

## SEMESTER V (Third Year)

### Branch/Course Electronics and Communication Engineering

Sl. No.	Types of Course	Code	Course Title	Hours per week			Credits	Marks
				L	T	P		
1.	Professional Core Courses	PCC-EC 501	Digital Communication Systems	3	0	0	3	100
		PCC-EC 551	Digital Communication Systems Lab	0	0	2	1	100
2.	Professional Core Courses	PCC-EC 502	Digital Signal Processing	3	0	0	3	100
		PCC-EC 552	Digital Signal Processing Lab	0	0	2	1	100
3.	Professional Core Courses	PCC-EC 503	Control Systems	3	0	0	3	100
		PCC-EC 553	Control System Lab	0	0	2	1	100
4.	Engineering Science Courses	ESC-IT 501	Data Structure and Algorithms	3	0	0	3	100
5.	Program Elective Course	PEC-EC 511(a-c)	Program Elective I	3	0	0	3	100
6.	Open Elective Course	OEC –XX 521 (a-e)	Open Elective I	3	0	0	3	100
7.	Humanities and Social Sciences	HSM-HU 581	Grooming & Personality Development	0	0	2	1	100
<b>Total</b>							<b>22</b>	<b>1000</b>

### Subject Pool For Program Elective Courses PEC I, 5<sup>th</sup> SEM

Sl No.	Code	Course Title	Credits
1.	PEC- EC 511(a)	Power Electronics	3
2.	PEC- EC 511(b)	Information Theory and Coding	3
3.	PEC- EC 511(c)	Speech and Audio Signal Processing	3

### Subject Pool For Open Elective Courses OEC I, 5<sup>th</sup> SEM

Sl. No	Code	Course Title	Credits
1.	OEC-HU 521(a)	Sanskrit for Technical Knowledge	3
2.	OEC-PH 521(b)	Material Science	3
3.	OEC-EC 521(c)	Bio Medical Electronics	3
4.	OEC-CSE 521(d)	Introduction to Object Oriented Technology & Python	3
5.	OEC-EI 521(e)	Optical Instrumentation	3

<b>SEMESTER VI (Third Year)</b>								
<b>Branch/Course Electronics and Communication Engineering</b>								
<b>Sl. No</b>	<b>Types of Course</b>	<b>Code</b>	<b>Course Title</b>	<b>Hours per week</b>			<b>Credits</b>	<b>Marks</b>
				<b>L</b>	<b>T</b>	<b>P</b>		
1.	Professional Core Courses	PCC-EC 601	EM Theory and Wave Propagation	3	0	0	3	100
2.	Professional Core Courses	PCC-EC 602	Microcontroller Based Embedded Systems	3	0	0	3	100
		PCC-EC 652	Microcontroller Based Embedded Systems Lab	0	0	2	1	100
3.	Professional Core Courses	PCC-EC 603	Computer Networks	3	0	0	3	100
		PCC-EC 653	Computer Networks Lab	0	0	2	1	100
4.	Professional Core Courses	PROJ-EC 654	Electronics Design /Mini Project	0	0	4	2	100
5.	Humanities and Social Science	HSM-HU 601	Values and Ethics	3	0	0	2	100
6.	Program Elective Course	PEC-EC 611 (a-c)	Program Elective II	3	0	0	3	100
7.	Open Elective Course	OEC XX 621 (a-e)	Open Elective II	3	0	0	3	100
8.	Humanities and Social Sciences	HSM-HU 681	Group Discussion & Personal Interview	0	0	2	1	100
<b>Total</b>							<b>22</b>	<b>1000</b>

<b>Subject Pool For Program Elective Courses PEC II, 6<sup>th</sup> SEM</b>			
<b>Sl No.</b>	<b>Code</b>	<b>Course Title</b>	<b>Credits</b>
1.	PEC- EC 611(a)	Analog VLSI	3
2.	PEC- EC 611(b)	Scientific Computing	3
3.	PEC- EC 611(c)	Mechatronics	3

Subject Pool For Open Elective Courses OEC II, 6 <sup>th</sup> SEM			
Sl No.	Code	Course Title	Credits
1.	OEC-HU 621(a)	History of Science & Engineering in India	3
2.	OEC-HU 621 (b)	Infrastructure Finance	3
3.	OEC-EC 621(c)	Microprocessors and Its Applications	3
4.	OEC-EI 621 (d)	Microprocessors & Its Programming	3
5.	OEC-M 621(e)	Computational Methods	3

SEMESTER VII (Fourth Year)								
Branch/Course Electronics and Communication Engineering								
Sl. No	Types of Course	Code	Course Title	Hours per week			Credits	Marks
				L	T	P		
1.	Program Elective Course	PEC-EC 711(a-c)	Program Elective III	3	0	0	3	100
2.	Program Elective Course	PEC-EC 712(a-c)	Program Elective IV	3	0	0	3	100
3.	Program Elective Course	PEC-EC 713(a-c)	Program Elective V	3	0	0	3	100
4.	Open Elective Course	OEC-xxx 721(a-e)	Open Elective III	3	0	0	3	100
5.	Humanities and Social Science	HSM-HU 701	Industrial Management and Entrepreneurships	3	0	0	3	100
6.	Project and Internship	PROJ-INT 791	Internship	0	0	4	2	100
7.	Project	PROJ-EC 792	Project Work I	0	0	10	5	100
<b>Total</b>							<b>22</b>	<b>700</b>

Subject Pool For Program Elective Courses PEC III, 7 <sup>th</sup> SEM			
Sl. No.	Code	Course Title	Credits
1.	PEC- EC 711(a)	Antenna Engineering	3
2.	PEC- EC 711(b)	Adaptive Signal Processing	3
3.	PEC- EC 711(c)	Mixed Signal Circuit Design	3

Subject Pool For Program Elective Courses PEC IV,7th SEM			
Sl. No.	Code	Course Title	Credits
1.	PEC- EC 712(a)	Microwave Theory and Techniques	3
2.	PEC- EC 712(b)	Embedded Systems	3
3.	PEC- EC 712(c)	Wavelets	3

Subject Pool For Program Elective Courses PEC V,7th SEM			
Sl. No.	Code	Course Title	Credits
1.	PEC- EC 713(a)	Digital Image and video Processing	2
2.	PEC- EC 713(b)	Error Correcting Codes	2
3.	PEC- EC 713(c)	Digital VLSI	2

Subject Pool For Open Elective Courses OEC III,7th SEM			
Sl. No.	Code	Course Title	Credits
1.	OEC-HU 721(a)	Introduction to Comparative literature	3
2.	OEC-HU 721(b)	Economic Policies in India	3
3.	OEC-M 721(c)	Mathematical Formulation & Approximations	3
4.	OEC-HU 721(d)	Soft Skills & Interpersonal Communication	3
5.	OEC-EI 721(e)	MEMS	3
6.	OEC-EC 721(f)	Nano Electronics	3

