

UNIT -1	
Introduction to Process Control: Introduction; control systems; process control block diagram; servomechanisms; control system evaluation; on off control; analog and digital control; process characteristics. **Sensors:** Sensor time response. Overview of Thermal sensors: RTD, thermistors, thermocouples. Overview of Mechanical sensors: Strain, motion, pressure, and flow. Optical sensors: Photodetectors, pyrometers, applications: design consideration of all sensors.	10hrs
UNIT -2	
Analog and digital signal conditioning; Analog signal conditioning: Linearization, Conversion, SCR and TRIAC. Final Control: Introduction; final control operation; Signal conversion. **Actuators:** Electrical, pneumatic, and hydraulic; Control elements: mechanical; electrical; Fluid valves; Control valve type; Control valve sizing; Process instrumentation. **Discrete state process control:** Introduction; definition; characteristics of the system; relay controllers.	10hrs
UNIT -3	
Controller Principles: Introduction; overview of control system parameters; continuous controller modes: proportional, integral, derivative control modes; composite control modes: PI, PD, PID; Telemetry: pneumatic telemetering system; electronic telemetry system; electrical electronic telemetering system. Analog /digital controllers: Introduction; electronic, pneumatic, digital controller; design considerations.	10hrs
UNIT -4	
Computer in process control: Data logging; supervisory control; computer-based controller; digital controller for a turbine and generator. Introduction to process loops; simple control schemes for level, flow, temperature as applied to reactor, heat exchanger. Overview of signal recorders: chart recorder, fiber optic recorder, magnetic recorder, UV Recorder, printing processes: Risograph, laser printers; Process control networks: Modbus communication RS485/RS422. **Applications of PLC to process control:** Traffic generation, water-bottle plant; Microprocessor/microcontroller application in process instrumentation: Microprocessor/microcontroller control of a petrol engine, microprocessor/ microcontroller based data logger; process loop tuning.	10 hrs

TEXTBOOKS	
1	Curtis D. Johnson; Process Control Instrumentation Technology, 7th Edition; Pearson Education
2	Alan S. Morris; Principles of Measurement and Instrumentation, 3rd Ed.; Butterworth-Heinemann (Reed Educational and Professional Publishing Ltd) 2001 .
3	C. Rangan, G. Sarma, V. Mani; Instrumentation Devices and Systems, TMH

REFERENCES	
1	S. K. Singh; Industrial Instrumentation and control; TMH
2	Donald P. Eckman; Automatic process control; Wiley
3	B. C. Kuo; Digital control systems; Oxford University Press

<table>
<tr><th colspan="6">RF DESIGN</th></tr>
<tr><td>Course Code</td><td colspan="2">ET822</td><td>Credits</td><td colspan="2">3</td></tr>
<tr><td rowspan="2">Scheme of Instruction
Hours/ Week</td><td>L</td><td>T</td><td>P</td><td colspan="2">TOTAL</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td colspan="2">40hrs/sem</td></tr>
<tr><td rowspan="2">Scheme of Examination
TOTAL = 125marks</td><td>IA</td><td>TW</td><td>TM</td><td>P</td><td>O</td></tr>
<tr><td>25</td><td>0</td><td>100</td><td>0</td><td>0</td></tr>
</table>

Course Objectives:

The course aims to provide the student with:

1. An introduction to passive components used in RF design and their characteristics.
2. An ability to design high frequency and low noise amplifiers for RF applications.
3. An ability to design RF subsystems such as mixers, oscillators and PLL's.
4. An introduction to various RF architectures used in modern cellular networks.

Course Outcomes:

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

CO1	Explain the RF system, noises, modulation, amplifier and oscillator.
CO2	Apply concepts the RF system, noises, modulation, amplifier and oscillator to RF design.
CO3	Analyze matching networks using passive elements and appropriate topology.
CO4	Design amplifiers, Mixers, PLL's and frequency synthesizers for RF applications.

