Curriculum for Undergraduate Degree (B.Tech.) in Electronics and Communication Engineering (w.e.f. AY: 2020-21)

Part III: Detailed Curriculum

Fifth Semester

Course Name:	**Electromagnetic Waves and Transmission Line**		
Course Code:	PC-EC501	**Category**:	Professional Core
Semester:	Fifth	**Credit**:	3
L-T-P:	3-0-0	**Pre-Requisites:**	Basic laws of Electromagnetics
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	Understand Characteristics of wave propagation in high frequency Transmission lines
2	Apply the knowledge of Impedance Transformation in Transmission lines and use as reactive circuit element
3	Characterization and analysis of Uniform Plane Wave in different media
4	Analysis of wave propagation in metallic waveguides
5	Understand principle of Radiation and Radiation characteristics of Antenna

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	Basics of Vectors, Vector calculus- Gradient, Divergence and Curl , Basic laws of Electromagnetics i.e Coulomb's law, Gauss' law, Divergence theorem. Current Densities, Biot-Savart's law, Ampere's law, Boundary conditions at Media Interface.	6
2	Time Varying Fields and Maxwell's Equation Faraday's law & Lenz's law, Displacement Current, Relation between Conduction current and Displacement Current density, Maxwell's equations, Time-harmonic fields, Wave Equation.	6
3	Uniform Plane Waves Definition of Uniform plane wave and it's theory , Propagation of plane wave in different media i.e in Free Space, Good Dielectric , Lossy Dielectric and Good Conductor, Concept of Loss tangent and skin depth, Poynting Theorem and Poynting Vector, Wave polarization, phase and group velocity, Surface current and power loss in a conductor, Plane Waves at a Media Interface- Reflection and refraction at dielectric	8

	interface, Total internal reflection, wave polarization at media interface, Reflection from a conducting boundary.	
4	Transmission Lines- Equations of Voltage and Current on TX line, Propagation constant and characteristic impedance, Reflection coefficient and Transmission coefficient, Distortion and attenuation in Tx Lines, Condition for minimum distortion, Formation of Standing Waves for different terminations, VSWR and Reflection Coefficient, Impedance Transformation on Loss-less and Low loss Transmission line, Power transfer on TX line, Smith Chart and it's applications in solution of Transmission line problems. Applications of transmission lines: Impedance Matching, use of transmission line sections as reactive circuit elements.	8
5	Wave Guide Analysis of waveguide through general approach, Rectangular waveguide, Modal propagation in rectangular waveguide, Concept of cutoff frequency, cutoff wavelength, Guide wavelength, Dominant mode and it's advantages, degenerate mode, evanescent mode, Surface currents on the waveguide walls, Field visualization, Attenuation in waveguide.	7
6	Radiation Condition of Radiation, Radiation from the Hertz dipole, Power radiated by hertz dipole, Radiation Parameters of antenna i.e Gain , Directivity, Aperture, Efficiency, Impedance, Bandwidth etc.	5
Total		**40**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Understand Characteristics of wave propagation in high frequency Transmission lines
2	Carryout Impedance Transformation in Transmission lines
3	Use Transmission line sections for realizing circuit elements
4	Characterize Uniform Plane Waves
5	Analyze wave propagation in metallic waveguides in modal form
6	Understand principle of Radiation and Radiation characteristics of Antenna

Learning Resources:	
1	Elements of Electromagnetics, 4th Edition – Matthew N O Sadiku, Oxford University Press
2	Networks, Lines and Fields, 2nd Edition- John D. Ryder, PHI Learning
3	Electromagnetic Waves & Radiating Systems, 2nd Edition – E. C. Jordan and K.G. Balmain, Pearson Education
4	Electromagnetic Waves – R K Shevgaonkar, Tata-McGraw-Hill

Course Name:	**Computer Architecture**		
Course Code:	PC-EC502	**Category:**	Professional Core
Semester:	Fifth	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Digital Electronics, Basic Electronics
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	Know the basic principles of working of a computer
2	Analyze the performance of computers
3	Know how computers are designed and built
4	Understand issues affecting modern processors performance (cache, pipeline etc.)

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	**Computer Organization & Architecture:** Basic Structure of Computers, Functional units, Structure of IAS Computer, Harvard & Von Neumann architecture, BUS architecture	4
2	**Data Representation:** Floating Point arithmetic, IEEE 754 floating point formats Multiplication & division of unsigned integers	3
3	**Instruction Set:** Machine instructions and programs, Types of instructions, Instruction sets: Instruction formats, CPU Organization, Instruction Length, Addressing modes, Assembly language, Stacks, Subroutines, Instruction cycle	3
4	**ALU Design:** Arithmetic microoperation, Arithmetic unit, Logic unit, Shifter unit, combinational ALU & sequential ALU	3
5	**Memory Organization:** Memory system overview, RAM, ROM, Hierarchical memory technology: Inclusion, Coherence and locality properties, Cache mapping, Techniques for reducing cache misses, Cache writing policies, Associative memories, Memory management, Virtual memory	6
6	**Processor Organization:** Fundamentals, Processor-memory communication, RISC & CISC based architecture	2
7	**Control unit Design**: Instruction sequencing, Interpretation, Hard wired control unit: Design methods, CPU hardwired control unit, Microprogrammed control unit: Basic concepts, Minimizing microinstruction size, Multiplier control unit, CPU Microprogrammed control unit, Nanoprogamming	5

8	**Parallel processing:** Forms of parallel processing, Flynn's classification –SISD, SIMD, MISD, MIMD architectures, Pipelining, instruction and arithmetic pipeline, data hazards, control hazards and structural hazards, techniques for handling hazards, Multiple issue processor, Multiprocessor, Array and Vector processors, Basic concepts of ILP, interconnect network	6
9	**Input-Output Organization:** I/O interface, Synchronous and Asynchronous data transfer, Interrupt, DMA, Standard I/O interfaces	2
10	**Overview of HDL:** VHDL/Verilog basics programming concept, Structural, dataflow, behavioral & mixed style modeling techniques	2
Total		**36**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Describe different components of computer systems
2	Explain different memory structures and mapping techniques
3	Describe parallel computation system
4	Develop simple functional units using VHDL/Verilog
5	Design and solve problems related to CPU architecture, memory management and pipelining