SEMESTER VIII (Fourth Year)								
Branch/Course Electronics and Communication Engineering								
Sl. No	Types of Course	Code	Course Title	Hours per week			Credits	Marks
				L	T	P		
1.	Program Elective Course	PEC-EC 811(a-c)	Program Elective VI	3	0	0	3	100
2.	Program Elective Course	PEC-EC 812(a-c)	Program Elective VII	3	0	0	3	100
3.	Open Elective Course	OEC-XX 821(a-f)	Open Elective IV	3	0	0	3	100
4.	Open Elective Course	OEC-XX 822(a-f)	Open Elective V	3	0	0	3	100
5.	Project	PROJ-EC 891	Project Stage II	0	0	12	6	100
<b>Total</b>							<b>18</b>	<b>500</b>

<b>Subject Pool For Program Elective Courses PEC VI, 8<sup>th</sup> SEM</b>			
<b>Sl No.</b>	<b>Code</b>	<b>Course Title</b>	<b>Credits</b>
1.	PEC- EC 811(a)	Medical Electronics & Applications	3
2.	PEC- EC 811(b)	Fiber Optic Communication	3
3.	PEC- EC 811(c)	High Speed Electronics	3

<b>Subject Pool For Program Elective Courses PEC VII, 8<sup>th</sup> SEM</b>			
<b>Sl. No.</b>	<b>Code</b>	<b>Course Title</b>	<b>Credits</b>
1.	PEC- EC 812(a)	Radar and Navigation Engineering	3
2.	PEC- EC 812(b)	Wireless Sensor Networks	3
3.	PEC- EC 812(c)	Mobile Communication and Networks	3

<b>Subject Pool For Open Elective Courses OEC IV, 8<sup>th</sup> SEM</b>			
<b>Sl No.</b>	<b>Code</b>	<b>Course Title</b>	<b>Credits</b>
1.	OEC-M 821(a)	Advanced Operations Research	3
2.	OEC-EE 821(b)	Advanced Topics in Power Systems	3
3.	OEC-HU 821(c)	Quality Control & Management	3
4.	OEC-HU 821(d)	Cyber Law and Computer Ethics	3
5.	OEC-EC 821(e)	Satellite Communication	3
6.	OEC-EE 821(f)	Energy Audit & Management	3

<b>Subject Pool For Open Elective Courses OEC V, 8<sup>th</sup> SEM</b>			
<b>Sl. No.</b>	<b>Code</b>	<b>Course Title</b>	<b>Credits</b>
1.	OEC-HU 822(a)	Digital Marketing	3
2.	OEC-HU 822(b)	Human Resource Development & Organizational Behavior	3
3.	OEC-EC 822(c)	Machine Learning	3
4.	OEC-EI 822(d)	Sensor Technology	3
5.	OEC-EE 822(e)	Automotive Control & Robotics	3
6.	OEC-ME 822(f)	Power Plant Engineering	3

**\*\*\* For details syllabus of OEC papers of all semester see the OEC Booklet**



### SEMESTER V (Third Year)

#### Branch/Course Electronics and Communication Engineering

Sl. No.	Types of Course	Code	Course Title	Hours per week			Credits	Marks
				L	T	P		
1.	Professional Core Courses	PCC-EC 501	Digital Communication Systems	3	0	0	3	100
		PCC-EC 551	Digital Communication Systems Lab	0	0	2	1	100
2.	Professional Core Courses	PCC-EC 502	Digital Signal Processing	3	0	0	3	100
		PCC-EC 552	Digital Signal Processing Lab	0	0	2	1	100
3.	Professional Core Courses	PCC-EC 503	Control Systems	3	0	0	3	100
		PCC-EC 553	Control System Lab	0	0	2	1	100
4.	Engineering Science Courses	ESC-IT 501	Data Structure and Algorithms	3	0	0	3	100
5.	Program Elective Course	PEC-EC 511(a-c)	Program Elective I	3	0	0	3	100
6.	Open Elective Course	OEC –XX 521 (a-e)	Open Elective I	3	0	0	3	100
7.	Humanities and Social Sciences	HSM-HU 581	Grooming & Personality Development	0	0	2	1	100
<b>Total</b>							<b>22</b>	<b>1000</b>

#### Subject Pool For Program Elective Courses PEC I, 5<sup>th</sup> SEM

Sl No.	Code	Course Title	Credits
1.	PEC- EC 511(a)	Power Electronics	3
2.	PEC- EC 511(b)	Information Theory and Coding	3
3.	PEC- EC 511(c)	Speech and Audio Signal Processing	3

#### Subject Pool For Open Elective Courses OEC I, 5<sup>th</sup> SEM

Sl. No	Code	Course Title	Credits
1.	OEC-HU 521(a)	Sanskrit for Technical Knowledge	3
2.	OEC-PH 521(b)	Material Science	3
3.	OEC-EC 521(c)	Bio Medical Electronics	3
4.	OEC-CSE 521(d)	Introduction to Object Oriented Technology & Python	3
5.	OEC-EI 521(e)	Optical Instrumentation	3

Course code	PCC-EC 501					
Category	Professional Core Course (PCC)					
Course title	Digital Communication Systems					
Scheme and Credits	L	T	P	Credits	Semester – V	
	3	0	0	3		
Pre-requisites (if any)	PCC-EC 303					

### Theory Syllabus:

<b>Unit No.</b>	<b>Detailed Description</b>	<b>Lecture/ Tutorial Period</b>
1.	<p><b>PULSE MODULATION TECHNIQUES:</b></p> <p><b>Introduction:</b> Basic concepts and discussions about the Elements of digital communication system.</p> <p><b>Digital Modulation Methods:</b> Pulse code modulation, quantization noise, linear and non- linear quantization, companding, line codes. Differential pulse code modulation, delta modulation, adaptive delta modulation, delta sigma modulation.</p> <p><b>Multiplexing:</b> Introduction to different type of multiplexing, Frequency, Time &amp; Code Division Multiplexing. Multiplexing hierarchy, synchronous and asynchronous multiplexing, pulse staffing and word staffing.</p>	8L
2.	<p><b>Baseband Transmission:</b> Base band transmission of digital signal, bandwidth estimation, Matched filter, inter-symbol interference, Nyquist filtering (zero ISI), raised cosine filtering, correlative coding, equalization, adaptive equalization, Eye pattern. Signaling techniques, line codes.</p>	11L
3.	<p><b>Signal Space Representation&amp; Carrier Modulation Techniques:</b></p> <p>Vector representation of signals in Euclidean space, proof of Schwartz inequality, Gram-Schmidt orthogonalization, conversion of AWGN channel, statistical characterization, likelihood function, error probability, correlation receiver, concept of optimum receiver, digital modulation tradeoffs, synchronization of carrier signal recovery</p> <p>Carrier modulation techniques: Generation, detection, estimation of power spectral density for ASK, BPSK, DPSK, QAM, BFSK, M-ARY-PSK &amp; -FSK, QPSK, MSK, QASK, GMSK. Probability of error calculation for all the mentioned techniques and comparison.</p>	16L



4.	<b>Information Theory And Coding:</b> Concept and measure of information, Entropy, Discrete and continuous messages, Channel capacity, Hartley and Shannon's law, Huffman coding, Linear block code, Cyclic code, Convolution code and Viterbi decoding.	7L
	<b>Total:</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. of Week Reserved:</b>	<b>02</b>

#### Text and/or Reference Books:

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

#### Course Outcomes:

At the end of this course students will be able to

1. Compare the different Pulse Code Modulations and their efficiency.
2. Analyze the aspects of quantization and bit multiplexing.
3. Analyse the eye pattern and implement the equalisation as per requirement.
4. Express signals in vector space and the corresponding modelling.
5. Characterise the different carrier keying techniques and their efficiency.
6. Characterise the upper-bounds of data compression and also error less communication.