UNIT -1	
Introduction: RF systems – basic architectures, Transmission media and reflections, Maximum power transfer. **Distributed Systems**: Transmission lines, reflection coefficient, Lossy transmission lines **Basic concepts of RF Design**: Effect of nonlinearity, cascaded nonlinear stages . Intersymbol interference **Ramdom processes and noise**: Random processes, Noise Sensitivity and Dynamic range, Passive impedance transformation	10hrs
UNIT -2	
Modulation and Detection:Analog modulation: Amplitude modulation, Phase and frequency modulation, **Digital modulation**: Basic concepts, Binary modulation, Quadrature modulation **Power Efficiency of Modulation schemes**: Constant and variable envelope signals, spectral regrowth, Noncoherent detection	10hrs
UNIT -3	
Transreceiver Architectures: Basic concept **Receiver architectures**: Heterodyne receiver, Homodyne receiver, Image Reject receiver, Digital IF receiver, Subsampling receiver **Transmitter Architectures** : Direct Conversion transmitters, Two step transmitters. **Low Noise Amplifiers and Mixer: Low Noise Amplifiers:** Basic concept, Input matching, Bipolar LNAs. **Downconversion Mixers**: Basic concept, Bipolar Mixers	10hrs
UNIT -4	
Oscillators: Basic concept, Basic LC oscillator topologies, voltage controlled oscillators, Effect of phase noise in RF communication, Q of an oscillator. **Frequency Synthesizer**: Phase Locked Loop: Basic concept, Basic PLL, Charge pump PLL, Type I and Type II PLLs. **Power Amplifier**: Linear and Nonlinear PAs, Classification of Power Amplifiers: Class A, B and C	10 hrs

TEXTBOOKS	
1	Behzad Razavi; RF Microelectronics; Prentice Hall Communication Engineering and Emerging Technologies Series, Prentice-Hall of India Pvt. Ltd., New Delhi
2	Thomas H. Lee; The Design of CMOS Radio-Frequency Integrated Circuits; Cambridge University Press, Second Edition 2004.

REFERENCES	
1	David M. Pozar; Microwave Engineering, Third Edition, John Wiley & Sons (ASIA) PTE. Ltd.

HIGH PERFORMANCE COMPUTER ARCHITECTURE					
Course Code	ET823		Credits	3	
Scheme of Instruction	L	T	P	TOTAL	
Hours/ Week	3	0	0	40hrs/sem	
Scheme of Examination	IA	TW	TM	P	O
TOTAL = 125marks	25	0	100	0	0

Course Objectives:

The course aims to provide the student with:

1. An understanding of the concepts of High performance computing and Computer architecture
2. An ability to differentiate between computer organization and architecture
3. An understanding of the concepts of Multi-core processors and pipelining
4. An understanding of different types of memories and memory management techniques
5. An understanding of the concepts of Basic Principle of Message Passing Programming
6. An understanding of the fundamentals of Grid and Cloud computing

Course Outcomes:

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

CO1	Explain the concept of high performance computing and its applications.
CO2	Understand the concept of pipelining, memory organization and management.
CO3	Apply parallel computing algorithms in practical applications and measurethe performance of the system.
CO4	Analyse the working of GPU and CPU and understand the concepts of Grid and Cloud computing.

UNIT -1	
Introduction to High performance computing(HPC): Need for HPC. Components of parallel computing systems. Multiprocessor vs multicore architectures. Sequential vs Parallel Computing. Basic Concepts of Computing: Program, Process, Thread, Instruction Levels of Parallelism: Data, Instruction, thread and process level, Classification of parallel architectures: Flynn's classification (SISD, SIMD, MIMD, MISD). Interconnection topologies, Programming models Computer organization v/s Architecture: Structure and Function, RISC and CISC Processors, Basic concept of Superscalar architecture Applications of Parallel Computing	10hrs
UNIT -2	
Basic concepts of Pipelining and types. Hazards and resolution techniques Types of memory: Primary, Secondary, Cache Memory hierarchy, Cache coherence Memory management: Swapping, Partitioning, Paging, Virtual Memory, TLB, Segmentation, page replacement policies	10hrs
UNIT -3	
Shared (Barrier, Mutual Exclusion) Distributed memory (UMA UNUMA, Loosely and Tightly coupled) Data Dependencies Algorithms for Parallel Processing: Matrix multiplication, Parallel Sorting algorithms Introduction to Performance Measures: Speedup and Efficiency, Amdahl’s Law, Gustafson’s-Barsis Law	10hrs
UNIT -4	
Multicore organization: Heterogeneous and homogeneous, Example (Intel core i7 and ARM cortex A15). General –Purpose GPU,CUDA basics, GPU vs CPU, GPU Architecture Overview. Basic Principle of Message Passing Programming, Building Blocks: Send and Receive Operations, Message Passing Interface (MPI) . Parallel processing using Grid and Cloud computing.	10 hrs