Learning Resources:	
1	Computer Organization & Architecture Designing for performance, Author: W. Stallings; Pearson
2	Computer Organization, Author: Carl Hamacher, Zvonko Vranesic, Safwat Zaky; MGH
3	Computer System Architecture, Author: M.M. Mano; Pearson
4	Advanced Computer Architecture Parallelism, Scalability, Programmability, Author: Kai Hwang & Naresh Jotwani; MGH
5	Computer Architecture and Organization, Author: J.P. Hayes; MGH
6	Structured Computer Organisation, Author: A.S. Tanenbum; Pearson
7	Computer Organization and Programming: With an Emphasis on Personal Computers, Author: C.W.Gear; MGH
8	Circuit Design And Simulation With VHDL, Author: Pedroni; PHI
9	Computer Organization and Design: The Hardware/Software Interface, Author: David A. Patterson, John L. Hennessy; Morgan Kaufmann
10	VHDL: Programming By Example, Author: Douglas Perry; MGH

Course Name:	**Digital Communication and Stochastic Process**		
Course Code:	PC-EC503	**Category**:	Professional Core
Semester:	Fifth	**Credit**:	3
L-T-P:	3-0-0	**Pre-Requisites:**	Analog Communication, Signals and Systems
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	To develop basic understanding the concept of Stochastic Process in Communication System.
2	To represent various signals in different mathematical forms.
3	To analyze baseband transmission mode of digital data.
4	To analyze different career modulation techniques considering noise aspects.

Course Contents:

Module No.	**Description of Topic**	**Contact Hrs.**
1	**Introduction to Stochastic Processes (SPs):** Definition and examples of SPs, classification of random processes according to state space and parameter space, elementary problems. Stationary and ergodic processes, correlation coefficient, covariance, auto correlation function and its properties, random binary wave, power spectral density.	6
2	**Signal Vector Representation:** Analogy between signal and vector, distinguishability of signal, orthogonality and orthonormality, basis function, orthogonal signal space, message point , signal constellation, geometric interpretation of signals, likelihood functions, Schwartz inequality, Gram-Schmidt orthogonalization procedure, response of the noisy signal at the receiver, maximum likelihood decision rule, decision boundary, optimum correlation receiver; probability of error , error function, complementary error function, Type-I and Type-II errors.	10
3	**Digital Data Transmission:** Concept of sampling, Pulse Amplitude Modulation (PAM), interlacing and multiplexing of samples, Pulse Code Modulation (PCM), quantization, uniform and non-uniform quantization, quantization noise, binary encoding, A-Law and μ -law companding, differential PCM, delta modulation and adaptive delta modulation. Digital transmission components, source, multiplexer, line coder, regenerative repeater, concept of line coding – polar/unipolar/bipolar	8

	NRZ and RZ, Manchester, differential encoding and their PSDs, pulse shaping, Inter Symbol Interference (ISI), Eye pattern, Nyquist criterion for zero ISI, equalizer, zero forcing equalizer, timing extraction.	
4	**Digital Modulation Techniques:** Types of Digital Modulation, coherent and non-coherent Binary Modulation Techniques, basic digital carrier modulation techniques: ASK, FSK and PSK. Coherent Binary Phase Shift Keying (BPSK), geometrical representation of BPSK signal; error probability of BPSK, generation and detection of BPSK Signal, power spectrum of BPSK. Quadrature Phase Shift Keying (QPSK), error probability of QPSK signal, generation and detection of QPSK signals, power spectra of QPSK signals, Offset Quadrature Phase shift Queuing (OQPSK). Concept of M-ary Communication, M-ary phase shift keying, the average probability of symbol error for coherent M-ary PSK, power spectra of MPSK. Coherent Frequency Shift Keying (FSK), Binary FSK, error probability of BFSK signals, generation and detection of Coherent Binary FSK signals, power spectra of BFSK signal. Minimum Shift Keying (MSK), signal constellation of MSK waveforms, error probability of MSK signal, Gaussian Minimum Shift Keying: (GMSK), basic concept of OFDM, constellation diagram. Some performance issues for different digital modulation techniques - Error Vector Magnitude (EVM), Eye Pattern and Relative Constellation Error (RCE), Conceptual idea for Vector Signal Analyzer (VSA)	12
Total		**36**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Understand the concept of Stochastic Process in Communication System.
2	Represent various signals in different mathematical forms.
3	Analyze baseband transmission mode of digital data.
4	Analyze different career modulation techniques considering noise aspects.

Learning Resources:	
1	Digital Communications, S. Haykin, Wiley India.
2	Principles of Communication Systems, H. Taub and D.L.Schilling, TMH Publishing Co.
3	Modern Digital and Analog Communication Systems, B.P.Lathi and Z.Ding, Oxford University Press.
4	Wireless Communication and Networks : 3G and Beyond, I. SahaMisra, TMH Education.
5	Digital Communications, J.G.Proakis, TMH Publishing Co.