Course code	PCC-EC551				
Category	Professional Core Course (PCC)				
Course title	Digital Communication Systems Laboratory				
Scheme and Credits	L	T	P	Credits	Semester – V
	0	0	2	1	
Pre-requisites (if any)	PCC-EC 451 PCC-EC 352				

**Laboratory Syllabus:**

Detailed Description	Practical Period
1. To design and study of Sampling and reconstruction (with and without Hold) and verification of Nyquist Criteria 2. To design and study of Pulse width modulation circuit 3. To design and study of Pulse position modulation circuit. 4. To design and study of Amplitude shift keying circuit. 5. To design and study of demodulation of ASK circuit. 6. To design and study of Frequency shift keying circuit. 7. To design and study of demodulation of FSK. 8. To study generation and detection of ASK, FSK, PSK, BPSK, QPSK and their relevant demodulation on trainer kit. 9. To study of two channel multiplexed PCM and its demodulation on trainer kit. 10. To study four channel time division multiplexing on trainer kit. 11. To study delta, adaptive delta modulation on trainer kit. 12. Study of encoding and decoding circuit on trainer kit/MATLAB.	
<b>Total:</b>	<b>42P</b>
<b>Total Week Required:</b>	<b>14</b>
<b>No. Of Week Reserved:</b>	<b>02</b>

**Course outcomes:**

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

1. Characterize the different fundamental communication blocks.
2. Design and estimate the circuital criteria of different pulse modulators.
3. Design and characterize the different shift keying modulators.
4. Optimize the circuital outcomes to drive the next stage.
5. Design a full-fledged communication system.

Course code	PCC-EC502				
Category	Professional Core Course (PCC)				
Course title	Digital Signal Processing				
Scheme and Credits	L	T	P	Credits	Semester – V
	3	0	0	3	
Pre-requisites (if any)	PCC-EC 303				

**Theory Syllabus:**

Unit No.	Detailed Description	Lecture/Tutorial Period
1.	<p><b>OVERVIEWS OF SIGNALS &amp; SYSTEMS</b></p> <p><b>Introduction to Digital Signal Processing:</b> Discrete Time Signals &amp; Sequences, Linear Time Invariant Systems, Stability, and Causality, Linear Constant Coefficient Difference Equations, Frequency Domain Representation of Discrete Time Signals and systems.</p> <p><b>Overview of Sampling Theory:</b> Review of sampling theory, aliasing, quantization, data converter error and specification.</p> <p>Z-transform and its properties, inverse z-transforms; difference equation – Solution by Z-transform, application to discrete systems – Stability analysis, frequency response – Convolution – Discrete Time Fourier transform, magnitude and phase representation.</p>	4L
2.	<p><b>DISCRETE TRANSFORMATIONS</b></p> <p><b>Discrete Fourier Series:</b> DFS Representation of Periodic Sequences. Properties of Discrete Fourier Series.</p> <p><b>Discrete Fourier Transforms:</b> Properties of DFT. Linear Convolution of Sequences using DFT. Computation of DFT: Over-lap Add Method, Over-lap Save Method, Relation between DTFT, DFS, DFT and Z-Transform.</p> <p><b>Fast Fourier transform (FFT):</b> FFT algorithms, decimation-in-time and decimation-in- frequency algorithm.</p> <p><b>Transforms:</b> DCT, STFT. Application of transforms in speech, audio, image coding.</p>	12L
3.	<p><b>DESIGN OF DIGITAL FILTERS:</b></p> <p>Introduction of digital filters, FIR, IIR filters, their representation advantages and disadvantages.</p> <p><b>IIR Digital Filters:</b> Analog Filter Approximations – Butterworth and Chebyshev, Design of IIR Digital filters from Analog Filters, Step and Impulse Invariant Techniques, Bilinear Transformation Method.</p> <p><b>FIR Digital Filters:</b> Characteristics of FIR Digital Filters, Frequency Response. Design of FIR Filters: Fourier Method. Digital Filters using Window Techniques, Frequency Sampling Technique, Comparison of IIR &amp; FIR filters.</p> <p><b>Applications of Filters:</b> Speech Signal Processing, Image Processing, TV &amp; RADAR, Music &amp; Audio System, DTMF generation and detection, FBAR Filter in Smart Phone.</p>	15L
4.	<p><b>OVERVIEWS OF MULTIRATE DIGITAL SIGNAL PROCESSING:</b></p> <p>Introduction, Down-sampling, Decimation, Up-sampling, Interpolation, Sampling Rate Conversion, Applications of Multi-Rate Signal Processing. Finite Word Length Effects: Limit cycles, Overflow oscillations, Round-off Noise in IIR Digital Filters. Computational Output Round Off Noise, Methods to prevent Overflow, Dead band effects.</p>	3L

5.	<b>DSP HARDWARES:</b> <b>Analysis of Finite Word length Effects:</b> Finite precision number representation and their arithmetic, round-off errors, effects on digital filters, limit cycle. <b>DSP Processor Architecture:</b> Typical DSP Processor Architecture: Texas instruments family of DSP processors, fixed point, floating point. TMS 320 C67X Board, Architecture.	8L
	<b>Total</b>	<b>42L</b>
	<b>Total Week Required</b>	<b>14</b>
	<b>No. of Week Reserved</b>	<b>02</b>

**Text and/or Reference Books:**

1. A. V. Oppenheim and R. W. Schaffer, "Discrete-Time Signal Processing", Pearson Education.
2. J. G. Proakis and D. G. Manolakis, "Digital Signal Processing: Principles, Algorithms, and Applications", Pearson Education.
3. S.K.Mitra, "Digital Signal Processing - A Computer based approach", TMH.
4. Lawrence R. Rabiner, Bernard Gold, "Theory and Application of Digital Signal Processing", Prentice-Hall.
5. Richard G. Lyons, "Understanding Digital Signal Processing", Pearson Education.
6. Emmanuel C. Ifeachor, Barrie W. Jervis, "Digital Signal Processing: A Practical approach", Pearson Education.
7. TMS320C67x/C67x+ DSP CPU and Instruction Set Reference Guide.