TEXTBOOKS	
1	Sanjay Razdan,Fundamentals of parallel computing, First edition, Narosa Publication
2	M. Sasikumar,Introduction to Parallel Processing, Second Edition, PHI Publication.
3	William Stallings,Computer Organization and Architecture, Tenth Edition, Pearson Education
4	Michael J. Quinn, Parallel Programming in C with MPI and OpenMP, First Edition, McGraw-Hill Publication
5	Ananth Grama,Introduction to Parallel Computing, Second Edition, Pearson Education

REFERENCES	
1	Kailash Jayaswal,Cloud Computing: Black Book , Edition: 2014, Dreamtech Press
2	Kai Hwang,Distributed and Cloud Computing- Edition: 2012, Elsevier

SECURE COMMUNICATION					
Course Code	**ET824**		**Credits**	**3**	
Scheme of Instruction Hours/ Week	**L**	**T**	**P**	**TOTAL**	
	3	**0**	**0**	**40hrs/sem**	
Scheme of Examination TOTAL = 125marks	**IA**	**TW**	**TM**	**P**	**O**
	25	**0**	**100**	**0**	**0**

Course Objectives:

The course aims to provide the student with:

1. An understanding of the fundamentals of cryptography
2.Knowledge about the various encryption techniques.
3.An understanding of the concept of Public key cryptography.
4.An ability to learn about message authentication and hash functions
5.An ability to impart knowledge on Network security

Course Outcomes:

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

CO1	Identify and describe the fundamentals of a secure network and Analyse the various encryption techniques in modern cryptography	
CO2	Illustrate various Public key cryptographic techniques	
CO3	Evaluate the various message authentication codes and cryptographic Hash Functions	
CO4	Discuss Digital Signatures,Authentication Applications and security issues related to internet and networks	.

UNIT -1	
Introduction of Secure Network:Key points(service, mechanisms and attacks),OSI security architecture, Security attacks, security services, security mechanisms, a model for network. Classical encryption techniques: Symmetric cipher model substitution techniques,Transposition techniques, rotor machines,steganography and numerical on different ciphers. Block Ciphers and DES(Data Encryption Standards):Block cipher principles, Data encryption standards, strength of DES, Block cipher design principles, Block ciphermodes of operation problems on DES.	10hrs
UNIT -2	
Public-Key Cryptography and RSA: Principles of public-key cryptosystems, RSA algorithm and numerical on RSA.Key Management; Other Public Key Crypto Systems:Diffie-Hellman key exchange, numericals. **Cryptographic Hash Functions:** Applications of Cryptographic Hash Functions, Requirements of Cryptographic Hash functions **Message Authentication codes:**Message Authentication Requirements,Message Authentication Functions and Message Authenticaion code.	10hrs
UNIT -3	
Digital Signature and Authentication Protocol: Digital signature properties and Digital Signature Requirements, Digital signature standard. **Authentication Applications:** Kerberos: Kerberos Version 4,Kerberos Version5.Comparison of Kerberos version 4 and Kerberos version 5. **X.509 authentication service:**-X.509 Definition ,X.509 Certificates format,X.509 Authentication procedures. Firewalls: Definition,Firewall Characteristics,Types of Firewalls and Firewall Configurations	10hrs
UNIT -4	
Electronic Mail Security: Pretty good privacy(PGP Cryptographic Functions,Transmission and Reception of PGP Message,General format of PGP Message,PGP Message Generation,PGP Message Reception), S/MIME Functions IP Security: Overview, IP security architecture,IP Security Policy, ESP(encapsulating security pay load).	10 hrs

TEXTBOOKS	
1	William Stallings, Cryptography and Network Security, 4th edition, Prentice Hall of India, 2008.