Course Name:	**Digital Signal Processing**		
Course Code:	PC-EC504	**Category:**	Professional Core
Semester:	Fifth	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Signals and Systems
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	To make students capable to evaluate the spectrum of different discrete time domain signals
2	To make students familiar with the design mechanism of digital IIR and FIR filters
3	To make students aware about LSI systems and its design implications

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	**Discrete Time domain signals and systems:** Classification of discrete time signals, mathematical operation of discrete time signals, Liner convolution of discrete signals, Inverse system and Deconvolution, Circular convolution, impulse and step response of LTI system, Overlap add method and overlap save method	6
2	**Z-transform and its application in system design:** Z-transform and properties of ROC, Inverse Z-transform, System transfer function and impulse response, Pole-Zero pattern of Z plane, Time domain behavior of single-real- pole, double real pole and complex conjugate pole corresponding to causal signal, S-plane to Z-plane conversion using Impulse invariant method and Bilinear transform, System realization using Direct-1,Direct-2, Cascade and parallel method.	8
3	**Fourier transformation of discrete signals:** Difference between DTFT and DFT, Spectrum development using DFT, Concept of IDFT, Twiddle factor, Radix-2 FFT algorithm, Decimation in time FFT and Decimation in frequency FFT algorithm	6
4	**IIR Filters:** Frequency response and specification of Digital IIR filters, Design of Low pass digital Butterworth filters and normalized transfer function using pole configuration, Design specification of IIR Filters with pass band & stop band attenuation and pass band stop band ripple, Chebyshev low pass digital IIR filter design and its frequency response	8
5	**FIR Filters:** Linear phase FIR filter basic concept, Frequency response of Linear phase FIR Filters, Fourier series method of FIR filter design, Gibbs phenomenon, Rectangular Window, Bartlet Window and Hamming Window for FIR Filter design.	7

6	**Multi rate Signal processing**: Basic concept of multi rate signaling and its application, Decimation(down sampling), Interpolation(up sampling), Anti aliasing and anti imaging Filters, Sampling rate conversion by rational factor I/D, Poly-phase filter structure, Interchanges of Filters and down samplers/ up samplers.	5
Total		**40**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Understand Signal and spectrum mathematically in discrete mode.
2	Analyze the response of an LSI system of different signals.
3	Design of different types of digital filters for applications.

Learning Resources:	
1	Proakis and Manolakis, Digital Signal Processing and applications, Pearson
2	Openhiem & Scaffer - Digital Signal Processing – Pearson India
3	A.Nagoorkani – Digital Signal Ptocessing - TMH
4	V.Udayshankara—Modern Digital Signal Processing , 2/e , PHI
5	S.K. Mitra- Digital Signal Processing, 4th Edition, McGraw Hill.

Course Name:	**Nano Electronics**		
Course Code:	PE-EC 501A	**Category:**	Professional Elective
Semester:	Fifth	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Device Physics
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	Familiarization with nano-electronics devices.
2	Fabrication and characterization techniques of nano-materials and nanodevices.
3	Applications of nano-electronics devices.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	Introduction to nanotechnology, Impacts, Limitations of conventional microelectronics, Trends in microelectronics and optoelectronics. Mesoscopic physics, trends in microelectronics and optoelectronics, characteristic lengths in mesoscopic systems, Quantum mechanical coherence. Classification of Nano structures, Low dimensional structures	8

	Quantum wells, wires and dots, Density of states and dimensionality. Basic properties of two dimensional semiconductor nanostructures, square quantum wells of finite depth, parabolic and triangular quantum wells. Quantum wires and quantum dots, carbon nano tube, graphene	
2	Introduction to methods of fabrication of nano-layers, different approaches, physical vapour deposition, chemical vapour deposition, Molecular Beam Epitaxy, Ion Implantation, Formation of Silicon Dioxide- dry and wet oxidation methods.	4
3	Introduction to characterization of nanostructures, tools used for of nano materials characterization, microscope-optical, electron, and electron microscope. Principle of operation of Scanning Tunnelling Microscope, Atomic Force Microscope, Scanning Electron microscope, Specimen interaction. Transmission Electron Microscope. X-Ray Diffraction analysis, PL & UV Spectroscopy, Particle size analyser.	7
4	Two dimensional electronic system, two dimensional behaviour, MOSFET structures, Heterojunctions, Quantum wells. Concept of super lattices.	5
5	Transport of charge in Nanostructures under Electric field - parallel transport, hot electrons, perpendicular transport. Quantum transport in nanostructures, Coulomb blockade. Transport of charge in magnetic field - Effect of magnetic field on a crystal. Aharonov-Bohm effect, the Shubnikov-de Hass effect, the quantum Hall effect.	7
6	Nanoelectonic devices- MODFETS, heterojunction bipolar transistors. Resonant tunnel effect, RTD, RTT, Hot electron transistors. Coulomb blockade effect and single electron transistor, CNT transistors. Heterostructure semiconductor laser. Quantum well laser, quantum dot LED, quantum dot laser. Quantum well optical modulator, quantum well sub band photo detectors, principle of NEMS.	9
		40

Course Outcomes:	
After completion of the course, students will be able to:	
1	Understand basic concepts of nanoelectronic devices and nano technology.
2	Gain the ability to indentify, formulate, and solve engineering problems;
3	Achieve a recognition of the need for, and an ability to engage in life-long learning.
4	Understand different fabrication and characterization techniques of nano device.

Learning Resources:	
1	Nano Terchnology and Nano Electronics – Materials, devices and measurement Techniques by WR Fahrner – Springe
2	Nano: The Essentials – Understanding Nano Scinece and Nanotechnology by T.Pradeep; Tata Mc.Graw Hill.
3	Nanotubes and nanowires by C.N.R. Rao and A. Govindaraj, RSC Publishing
4	Nanotechnology-Enabled Sensors, KouroshKalantar-zadeh, Springer publications (2007)

Course Name:	**Speech and Audio Processing**		
Course Code:	PE-EC501B	**Category**:	Professional Elective
Semester:	Fifth	**Credit**:	3
L-T-P:	3-0-0	**Pre-Requisites:**	Signals and Systems
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	To understand the mathematical modeling of speech signal processing and different speech coding standards.
2	To be aware of the basic understanding of linear prediction of speech and different speech quantization techniques.
3	To know about the linear prediction coding and the limitations of it.
4	To have the knowledge of code excited linear prediction.