**Course outcomes:**

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

1. Interpret, represent and process discrete/digital signals and systems.
2. Understand thoroughly the frequency domain analysis of discrete time signals.
3. Design & analyze DSP systems like FIR and IIR Filter etc.
4. Learn about digital data communication and real-time DSP.
5. Understand the spectral analysis of the signals.
6. Implement practical issues such as computational complexity, hardware resource limitations as well as cost of DSP systems or DSP Processors.

Course code	PCC-EC552				
Category	Professional Core Course (PCC)				
Course title	Digital Signal Processing Laboratory				
Scheme andCredits	L	T	P	Credits	Semester – V
	0	0	2	1	
Pre-requisites (if any)	PCC-EC 352				

### Laboratory Syllabus:

Detailed Description	Practical Period
<b>Experiments based on MATLAB/SciLab/OCTAVE:</b> <ol style="list-style-type: none"> <li>1. Generation of waveforms (Continuous and discrete)</li> <li>2. Verification of Sampling Theorem.</li> <li>3. Time and Frequency Response of LTI systems (First and second order).</li> <li>4. Linear Convolution, Circular Convolution and Linear Convolution using Circular Convolution.</li> <li>5. To find the DFT and IDFT for the given input sequence.</li> <li>6. Linear convolution using DFT (Overlap-add and Overlap-Save methods).</li> <li>7. To find FFT and IFFT for the given input sequence.</li> <li>8. FIR and IIR filter design using Filter Design Toolbox.</li> <li>9. FIR Filter (Low-pass, High-pass and Band-pass) design (Window method).</li> <li>10. IIR Filter (Low-pass, High-pass and Band-pass) design (Butterworth and Chebychev).</li> </ol>	
<b>Experiments on Digital Signal Processor/ DSP kits:</b> <ol style="list-style-type: none"> <li>1. Generation of sine wave and standard test signals.</li> <li>2. Convolution: Linear and Circular</li> <li>3. Real Time FIR Filter implementation (Low-pass, High-pass and Band-pass) by inputting a signal from the signal generator</li> <li>4. Real Time IIR Filter implementation (Low-pass, High-pass and Band-pass) by inputting a signal from the signal generator</li> <li>5. Sampling of analog signal and study of aliasing.</li> </ol>	
<b>Total:</b>	<b>42P</b>
<b>Total Week Required:</b>	<b>14</b>
<b>No. Of Week Reserved:</b>	<b>02</b>

### Text and/or Reference Books:

1. Sanjit Kumar Mitra, Digital Signal Processing Laboratory using MATLAB, WCB/McGraw-Hill.

2. Vinay K. Ingle, John G. Proakis, Digital Signal Processing Using MATLAB, Cengage Learning.

**Course outcomes:**

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

1. Explore the concepts of design, simulation and implementation of various systems using MATLAB/SciLab/OCTAVE and DSP kit.
2. Design, analyze and simulate signal sampling, quantization and reconstruction.
3. Design, generate and study various signal processing techniques for LTI systems like shifting, inversion, convolution, circular convolution etc.
4. Design and implement signal processing techniques on FPGA/Zed Board.
5. Design and simulate end to end system in simulink using inbuilt/selfgenerated modules.

Course code	PCC- EC 503				
Category	Professional Core Course (PCC)				
Course title	Control System				
Scheme and Credits	L	T	P	Credits	Semester – V
	3	0	0	3	
Pre-requisites (if any)	PCC-EC 303 ESC-EE-201 ESC-EE 301				

**Theory Syllabus:**

<b>Unit No.</b>	<b>Detailed Description</b>	<b>Lecture/ Tutorial Period</b>
1.	<b>Introduction:</b> control systems, Concept of feedback and Automatic control, Effects of feedback, Objectives of control system, Definition of linear and nonlinear systems, Elementary concepts of sensitivity and robustness. Types of control systems, Servomechanisms and regulators, examples of feedback control systems. Transfer function concept. Pole and Zeroes of a transfer function. Properties of Transfer function.	3L
2.	<b>Mathematical modeling of dynamic systems:</b> Translational systems, Rotational systems, Mechanical coupling, Liquid level systems, Electrical analogy of Spring–Mass–Dashpot system. Block diagram representation of control systems. Block diagram algebra. Signal flow graph. Mason’s gain formula. Control system components: Potentiometer, Synchros, Resolvers, Position encoders. DC and AC tacho-generators. Actuators. Block diagram level description of feedback control systems for position control, speed control of DC motors, temperature control, liquid level control, voltage control of an Alternator.	10L

3.	<b>Time domain analysis:</b> Time domain analysis of a standard second order closed loop system. Concept of un-damped natural frequency, damping, overshoot, rise time and settling time. Dependence of time domain performance parameters on natural frequency and damping ratio. Step and Impulse response of first and second order systems. Effects of Pole and Zeros on transient response. Stability by pole location. Routh-Hurwitz criteria and applications. Error Analysis: Steady state errors in control systems due to step.	8L
4.	<b>Stability Analysis:</b> Characteristic equation, methods of determining linear control systems, Routh-Hurwitz criterion, Nyquist criterion, application of Nyquist criterion, effects of addition of poles and zeros of $G(s)$ , $H(s)$ on the shape of Nyquist locus. Root locus method: root locus plots, summary of general rules for construction root loci, root locus analysis of control systems. Frequency domain analysis of control systems: frequency domain characteristics, peak response, resonance frequency and bandwidth of a second order system, Bode plot, gain margin, phase margin, constant M locus, constant N locus, Nichol's chart.	9L
5.	<b>Control System performance measure:</b> Improvement of system performance through compensation. Lead, Lag and Lead-lag compensation, PI, PD and PID control.	5L
6.	<b>State variable Analysis:</b> Concepts of state variables. State space model. Diagonalization of State Matrix. Solution of state equations. Eigen values and Stability Analysis. Concept of controllability and observability.	7L
	<b>Total</b>	<b>42L</b>
	<b>Total Week Required</b>	<b>14</b>
	<b>No. of Week Reserved</b>	<b>02</b>

#### Text and/or Reference Books:

1. K. Ogata, "Modern Control Engineering", 4th Edition, Pearson Education.
2. I. J. Nagrath & M. Gopal, "Control System Engineering", New Age International Publication.
3. D. Roy Choudhury, "Control System Engineering", PHI.
4. B.C. Kuo & F. Golnaraghi, "Automatic Control Systems", 8th Edition, PHI.

#### Course outcomes:

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

1. Develop mathematical model of mechanical, electrical, thermal, fluid system and different control system components like servomotors, synchros, potentiometer, tachogenerators etc.
2. Analyze stability of LTI system using Routh-Hurwitz (RH) criteria, root locus techniques in time domain and bode plot and Nyquist technique in frequency domain.

3. Design different control law or algorithms like proportional control, proportional plus derivative(PD) control, proportional plus integration(PI) control, and proportional plus integration plus derivative (PID) control and compensators like lag, lead, lag-lead for LTI systems.
4. Apply state variable techniques for analysis of linear systems.
5. Analyze the stability of linear discrete system.
6. Solve numerical problems on LTI system modeling, responses, error dynamics and stability.