REFERENCES	
1	C. Kaufman, R. Perlman, and M. Speciner, Network Security: PrivateCommunication in a Public World, 2nd edition, Pearson Education (Asia) Pvt. Ltd., 2002.
2	William Stallings , "Network Security Essentials Applications and Standards", 2nd ed., Pearson Education, 2003

SYSTEM VERIFICATION AND VALIDATION					
Course Code	ET825		Credits	3	
Scheme of Instruction	L	T	P	TOTAL	
Hours/ Week	3	0	0	40hrs/sem	
Scheme of Examination	IA	TW	TM	P	O
TOTAL = 125marks	25	0	100	0	0

Course Objectives:

The course aims to provide the student with:

1. An understanding of basic theory and techniques for verification of digital circuits and systems.
2. An ability to understand the theory of testing combinational and sequential logic circuits.
3. An ability to perform fault simulation and detect faults.
4. An understanding of different techniques in Scan Chain Test and Built in Self-Test (BIST)

Course Outcomes:

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

CO1	Explain the basic theory and techniques of System Verification.
CO2	Explain different Scan Chain Based Test and BIST techniques.
CO3	Perform Fault Simulation for Digital circuits
CO4	Generate Test Patterns for combinational circuit

UNIT -1	
Verification :Binary Decision Diagram :Introduction and construction ,Reduction rules andAlgorithms, ROBDDs , Operation on BDDs and its Algorithms , Representation of SequentialCircuits . **Temporal Logic:**Introduction and Basic Operators,Syntax and Semantics of LTL, CTL and CLT* ,Equivalence and Expressive Power . **Model Checking:** Introduction to Verification, Specification and Modelling, Model CheckingAlgorithm, Symbolic Model Checking	10hrs
UNIT -2	
Automata and its use in Verification, Automata Theoretic Model Checking, Practical Examples with SMV Test Introduction to Digital Testing :Introduction, Test process and Test economics , Functional vs. Structural Testing Defects, Errors, Faults and Fault Modeling (mainly stuck at fault modeling) . Fault Equivalence, Fault Dominance, Fault Collapsing and Checkpoint Theorem	10hrs
UNIT -3	

Fault Simulation and Testability Measures :Circuit Modeling and Algorithms for Fault Simulation , Serial Fault Simulation, Parallel Fault Simulation , Deductive Fault Simulation Concurrent Fault Simulation . Combinational SCOAP Measures and Sequential SCOAP Measures . **Combinational Circuit Test Pattern Generation** :Introduction to Automatic Test Pattern Generation (ATPG) and ATPG Algebras ,Standard ATPG Algorithms,D-Calculus and D-Algorithm,Basics of PODEM and FAN.	10hrs
UNIT -4	
Sequential Circuit Testing and Scan Chains :ATPG for Single-Clock Synchronous Circuits Use of Nine-Valued Logic and Time-Frame Expansion Methods Complexity of Sequential ATPG. Scan Chain based Sequential Circuit Testing Scan Cell Design, Design variations of Scan Chains, Sequential Testing based on Scan Chains, Overheads of Scan Design Partial-ScanDesign **Built in Self test (BIST)** :Introduction to BIST architecture, BIST Test Pattern Generation, Response Compaction and Response Analysis . Memory BIST March Test BIST with MISR Neighborhood Pattern Sensitive Fault Test Transparent Memory BIST	10 hrs

TEXTBOOKS	
1	M. Huth and M. Ryan, Logic in Computer Science modeling and reasoning aboutsystems, Cambridge University Press, 2 nd Edition, 2004.
2	Bushnell and Agrawal, Essentials of Electronic Testing for Digital, Memory and Mixed-Signal Circuits, Kluwer Academic Publishers, 2000.
3	Hideo Fujiwara, “Logical testing and design for testability”, The MIT Press.

REFERENCES

1	Michael Huth and Mark Ryan, “Logic in Computer Science: Modelling and Reasoningabout Systems”, 2 nd edition, Cambridge University Press, New York, NY, USA.
2	Ashok K. Sharma, “Advanced Semiconductor Memories: Architectures, Designs, andApplications”, Wiley-IEEE Press, 2002.
3	https://nptel.ac.in/courses/106103016/
4	https://nptel.ac.in/courses/106103116/