Course Contents:

Module No.	**Description of Topic**	**Contact Hrs.**
1	**Introduction:** Speech production and modelling - Human Auditory System; General structure of speech coders; Classification of speech coding techniques - parametric, waveform and hybrid ; Requirements of speech codecs - quality, coding delays, robustness.	2
	Speech Signal Processing: Pitch-period estimation, all-pole and all-zero filters, convolution; Power spectral density, periodogram, autoregressive model, autocorrelation estimation.	4
2	**Linear Prediction of Speech:** Basic concepts of linear prediction; Linear Prediction Analysis of non-stationary signals -prediction gain, examples; Levinson-Durbin algorithm; Long term and short-term linear prediction models; Moving average prediction.	6
	Speech Quantization: Scalar quantization-uniform quantizer, optimum quantizer, logarithmic quantizer, adaptive quantizer, differential quantizers; Vector quantization - distortion measures, codebook design, codebook types.	4
3	**Scalar Quantization of LPC:** Spectral distortion measures, Quantization based on reflection coefficient and log area ratio, bit allocation; Line spectral frequency - LPC to LSF conversions, quantization based on LSF.	6

	Linear Prediction Coding: LPC model of speech production; Structures of LPC encoders and decoders; Voicing detection; Limitations of the LPC model.	4
4	**Code Excited Linear Prediction:** CELP speech production model; Analysis-by-synthesis; Generic CELP encoders and decoders; Excitation codebook search - state-save method, zero-input zero-state method; CELP based on adaptive codebook, Adaptive Codebook search; Low Delay CELP and algebraic CELP.	6
	Speech Coding Standards: An overview of ITU-T G.726, G.728 and G.729 standards	4
Total		**36**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Understand the mathematical modeling of speech signal processing and different speech coding standards.
2	Understand and analyze linear prediction of speech and different speech quantization techniques.
3	Understand and analyze linear prediction coding.
4	Understand and model code excited linear prediction.

Learning Resources:	
1	"Digital Speech" by A. M. Kondoz, Second Edition (Wiley Students‟ Edition), 2004.
2	"Speech Coding Algorithms: Foundation and Evolution of Standardized Coders", W. C. Chu, Wiley Inter science, 2003.

Course Name:	**Power Electronics**		
Course Code:	PE-EC501C	**Category**:	Professional Elective
Semester:	Fifth	**Credit**:	3
L-T-P:	3-0-0	**Pre-Requisites:**	Basic knowledge of semiconductor devices and Analog Electronics
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	Acquire knowledge on power semiconductor devices
2	Perform analysis of controlled rectifiers.
3	Perform Analysis and solve engineering problems on DC Choppers and Inverters.
4	Apply the knowledge of simple design of SMPS.

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1	Power Semiconductor Devices: Rectifier diodes, fast recovery diodes, Schottky barrier diode, Power BJT, Power MOSFET, IGBT. Characteristics and Rating.	6
2	SCR, TRIAC and GTO: Ratings, Static and Dynamic Characteristics, Trigger, driver, switching-aid circuits and cooling. SCR turn –on and turn - off methods, Triggering circuits, SCR Commutation circuits, SCR Series and Parallel operation, Snubber Circuit.	7
3	Controlled Rectifiers: Single phase and three phase controlled Rectifiers with resistive loads, RL load, Effect of source inductance- performance parameters .Dual Converters.	7
4	DC Chopper: Basic Principles, Step up and Step down choppers, Time ratio control and current limit control, Buck, Boost, Buck Boost and Cuk Converters, Concept of Resonant Switching. Switching Mode Power supply and simple design problems.	8
5	Single-phase inverters: Principle of operation of full bridge square wave PWM inverters. Sinusoidal PWM, modified Sinusoidal PWM techniques, Driver circuits for above inverters and mathematical analysis of output (Fourier series) voltage and harmonic control at output of inverter (Fourier analysis of output voltage). Performance Parameters, Single phase current source inverter.	7
6	Applications: Block diagram and configuration of UPS, salient features of UPS, selection of battery and charger ratings. Speed control of DC Motors and Stepper Motor Drives	3
Total		**38**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Understand and apply the knowledge of device characteristics in power electronics domain.
2	Analyze the controlled rectifiers.
3	Perform Analysis of DC Choppers and Inverters.
4	Perform simple design of SMPS.

Learning Resources:	
1	Power Electronics Circuits, Devices and Applications, M.H. Rashid, 3rd Edition, Pearson Education.
2	Power electronics, Mohan, Robbins,3rd Edition , John Wiley and sons.
3	Modern Power Electronics, P.C. Sen. 2nd edition , S. Chand & Co.
4	Power Electronics, P.S. Bimbhra, 5th Edition, Khanna Publishers.

Course Name:	**Scientific Computing**		
Course Code:	PE-EC501D	**Category:**	Professional Elective
Semester:	Fifth	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Basic Mathematics and Numerical Techniques
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	To impart basic concept of approximation.
2	To impart knowledge about floating point arithmetic.
3	To understand the solution techniques of linear and non-linear equations.
4	To understand the method of least square.
5	To find eigen values and eigen vectors of a matrix.
6.	To learn the optimization techniques.
7.	To solve integration and odes.