Course code	PCC-EC553				
Category	Professional Core Course (PCC)				
Course title	Control System Laboratory				
Scheme and Credits	L	T	P	Credits	Semester – V
	0	0	2	1	
Pre-requisites (if any)	PCC-EC 351 PCC-EC 352				

### Laboratory Syllabus:

<b>Detailed Description</b>	<b>Practical Period</b>
<p><b>List of Experiments:</b></p> <ol style="list-style-type: none"> <li>1. Familiarization with MATLAB Control System tool Box, MATLAB-SIMULINK tool box &amp; pSPICE.</li> <li>2. Determination of step response for 1st order &amp; 2nd order system with unity feedback on CRO &amp; calculation of control system specifications for variations of system design.</li> <li>3. Simulation of step response &amp; impulse response for Type-I &amp; Type-II system with unity feedback using MATLAB &amp; pSPICE.</li> <li>4. Determination of root locus, Bode-plot, Nyquist Plot, using MATLAB control system toolbox for a given 2nd order transfer function &amp; determination of different control system specifications.</li> <li>5. Determination of PI, PD, and PID controller action on 1<sup>st</sup> order simulated process.</li> <li>6. Determination of approximate transfer function experimentally using Bode Plot.</li> <li>7. Evaluation of steady-state error, setting time, percentage peak overshoots, gain margin, phase margin with addition of lead compensator in forward path transfer functions using MATLAB &amp; pSPICE.</li> <li>8. Study of position control system using servomotor.</li> </ol>	



9. Design and hardware implementation of a temperature controller using microprocessor/microcontroller.	
<b>Total:</b>	<b>42 P</b>
<b>Total Week Required:</b>	<b>14</b>
<b>No. of Week Reserved:</b>	<b>02</b>

**Text and/or Reference Books:**

1. Kuo, "Automatic Control System", PHI.
2. Purkait, Satpati, Mondal & Mallik, "Control Systems", TMH WBUT Series.
3. M. Gopal, "Digital control & state variables".

**Course outcomes:**

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

1. Introduction to Matlab, Simulink, and QUARC.
2. Identification of the transfer functions of a DC motor.
3. Practice the theoretical concepts and computational tools that they learn in theory part to design controllers for a given hardware application.
4. Experience using modern software tools to design and implement feedback controllers to control physical system and meet given performance specifications.
5. Understand the iterative nature of a successful controller design, which requires careful interpretation of the collected data and subsequently tuning of their design.
6. Effects of gains on transient response and steady-state errors.

Course code	ESC- IT- 501				
Category	Engineering Science Course (ESC)				
Course title	Data Structure & Algorithm				
Scheme and Credits	L	T	P	Credits	Semester V
	3	0	0	3	
Pre-requisites (if any)	ESC-CSE-201				

**Theory Syllabus:**

<b>Module</b>	<b>Detailed Description</b>	<b>Lecture / Tutorial Period</b>
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1.	Introduction: Basic Terminologies: Elementary Data Organizations, Data Structure. Operations: insertion, deletion, traversal etc.; Analysis of an Algorithm, Asymptotic Notations, Time-Space trade off. Searching: Linear Search and Binary Search Techniques and their complexity analysis.	10L
2.	Stacks and Queues: ADT Stack and its operations: Algorithms and their complexity analysis, Applications of Stacks: Expression Conversion and evaluation – corresponding algorithms and complexity analysis. ADT queue, Types of Queue: Simple Queue, Circular Queue, Priority Queue; Operations on each types of Queues: Algorithms and their analysis.	10L
3.	Linked Lists: Singly linked lists: Representation in memory, Algorithms of several operations: Traversing, Searching, Insertion into, Deletion from linked list; Linked representation of Stack and Queue, Header nodes, Doubly linked list: operations on it and algorithmic analysis; Circular Linked Lists: all operations their algorithms and the complexity analysis.	10L
	Trees: Basic Tree Terminologies, Different types of Trees: Binary Tree, Threaded Binary Tree, Binary Search Tree, AVL Tree; Tree operations on each of the trees and their algorithms with complexity analysis. Applications of Binary Trees. B Tree, B+ Tree: definitions, algorithms and analysis.	
4.	Sorting and Hashing: Objective and properties of different sorting algorithms: Selection Sort, Bubble Sort, Insertion Sort, Quick Sort, Merge Sort, Heap Sort;  Performance and Comparison among all the methods, Hashing.  Graph: Basic Terminologies and Representations, Graph search and traversal algorithms and complexity analysis.	12L
	<b>Total</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. Of Week Reserved:</b>	<b>02</b>

**Books: Text and/or Reference:**

Books:

1. “Fundamentals of Data Structures”, Illustrated Edition by Ellis Horowitz, Sartaj Sahni, Computer Science Press.

2. Algorithms, Data Structures, and Problem Solving with C++”, Illustrated Edition by Mark Allen Weiss, Addison-Wesley Publishing Company
3. “How to Solve it by Computer”, 2nd Impression by R. G. Dromey, Pearson Education.

Course outcomes:

1. To impart the basic concepts of data structures and algorithms.
2. To understand concepts about searching and sorting techniques.
3. To understand basic concepts about stacks, queues, lists, trees and graphs.
4. To enable them to write algorithms for solving problems with the help of fundamental data structures.

Course code	PEC-EC 511(a)				
Category	Program Elective Course (PEC)				
Course title	Power Electronics				
Scheme and Credits	L	T	P	Credits	Semester – V
	3	0	0	3	
Pre-requisites (if any)	PCC-EC 401 ESC-EE-201				

### Theory Syllabus:

<b>Unit No.</b>	<b>Detailed Description</b>	<b>Lecture/ Tutorial Period</b>
1.	<p><b>Introduction:</b> Application of Power Electronics to : Motor control with emphasis on Traction and Industrial Process control, Power Supplies - Revolution in Personal Computers UPS, Power Transmission - Facts Technology, HVDC, Chemical Process, Battery charging, Power extraction from non-conventional energy sources, Automotive electronics.</p> <p><b>Power Semiconductor Devices:</b> Construction, Principle of operation, Characteristics and applications of Power Transistor &amp; Thyristor. Characteristics of GTO, DIAC, MCT, TRIAC, Power MOSFET and IGBT; Two-Transistor Model of Thyristor, Thyristor Commutation methods.</p>	8L
2.	<p><b>SCR:</b> Construction and characteristics, specification and ratings, pulse transformer, optical isolators, methods of turn on, triggering circuits for SCR: R, RC, UJT relaxation oscillator. Rating extension by series and parallel connections, string efficiency. Protection of SCR-Protection against over voltage, over current, dv/dt, di/dt, Gate protection.</p>	12L