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1	**Introduction:** Sources of Approximations, Data Error and Computational, Truncation Error and Rounding Error, Absolute Error and Relative Error, Sensitivity and Conditioning, Backward Error Analysis, Stability and Accuracy	4
2	**Computer Arithmetic:** Floating Point Numbers, Normalization, Properties of Floating Point System, Rounding, Machine Precision, Subnormal and Gradual Underflow, Exceptional Values, Floating Point Arithmetic, Cancellation	6
3	**System of liner equations:** Linear Systems, Solving Linear Systems, Gaussian elimination, Pivoting, Gauss-Jordan, Norms and Condition Numbers, Iterative Methods for Linear Systems, Gram-Schmidt Orthogonalisation	6
4	**Linear least squares:** Data Fitting, Linear Least Squares, Normal Equations Method, Nonlinear Least Squares	4
5	**Eigenvalues and Eigen vectors:** Eigenvalues and Eigenvectors, Methods for Computing All Eigenvalues, Jacobi Method, Methods for Computing Selected Eigenvalues	4
6	**Nonlinear equations:** Fixed Point Iteration, Newton's Method- functions of one and two variables	4
7	**Numerical Integration**: Quadrature Rule, Newton-Cotes Rule, Gaussian Quadrature Rule	4
8	**Optimization:** One-Dimensional Optimization, Symmetric Positive Definite Systems and Indefinite System, Multidimensional Unconstrained Optimization	4
8	**Initial Value Problems for ODES:** Euler's Method, Taylor Series Method, Runga-Kutta Method; **Boundary Value Problems for ODES:** Finite Difference Methods	4
Total		**40**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Explain the errors in numerical computations and floating point arithmetic.
2	Analyze the consistency of system of linear equations.
3	Solve the problems of eigen values and eigen vectors.
4	Analyze the efficiency of quadrature formulae.
5	Interpret data with least square method.

Learning Resources:	
1	Heath Michael T., "Scientific Computing: An Introductory Survey", McGraw-Hill, 2nd Ed., 2002
2	Press William H., Saul A. Teukolsky, Vetterling William T and Brian P. Flannery, Numerical Recipes: The Art of Scientific Computing", Cambridge University Press, 3rd Ed., 2007
3	Xin-she Yang (Ed.)., "Introduction To Computational Mathematics", World Scientific Publishing Co., 2nd Ed., 2008
4	Kiryanov D. and Kiryanova E., "Computational Science", Infinity Science Press, 1st Ed., 2006
5	Quarteroni, Alfio, Saleri, Fausto, Gervasio and Paola, "Scientific Computing With MATLAB And Octave", Springer, 3rd Ed., 2010

Course Name:	**Soft Skill and Interpersonal Communication**		
Course Code:	OE-EC501A	**Category**:	Open Elective
Semester:	Fifth	**Credit**:	3
L-T-P:	3-0-0	**Pre-Requisites:**	Participants should have basic knowledge of soft skills and communication.
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	To know various factors of life influencing language and communication.
2	To develop diverse life-skills to enhance interpersonal communication.
3	To boost self-inquisitiveness and maneuver skills to nurture integral development.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	**SELF ANALYSIS** SWOT Analysis, Who am I, Attributes, Importance of Self Confidence, Self Esteem.	3
2	**CREATIVITY** Out of box thinking, Lateral Thinking. **ATTITUDE** Factors influencing Attitude, Challenges and lessons from Attitude, Etiquette.	6
3	**MOTIVATION** Factors of motivation, Self talk, Intrinsic & Extrinsic Motivators. **GOAL SETTING**	7

	Wish List, SMART Goals, Blue print for success, Short Term, Long Term, Life Time Goals. **Time management** Value of time, Diagnosing Time Management, Weekly Planner To do list, Prioritizing work.	
4	**INTERPERSONAL SKILLS** **Gratitude** Understanding the relationship between Leadership Networking & Team work. Assessing Interpersonal Skills Situation description of Interpersonal Skill. **Team Work:** Necessity of Team Work Personally, Socially and Educationally	6
5	**LEADERSHIP** Skills for a good Leader, Assessment of Leadership Skills, Presentation Skills.	3
6	**STRESS MANAGEMENT** Causes of Stress and its impact, how to manage & distress, Circle of control, Stress Busters. **Emotional Intelligence** What is Emotional Intelligence, emotional quotient why Emotional Intelligence matters, Emotion Scales. Managing Emotions.	5
7	**CONFLICT RESOLUTION** Conflicts in Human Relations – Reasons Case Studies, Approaches to conflict resolution. **DECISION MAKING** Importance and necessity of Decision Making, Process and practical way of Decision Making, Weighing Positives & Negatives	6
Total		**36**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Communicate better in different situation.
2	Develop leadership quality and resolve conflicts.
3	Enhance life-skills for holistic development.

Learning Resources:	
1	Inner Engineering- A Yogi's Guide to Joy, Sadhguru, Penguin Random House
2	You Can Win, Shiv Khera, 1st edition, Bloomsbury India; Bloomsbury Press.

Course Name:	**Cyber Law and Intellectual Property Right**		
Course Code:	OE-EC501B	**Category:**	Open Elective
Semester:	Fifth	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Basic Knowledge of Computer Systems and Internet Technology
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	Basic understanding of Cyber Law and its significances
2	Basic understanding of Cryptography and its legal aspects
3	To impart basic concept of intellectual property rights and its role
4	To impart knowledge about the different intellectual property rights and their identification
5	To impart information on steps towards successful registration and protection of intellectual property rights at national, regional and international levels
6	Searching patent and trademark databases
7	To impart knowledge on legal aspects for intellectual property protection

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	**Cyber World :** An Overview, The internet and online resources ,Security of information, Digital signature **An Overview Cyber Law:** Introduction about the cyber space , Regulation of cyber space – introducing cyber law Scope of Cyber laws – ecommerce; online contracts; IPRs (copyright, trademarks and software patenting)	8
2	**Cyber Law in India** with special reference to Information Technology (Amendment) Act, 2008, Cryptography, Encryption, Digital Signature, Electronic Signature. E-commerce: EDI, Legal aspects of E-commerce, E-governance ,E-Record & E-Contract,E-Taxation and Cyber crime	8
3	**IPR:** Introduction : Origin and Genesis of IPR , Theories of IPR – Locke's, Hegel and Marxian Ethical, moral and human rights perspectives of IPR, Intellectual Property Rights: International Relevance, Internationalization of IP protection – Paris Convention, Berne Convention, TRIPS Agreement–basic principles and minimum standards – limits of one-size-fit for all flexibilities under TRIPS	8