	<b>Rectifiers:</b> Diode rectifiers Applications: Power Supplies, Front end converter for ac motor drives, battery charger, and chemical process. Single phase Half wave with R load, Single phase Half wave with R-L load, Single phase Full wave bridge rectifier with dc link capacitive filter, issue of harmonics, Three phase Full wave bridge rectifier with dc link capacitive filter, issue of harmonics.	
3.	<b>Converters-I:</b> Single Phase half & full wave converters with RL & RLE load, Single phase dual converters, Three phase half wave converters. Three phase full wave converters with RL load, Three phase dual converters. <b>Converters-II:</b> Single and three-phase semi converters with RL & RLE load. Power factor improvement-Extinction angle control, symmetrical angle control, pulse width modulation control and sinusoidal pulse width modulation control. Inversion operation. Effect of load and source impedances.	12L
4.	<b>DC-DC Converters:</b> Step Up/Down Chopper, Control strategies, Chopper Configurations, Analysis of type A Chopper. Voltage, current and load commutated chopper. Multiphase Chopper. <b>DC- AC Power Converters:</b> Principle of operation of Inverters, Half bridge, full bridge, three phase- six step operation, voltage control, PWM techniques.	10L
	<b>Total:</b>	<b>42L</b>
	<b>Total Weeks Required:</b>	<b>14</b>
	<b>No. of Weeks Reserved:</b>	<b>02</b>

#### Text and/or Reference Books:

1. M. H. Rashid, "Power Electronics, Circuits Devices and Applications", Pearson. 2011
2. P. S. Bimbhra, "Power Electronics", Khanna Publishers. 2012
3. Ned Mohan, "Power Electronics", John Wiley. 2013
4. Krein P. T., "Elements of Power Electronics", Oxford. 1998
5. M. D. Singh and K. B. Khanchandani, "Power Electronics", 2/e, MGH.2008

#### Course outcomes:

After completion of the course, the students will able to

1. Relate basic semiconductor physics to properties of power devices and combine circuit mathematics.
2. Characterize linear and nonlinear devices
3. Compare the performances different power semiconductor devices and passive components.
4. Design and analyze power convertor circuits
5. Identify the critical areas in application levels and derive typical solutions
6. Compare the energy usage efficiencies of power electronic applications.

Course code	PEC-EC 511(b)				
Category	Program Elective Course (PEC)				
Course title	Information Theory and Coding				
Scheme and Credits	L	T	P	Credits	Semester – V
	3	0	0	3	
Pre-requisites (if any)	PCC-EC 303 PCC-EC 501 BSC-M 301				

### Theory Syllabus:

<b>Unit no.</b>	<b>Detailed Description</b>	<b>Lecture/ Tutorial Period</b>
1.	Basics of information theory, entropy for discrete ensembles; Shannon's noiseless Coding theorem; Encoding of discrete sources.	10L
2.	Markov sources; Shannon's noisy coding theorem and converse for discrete channels; Calculation of channel capacity and bounds for discrete channels; Application to continuous channels.	16L
3.	Techniques of coding and decoding; Huffman codes and uniquely detectable codes; Cyclic codes, convolutional arithmetic codes, Viterbi decoding, Error Correcting Codes	16L
	<b>Total:</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. of Week Reserved:</b>	<b>02</b>

### Text and/or Reference Books:

1. N. Abramson, "Information and Coding", McGraw Hill, 1963.
2. M. Mansurpur, "Introduction to Information Theory", McGraw Hill, 1987.
3. R.B. Ash, "Information Theory", Prentice Hall, 1970.
4. Shu Lin and D.J. Costello Jr., "Error Control Coding", Prentice Hall, 1983.

### Course Outcomes:

At the end of the course, students will be able to:

1. Calculate information, entropy, mutual information and channel capacity for various channels.
2. Compare various source coding techniques in terms of their efficiency.
3. Inspect error detection and correction in linear block codes.

4. Develop encoding circuits for cyclic codes.
5. Construct BCH codes.
6. Construct convolution codes.

Course code	PEC-EC 511(c)				
Category	Program Elective Course (PEC)				
Course title	Speech and Audio Signal Processing				
Scheme and Credits	L	T	P	Credits	Semester – V
	3	0	0	3	
Pre-requisites (if any)	PCC-EC 303 PCC-EC 401				

**Theory Syllabus:**

<b>Unit no.</b>	<b>Detailed Description</b>	<b>Lecture/ Tutorial Period</b>
1.	<b>Introduction:-</b> 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.	4L
2.	<b>Speech Signal Processing:</b> Pitch-period estimation, all-pole and all-zero filters, convolution; Power spectral density, period gram, autoregressive model, autocorrelation estimation.	4L
3.	<b>Linear Prediction of Speech:</b> 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.	8L
4.	<b>Speech Quantization:</b> Scalar quantization–uniform quantizer, optimum quantizer, logarithmic quantizer, adaptive quantizer, differential quantizers; Vector quantization – distortion measures, codebook design, codebook types.	6L
5.	<b>Scalar Quantization of LPC:</b> 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.	6L
6.	<b>Linear Prediction Coding:</b> LPC model of speech production; Structures of LPC encoders and decoders; Voicing detection; Limitations of the LPC model.	6L
7.	<b>Code Excited Linear Prediction:</b> 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. Speech Coding Standards-An overview of ITU-T G.726, G.728 and	8L

	G.729standards.	
	<b>Total:</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. of Week Reserved:</b>	<b>02</b>

**Text and/or Reference Books:**

1. A.M. Kondo, “Digital Speech” Second Edition (Wiley Students\_ *Edition*), 2004.
2. W.C.Chu, “Speech Coding Algorithms: Foundation and Evolution of Standardized Coders”, WileyInter science, 2003.
3. B Gold & N Morgan, “Speech and Audio Signal Processing”, Wiley Students Edition.
4. L R Rabiner & B H Juang, “Fundamentals of Speech recognition”, Prentice Hall Signal Processing Series.

**Course Outcomes:**

At the end of the course, students will be ability to:

1. Model mathematically the speech signal
2. Analyze the quality and properties of speech signal.
3. Modify and enhance the speech and audio signals.
4. Design and execute simple studies over speech processing methods.

Course Code	HSM-HU 581				
Category	Humanities and Social Sciences including Management Courses				
Course Title	Grooming & Personality Development				
Scheme and credits	L	T	P	Credits	Semester—V
	0	0	2	1	
Pre-requisites (if any )	Basic knowledge of speaking and writing in English				

<b>Unit. No.</b>	<b>Detailed Description</b>	<b>Lecture/Tutorial Period</b>
1.	<b>Self-Development Skills:</b> Introduction to personality; Self-Esteem and Self-Confidence; problem solving; Stress Management; Goal-Setting.	
2.	<b>Public Speaking:</b>	

	Importance: Types, Mechanics, Pillars of Public Speaking, Overcoming fear of Public Speaking.	
3.	<b>Oral presentation and professional speaking:</b> Basics of English pronunciation public preparing for a speech.; Elements of effective presentations, Body language and use of voice during presentation; connecting with the audience during presentation; projecting a positive image while speaking; planning and preparing a model presentation; Organizing the presentation to suit the audience and content.	
4.	<b>Career Oriental Communication:</b> Design and Style applying for a job: Language and format of job application, Resume& bio-data.	
5.	<b>Job Interview:</b> Purpose and process, language and style to be used, types of interview question and how to answer them.	
	<b>Total</b>	<b>28P</b>
	<b>Total week required</b>	<b>14</b>
	<b>No. of week reserved</b>	<b>02</b>

#### **Text /Reference Books:**

1. Barun K. Mitra, "Development and Soft Skills", Oxford University Press, New Delhi: 2016.
2. Rajiv K. Mishra, "Personality Development: Transform Yourself", Rupa Publications, 2012.
3. Elizabeth B. Hurlock, "Personality Development", McGraw Hill Education, 2017.
4. Personality Development and Career Management. M. Onkar S. Chand Publication.
5. Managing Soft Skills for Personality Development. Ed. by B. N. Ghosh. McGraw Hill, India: 2012.

#### **Course outcomes:**

On completion of the course students will be able to:



1. Groom themselves through the knowledge of personality development attributes –self-confidence, problem solving and stress management skills etc.
2. Deliver confidently an organized, refined, professional and credible speech for better suit the audience.
3. Acquire the basic concepts of English pronunciation and elements of effective presentations, body language and use of voice during presentation.
4. Connect with the audience during presentation and exhibit the art of projecting a positive image while speaking and preparing a model presentation.
5. Learn the effective language for writing job application, resume and bio-data.
6. Familiar with common interview questions and the techniques to answer them.

<b>SEMESTER VI (Third Year)</b> <b>Branch/Course Electronics and Communication Engineering</b>								
Sl. No	Types of Course	Code	Course Title	Hours per week			Credits	Marks
				L	T	P		
1.	Professional Core Courses	PCC-EC 601	EM Theory and Wave Propagation	3	0	0	3	100
2.	Professional Core Courses	PCC-EC 602	Microcontroller Based Embedded Systems	3	0	0	3	100
		PCC-EC 652	Microcontroller Based Embedded Systems Lab	0	0	2	1	100
3.	Professional Core Courses	PCC-EC 603	Computer Networks	3	0	0	3	100
		PCC-EC 653	Computer Networks Lab	0	0	2	1	100
4.	Professional Core Courses	PROJ-EC 654	Electronics Design /Mini Project	0	0	4	2	100
5.	Humanities and Social Science	HSM-HU 601	Values and Ethics	3	0	0	2	100
6.	Program Elective Course	PEC-EC 611 (a-c)	Program Elective II	3	0	0	3	100
7.	Open Elective Course	OEC XX 621 (a-e)	Open Elective II	3	0	0	3	100
8.	Humanities and Social Sciences	HSM-HU 681	Group Discussion & Personal Interview	0	0	2	1	100
<b>Total</b>							<b>22</b>	<b>1000</b>

<b>Subject Pool For Program Elective Courses PEC II, 6<sup>th</sup> SEM</b>			
Sl No.	Code	Course Title	Credits
1.	PEC- EC 611(a)	Analog VLSI	3
2.	PEC- EC 611(b)	Scientific Computing	3
3.	PEC- EC 611(c)	Mechatronics	3

Subject Pool For Open Elective Courses OEC II, 6 <sup>th</sup> SEM			
Sl No.	Code	Course Title	Credits
1.	OEC-HU 621(a)	History of Science & Engineering in India	3
2.	OEC-HU 621 (b)	Infrastructure Finance	3
3.	OEC-EC 621(c)	Microprocessors and Its Applications	3
4.	OEC-EI 621 (d)	Microprocessors & Its Programming	3
5.	OEC-M 621(e)	Computational Methods	3

Course code	PCC-EC 601				
Category	Professional Core Course				
Course Title	EM Theory and Wave Propagation				
Scheme and Credits	L	T	P	Credits	Semester – VI
	3	0	0	3	
Pre-requisites (if any)	ESC- EE 101 PCC- EC 301				

### Theory Syllabus:

Unit No.	Detailed Description	Lecture / Tutorial Period
1.	<b>Elements of vector calculus:</b> Gradient, divergence and curl: Physical significance; integral calculus (line, surface and volume integrals; Gauss and Stokes theorem, Dirac delta function; Helmholtz theorem for vector fields Laplace equation, Poisson equation.	4L
2	<b>Maxwell's equation for static EM fields:</b> Coulomb's law, Faraday's law, Electric Flux density, Gauss's law, relation between E and V, Ampere's Circuit law, Magnetic Flux density,	4L
3.	<b>Maxwell's equation for time varying EM fields:</b> Current ,Conduction, Convection, Displacement; Maxwell's equation in final form for time varying EM fields: Differential form, Integral form, using Phasor notation, derivation and physical significance, Vector and Scalar potential, Conditions at a boundary surface.	4L
4.	<b>Wave equations:</b> Homogeneous, isotropic medium, orientation of electric field, magnetic field and direction of propagation, Helmholtz equation, wave equation in free space, conducting medium, Uniform plane wave, intrinsic impedance, Poynting vector, polarization: circular, elliptical	8L
.5.	<b>Uniform Plane waves:</b> Wave propagation through various media; good conductor, perfect dielectric	8L

	Reflection and refraction: normal incidence and oblique incidence in perfect conductor, perfect dielectric, horizontal and vertical polarization, Brewster angle, total internal reflection, evanescent wave, surface impedance, phase and group velocity; skin depth.	
6.	<b>Transmission lines:</b> Parameters, equation: current, voltage, input impedance, condition of lossless line, distortion less line, characteristic impedance SWR: Voltage and current, shorted line, open circuited line, matched line, power, Smith chart	6L
7.	<b>Wave propagation:</b> Friis transmission formula, Propagation effect of Link on EM Wave propagation in Different frequency Ranges. Interference Effects of Ground, Antennas Located over Flat & Spherical Earth, Coverage Diagram, Surface wave propagation, Ionospheric propagation, Including Effects of Earths' Magnetic Fields. Tropospheric Scatter, Ducts & Nonstandard Refraction, ELF propagation using Earth-Ionosphere. Waveguide Model. Scattering & Absorption at Microwave Frequencies. Introduction to Propagation modeling and Predictive studies on Propagation. Multipath fading.	8L
	<b>Total:</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>Total Week Reserved:</b>	<b>02</b>

### Text/ Reference Book:

- 1 Sadiku N. O., "Elements of Electromagnetics", Oxford.
- 2 Jordan E.C, Balmain K.G., "Electromagnetic Waves And Radiating Systems", PHI.
- 3 Harrington Roger F., "Time-Harmonic Electromagnetic Fields", Willey.
- 4 Stratton Julius Adams, Julius Adams Stratton, "Electromagnetic Theory"
- 5 John Kraus, Daniel Fleisch, "Electromagnetics with applications", Mcgraw Hill.
- 6 Griffiths David J. "Introduction to Electrodynamics", Cambridge University Press.
- 7 Guru B S, Hiziroglu H R, "Electromagnetic Field Theory Fundamentals", Cambridge University Press.
- 8 Reitz, John R, Milford Frederick J., Christy Robert W., "Foundations of Electromagnetic Theory", Addison Wesley.
- 9 Laud B.B, "Electromagnetics" New Age International.