4	**Intellectual Property: Issues and Challenges:** Geographical Indications, Layout designs of Integrated Circuits and Protection of Plant Varieties and Farmers' Rights. Copyright protection with reference to performers rights and Artist rights,Global governance towards Patents , Trade Marks: Legal recognition, Comparative analysis in India, EU and USA, Trade secrets : Legal recognition, Comparative analysis in India, EU and USA	8
5	**Intellectual Property: Contemporary Trends** Benefit sharing and contractual agreements – International Treaty on Plant Genetic Resources for Food and Agriculture – issues on patent policy and farmers' rights- CBD, Nagoya Protocol and Indian law, International perspectives	4
Total		**36**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Understand Cyber Law in India with an Overview of IT Act,2000
2	Understand e-commerce and e-governance and different security issues on legal perspective
3	Understand the role of intellectual property rights
4	Identify the main types of intellectual property rights
6	Search patent and trademark databases
7	Understand the legal aspects for intellectual property protection

Learning Resources:	
1	Duggal Pavan, Cyber Law - An exhaustive section wise Commentary on The Information Technology Act along with Rules, Regulations, Policies, Notifications etc. UNIVERSAL LAW PUBLISHING CO. PVT. LTD. C-FF-1A, Dilkhush Industrial Estate, (Near Azad Pur Metro Station) G. T. Karnal Road, Delhi -110033, INDIA2014
2.	Dr. Jyoti Rattan,Cyber Laws & Information Technology, Edited by Dr.Vijay Rattan, Bharat Law House Pvt Ltd,New Delhi
3	Intellectual Property Rights in India : General Issues and Implications PrankrishnaPal
4	Jonathan Rosenoer, "Cyberlaw: the Law of the Internet", Springer-verlag, 1997.
5	W. Cornish & Llewelyn – Intellectual Property: Patent, Copyrights, Trade Marks & Allied Rights",London Sweet & Maxwell.
6	Nard Madison- The Intellectual Property, Aspian Publication
7	Carlosm Correa- Oxford commentaries on GATT/ WTO Agreements trade Related aspects of Intellectual Property Rights, Oxford University Press.
8	Cornish William – Intellectual Property. Cambridge University Press.

Course Name:	**Human Resource Management**		
Course Code:	OE-EC501C	**Category**:	Open Elective
Semester:	Fifth	**Credit**:	3
L-T-P:	3-0-0	**Pre-Requisites:**	Basic Management Concepts
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	To make the students aware about basic managerial and human resource concepts
2	To make the learner aware about the latest HR trends applicable in an organisation

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1.	Meaning & Definition, Functions, Scope & Objectives, Qualities of a HR Manager	5
2.	Meaning & Definition, Importance of HRP,HRP Process. Barriers of HRP, Factors of sound HRP.Recruitment – Meaning & Definition, Sources of Recruitment, Recruitment Process, Effective Recruitment.	7
3	Training & Performance Appraisal- Definition & Objective ,Areas of Training, Meaning & Definition of Performance Appraisal, process, Effective principles of performance Appraisal	7
4	Concept & Meaning, Objective & Importance, Reasons of poor Industrial Relation. Industrial Disputes- Meaning & Definition, Causes of Industrial Dispute, Prevention of Industrial Dispute, Conditions for good Industrial Relation.	9
5	Meaning & Need, Forms of Participation, Scheme of participation, Merits & Demerits. Collective Bargain- Meaning & Definition, Objective & Importance, Process of Collective Bargain, Effective Condition. Employee Discipline-Guidelines for action, Penalties & Punishment, Rewards of Discipline.	8
Total		**36**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Understand the professional and personal qualities of a HR manager
2	Apply different methods of selecting human resources through recruitment, training and performance appraisal system.
3	Understand how to develop a favourable working environment in an organization through participation in management and maintain a good industrial relation for the overall benefit of the society.

Learning Resources:	
1	Human Resource Management. P. Subba Rao, Himalaya Publishing House, 2012
2	Human Resource Management. K.Aswathappa. Mc GRAW HILL Education, 2013.
3	Human Resource Development Management . A. M.Seikh S.Chand, 2003
4	Human Resource Management . S.S.Khanka, S. Chand, 2014.

Course Name:	**Electromagnetic Waves and Transmission Line Lab**		
Course Code:	PC-EC591	**Category:**	Professional Core
Semester:	Fifth	**Credit:**	1
L-T-P:	0-0-2	**Pre-Requisites:**	Basic knowledge of Transmission lines and Antenna
Full Marks:	100		
Examination Scheme:	Semester Examination: 60	Continuous Assessment: 35	Attendance: 05

Course Objectives:	
1	Understand basic characteristics of Gunn and Klystron oscillators
2	To perform measurement of Guide wavelength, cutoff wavelength in waveguide
3	To perform measurement of unknown impedance using shift in minima technique
4	To perform measurement of HPBW, Directivity of Dipole and Folded Dipole Antenna
5	To perform measurement of HPBW, Directivity and Gain of Pyramidal Horn Antenna

Course Contents:

Module No.	Description of Topic/ Experiment	Contact Hrs.
1	Introduction and familiarization with RF components	2
2	Study of Gunn Oscillator through V-I characteristics and Tuning	2
3	Study of Klystron oscillator	2
4	Plotting of standing wave pattern along a Tx line under short circuit and resistive load termination	2

5	Measurement of Guide wavelength, cutoff wavelength in waveguide	2
6	Measurement of Impedance of a terminated waveguide using shift in minima technique	4
7	Study on Radiation Pattern of Dipole Antenna (HPBW, Directivity, Front to Back Ratio)	4
8	Study on Radiation Pattern of Folded Dipole Antenna	4
9	Study on Radiation Pattern, Gain, Directivity of Pyramidal Horn Antenna	4
Total		**26**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Understand handling of test benches using Gunn and Klystron sources
2	Measure the Guide wavelength, cutoff wavelength in waveguide
3	Measure unknown impedance using shift in minima technique
4	Measure the HPBW, Directivity of Dipole and Folded Dipole Antenna
5	Measure the HPBW, Directivity and Gain of Pyramidal Horn Antenna

Learning Resources:	
1	Networks, Lines and Fields, 2nd Edition- John D. Ryder, PHI Learning
2	Basic Microwave Techniques and Laboratory Manual, M.L.Sisodia, G.S. Raghuvanshi, New Age International (P) Ltd.

Course Name:	**Computer Architecture Lab**		
Course Code:	PC-EC592	**Category:**	Professional Core
Semester:	Fifth	**Credit:**	1
L-T-P:	0-0-2	**Pre-Requisites:**	Digital Electronics
Full Marks:	100		
Examination Scheme:	Semester Examination: 60	Continuous Assessment: 35	Attendance: 05

Course Objectives:	
1	Know different design procedures in VHDL/Verilog
2	Understand the behavior of logic gates, arithmetic, combinational and sequential circuits and design them in VHDL/Verilog
3	Understand the behavior of ALU, RAM and ROM and design them in VHDL/Verilog

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1	Overview of HDL: VHDL/Verilog basic programming concept, Structural, dataflow, behavioral & mixed style modeling techniques	2
2	Implementation of logic gates using data flow modeling and behavioral modeling in VHDL/Verilog.	2
3	Implementation of NAND, NOR, XOR and a given logic function using structural modeling in VHDL/Verilog	2
4	Design of Half Adder and Full Adder in VHDL/Verilog	2
5	Design of 3 bit array multiplier in VHDL/Verilog	4
6	Design of MUX and decoder using Behavioral modeling in VHDL/Verilog	2
7	Design of shift register using D flip flop in VHDL/Verilog	2
8	Design of counter using JK flip flop in VHDL/Verilog	2
9	Design of memory (RAM, ROM) and perform memory operations in VHDL/Verilog	4
10	Design of 4 bit ALU in VHDL/Verilog	2
Total		**24**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Explain different design styles in HDL
2	Design basic arithmetic circuits using VHDL/Verilog
3	Design basic combinational circuits using VHDL/Verilog
4	Design basic sequential circuits using VHDL/Verilog
5	Design ALU and memory using VHDL/Verilog

Learning Resources:	
1	Circuit Design And Simulation With VHDL, Author: Pedroni; PHI
2	VHDL: Programming By Example, Author: Douglas Perry; MGH

Course Name:	**Digital Communication Lab**		
Course Code:	PC-EC593	**Category:**	Professional Core
Semester:	Fifth	**Credit:**	1
L-T-P:	0-0-2	**Pre-Requisites:**	Analog Communication
Full Marks:	100		
Examination Scheme:	Semester Examination: 60	Continuous Assessment: 35	Attendance: 05

Course Objectives:	
1	To demonstrate PAM, PCM, delta and adaptive delta modulation-demodulation, line-coders: polar, unipolar, bipolar, NRZ, RZ and Manchester coding.
2	To demonstrate BPSK, BFSK, ASK, QPSK modulation-demodulation schemes.
3	To generate 7-length and 15-length pseudorandom noise sequence using shift register and apply it to coded communication.
4	To simulate the probability of symbol error rate for BPSK, BFSK modulation.

Course Contents:		
Module No.	**Description of Topic/ Experiment**	**Contact Hrs.**
01	Design, implementation and study of all the properties of 7-length and 15-length p-n sequences using shift register.	2
02	Study of PAM and demodulation.	2
03	Study of PCM and demodulation.	2
04	Study of line coders: polar/unipolar/bipolar NRZ ,RZ and Manchester.	2
05	Study of delta modulator and demodulator.	2
06	Study of adaptive delta modulator and demodulator.	2
07	Study of BPSK modulator and demodulator.	2
08	Study of BFSK modulator and demodulator.	2
09	Study of ASK modulator and demodulator.	2
10	Study of QPSK modulator and demodulator.	2
11	Simulation study of probability of symbol error for BPSK modulation.	2
12	Simulation study of probability of symbol error for BFSK modulation.	2
Total		**24**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Demonstrate PAM, PCM, delta and adaptive delta modulation-demodulation, line-coders: polar, unipolar, bipolar, NRZ, RZ and Manchester coding.
2	Demonstrate BPSK, BFSK, ASK, QPSK modulation-demodulation schemes.
3	Generate 7-length and 15-length pseudorandom noise sequence using shift register and apply it to coded communication.
4	Simulate the probability of symbol error rate for BPSK, BFSK modulation.

Learning Resources:	
1	Lab Manual

Course Name:	**Digital Signal Processing Lab**		
Course Code:	PC-EC594	**Category**:	Professional Core
Semester:	Fifth	**Credit**:	1
L-T-P:	0-0-2	**Pre-Requisites:**	Discrete Signals & Systems, Code Composer Studio(CCS), MATLAB
Full Marks:	100		
Examination Scheme:	Semester Examination: 60	Continuous Assessment: 35	Attendance: 05

Course Objectives:	
1	To generate the elementary signals/ waveforms
2	To Calculate and Plot DFT of given DT signal and prove it theoretical
3	To Implement DFT using FFT algorithm of a given sequence
4	To Plot Magnitude and Phase response of FIR and IIR filter for any given sequence.

Course Contents:

Module No.	**Description of Topic/ Experiment**	**Contact Hrs.**
1	Generation And Display Of Discrete Time domain Signals using MATLAB.	2
2	Addition, Multiplication, Folding, Delay/ Advance operation using MATLAB.	2
3	Linear Convolution using MATLAB and DSP Kit (TMS320C6713).	4
4	Circular Convolution using MATLAB and DSP Kit (TMS320C6713).	4
5	Z- Transform And Inverse Z- Transform Of Various Discrete Sequences.	2
6	Discrete Fourier Transform And Inverse Discrete Fourier Transform of different Discrete Signals Using FFT Algorithm.	2
7	FIR filter design using Rectangular and Blackman windows method.	4
8	Butterworth IIR Filter Design using MATLAB.	2
9	Chbyshev Type- I and Chbyshev Type- II IIR Filter Design using MATLAB	4
Total		**26**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Able to generate elementary signals/ waveforms and perform arithmetic operations on signals.
2	Able to Implement FFT of given sequence and identify the reduction of computations using FFT.
3	Able to plot frequency response of a given system and verify the properties of LTI system.
4	Able to Implement and design FIR and IIR filter for a given sequence.

Learning Resources:	
1	Laboratory Manual

Course Name:	**Aptitude Skill Development-I**		
Course Code:	MC571	**Category:**	Mandatory Course
Semester:	Fifth	**Credit:**	0
L-T-P:	2-0-0	**Pre-Requisites:**	Basic knowledge of Mathematics and English Language
Full Marks:	100		
Examination Scheme:	Semester Examination: NA	Continuous Assessment: 100	Attendance: NA

Course Objectives:	
1	To be familiar with the basic concepts of QUANTITATIVE ABILITY.
2	To be familiar with the basic concepts of LOGICAL REASONING Skills .
3	To be familiar with the basic concepts of PROBABILITY.
4	Acquire knowledge in VERBAL REASONING and VOCABULARY

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1	Basics of Quantitative Abilities: Number System, HCF and LCM, Average, Ratio, Proportion and Variations, Problems on Percentage.	4
2	Arithmetic Quantitative Abilities: Problems on Ages, Profit and Loss, Time and Work, Problems on Simple and Compound Interest, Problems on Time, Speed and Distance.	6
3	Permutation and Combination, Set theory, Mensuration and Logarithm.	5
4	Logical Reasoning: Number Series, Alpha Numerical, Letter & Symbol Series, Numerical and Alphabet Puzzles, Seating Arrangement, Blood Relation and Calendars.	7
5	Data Interpretation	2
Total		**24**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Understand the basic concepts of QUANTITATIVE ABILITY.
2	Understand the basic concepts of LOGICAL REASONING Skills .
3	Understand the basic concepts of PROBABILITY.
4	Acquire satisfactory competency in use of VERBAL REASONING

Learning Resources:	
1	Arun Sharma, "Quantitative abilities", McGraw-Hill
2	R.S.Agrawal, "Quantitative Aptitude for Competitive Examinations", S. Chand
3	R.S.Agarwal,"A Modern Approach to Verbal & Non-Verbal Reasoning ",S.Chand

Course Name:	**Essence of Indian Traditional Knowledge**		
Course Code:	MC573	**Category:**	Mandatory Course
Semester:	5th	**Credit:**	0
L-T-P:	2-0-0	**Pre-Requisites:**	Nil
Full Marks:	100		
Examination Scheme:	Semester Examination: NA	Continuous Assessment/Sessional: 100	Attendance: NA

Course Objectives:	
1	To impart basic principles of thought process, reasoning and inferencing.Sustainability is at the core of Indian Traditional knowledge Systems connecting society and nature
2	To facilitate students with the concepts of Indian traditional knowledge and to make them understand the importance of the root of knowledge system
3	Holistic life style of Yogic Science and wisdom capsules in Sanskrit Literature are also important in modern society with rapid technological advancements and social disruptions.
4	The Course focuses on Introduction to Indian Knowledge System, Indian Perspective of modern scientific world-view and basic principles of Yoga and holistic health care system.

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1	Introduction to traditional knowledge: Define traditional knowledge, nature and characteristics, scope and importance, kinds of traditional knowledge, the physical and social contexts in which traditional knowledge develop, the historical impact of social change on traditional knowledge systems. Indigenous Knowledge (IK), characteristics, traditional knowledge vis-àvis indigenous knowledge, traditional knowledge Vs western knowledge traditional knowledge vis-à-vis formal knowledge	4
2	Basic structure of Indian Knowledge Systems (i) Veda (ii) Upa-Veda(iii) Vedanga (iv) Upanga Modern Science and Indian Knowlwdge Systems Yoga and Holistic Health Care Case Studies.	4
3	Protection of traditional knowledge (TK): the need for protecting traditional knowledge Significance of TK Protection, value of TK in global economy, Role of Government to harness TK.	4
4	Legal frame work and TK: A: The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, Plant Varieties Protection and Farmer's Rights Act, 2001 (PPVFR Act); B: The Biological Diversity Act 2002 and Rules 2004, the protection of traditional knowledge bill, 2016. Geographical indicators act 2003.	4
5	Traditional knowledge and intellectual property: Systems of traditional knowledge protection, Legal concepts for the protection of traditional knowledge, Certain non IPR mechanisms of traditional knowledge protection, Patents and traditional knowledge.	4
6	Traditional knowledge in different sectors: Traditional knowledge and engineering, Traditional medicine system, TK and biotechnology, TK in agriculture, Importance of conservation and sustainable development of environment, Management of biodiversity, Food security of the country and protection of TK.	4
Total		**24**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Understand the concept of Traditional knowledge and its importance.
2	Understand the need and importance of protecting traditional knowledge.
3	Understand the various enactments related to the protection of traditional knowledge.
4	Understand the concepts of Intellectual property to protect the traditional knowledge

Learning Resources:	
1	A. Jha, Traditional Knowledge System in India, 2009.
2	B.K. Mohanta and V.K. Singh, Traditional Knowledge System and Technology in India, Pratibha Prakashan, 2012.
3	Shivaramakrishna V(Ed.) Cultural Heritage of India- Course Material, Bharatiya Vidya Bhavan, Mumbai
4	K. Kapoor and M. Danino, Knowledge Traditions and Practices of India, Central Board of Secondary Education, 2012.
5	Yoga Sutra of Patanjali, Ramakrishna Mission, Kolkata
6	E-Resources: http://nptel.ac.in/courses/121106003/