### Course Outcomes:

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

1. Characterize the electromagnetic waves in vector domain
2. Analyze the solutions of Maxwell's equations in mediums of different dielectric constants
3. Characterize the plane wave propagation, reflection, refraction and power flow
4. Apply Maxwell's equations to solutions of problems of transmission lines

5. Use sections of transmission line sections for realizing circuit elements
6. Analyze wave propagation on metallic waveguides in modal form.

Course code	PCC-EC 602				
Category	Professional Core Course (PCC)				
Course Title	Microcontroller based Embedded Systems				
Scheme and Credits	L	T	P	Credit	Semester – VI
	3	3	3	3	
Pre-requisites (if any)	PCC-EC 403				

### Theory Syllabus:

<b>Unit no.</b>	<b>Detailed Description</b>	<b>Lecture/ Tutorial Period</b>
1.	<b>Introduction:</b> Concepts of virtual memory, Cache memory; Advanced coprocessor architectures- 286, 486, Pentium; Microcontrollers 8051 systems- pin and port description.	3L
2.	<b>RISC and ARM:</b> Introduction to RISC processors; ARM microcontrollers interface design.	2L
3.	<b>Overview of Embedded System:</b> Embedded System, Embedded Processor in System, Components of Embedded System, Brief introduction to Embedded software in system, Design Process in Embedded System.	5L
4.	<b>Embedded Hardware: Processor &amp; Memory:</b> Brief overview of 8051 Architecture and real world interfacing, Introduction to advanced Processor Architectures-ARM, Processor and Memory organization, Parallelism in instruction level, Processor and memory selection	8L
5.	<b>I/O Types:</b> Serial and Parallel communication Ports, Timer and Counting devices, Watchdog timers, real time Clock, Serial bus Communication Protocols- I2C, CAN, and Parallel Communication Protocol-ISA.	4L
6.	<b>Interrupt Service Mechanism:</b> Concept of ISR, different interrupt sources, Interrupt handling Mechanism, Multiple Interrupts, Interrupt Latency and deadline.	2L

7.	<b>Embedded Software Development- Software Development:</b> Programming concept in ALP (assembly language programming) and High level language-C, Processor directives, functions and macros and other programming elements, Embedded C++ concept only.	3L
8.	<b>RTOS(Real time operating System):</b> OS overview, Process, Interrupt and memory management, RTOS overview, Basic Design rule using RTOS, Task scheduling using Priority based scheduling, cyclic scheduling and round robin scheduling.	5L
9.	<b>Embedded system Design using PIC microcontroller:</b> Introduction to Microchip PIC16 family, PIC16F873 processor architecture- features, memory organization, on chip peripherals, Watchdog timer, ADC, Data EEPROM, Asynchronous serial port, SPI mode, I2C mode, Interfacing with LCD, ADC, sensors, stepper motor, key board, DAC.	8L
10.	<b>Case study of different types of Embedded System:</b> Design of Automated Chocolate Vending Machine, Digital Camera.	2L
	<b>Total:</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. of Week Reserved:</b>	<b>02</b>

### Text/ Reference Book

- 1 Deshmukh Ajay V., “Microcontrollers Theory and Application”, TMH, 2011.
- 2 Kamal Raj “Embedded Systems: Architecture, Programming & Design,” TMH,
- 3 Vahid Frank “Embedded System Design: A unified Hardware/ Software Introduction”, Willey, 2011.
- 4 Balmain Jordan K.G. “Electromagnetic Waves And Radiating Systems”, PHI.
- 5 Peatman J. B. “Design with PIC Microcontrollers”, Pearson India, 2008.

### Course outcomes:

After completion of the course, the student will able to

1. Program and test the microcontrollers
2. Describe the internal architectures
3. Characterize the embedded systems with the hardware like IO devices, memory, interrupts, processors
4. Develop the software of embedded systems
5. Design embedded systems using PIC microcontrollers.

Course code	PCC-EC 652				
Category	Professional Core Course (PCC)				
Course title	Microcontroller based Embedded systems Laboratory				
Scheme and Credits	L	T	P	Credits	Semester – VI
	0	0	2	1	
Pre-requisites (if any)	PCC-EC 453				

### Laboratory Syllabus

<b>Detailed Description</b>	<b>Practical Period</b>
<ol style="list-style-type: none"> <li>1. Familiarization with 8085 &amp; 8051 simulator on PC.</li> <li>2. Study of prewritten programs using basic instruction set (data transfer, Load/Store, Arithmetic, Logical) on the KIT. Assignments based on above.</li> <li>3. Programming using kit and simulator for: i) Table look up ii) Copying a block of memory iii) Shifting a block of memory iv) Packing and unpacking of BCD numbers v) Addition of BCD numbers vi) Binary to ASCII conversion vii) String Matching, Multiplication using shift and add method and Booth's Algorithm.</li> <li>4. Program using subroutine calls and IN/OUT instructions using 8255 PPI on the trainer kit e.g. subroutine for delay, reading switch state and glowing LEDs accordingly.</li> <li>5. Study of timing diagram of an instruction on oscilloscope.</li> <li>6. Interfacing of 8255: Keyboard and Multi-digit Display with multiplexing using 8255.</li> <li>7. Study of 8051 Micro controller kit and writing programs as mentioned in S/L3. Write programs to interface of Keyboard, DAC and ADC using the kit.</li> <li>8. Serial communication between two trainer kits.</li> </ol>	
<b>Total:</b>	<b>42L</b>
<b>Total Week Required:</b>	<b>14</b>
<b>No. of Week Reserved:</b>	<b>02</b>

### Course outcomes:

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

1. Program the microcontrollers
2. Can map the IO, memory and other peripherals
3. Analyze the timing diagrams on oscilloscope
4. Apply serial communication between two trainer kits.

Course code	PCC-EC 603				
Category	Professional Core Course (PCC)				
Course Title	Computer Networks				
Scheme and Credits	L	T	P	Credits	Semester – VI
	3	0	0	3	
Pre-requisites (if any)					

### Theory Syllabus:

<b>Unit No.</b>	<b>Detailed Description</b>	<b>Lecture/ Tutorial Period</b>
1.	<p><b>Overview of Data Communication and Networking:</b> Introduction; Data communications: components, data representation (ASCII, ISO etc.), direction of data flow (simplex, half duplex, full duplex); network criteria, physical structure (type of connection, topology), categories of network (LAN, MAN, WAN); Internet: brief history, Protocols and standards; Reference models: OSI reference model, TCP/IP reference model, their comparative study.</p> <p><b>Physical Level:</b> Overview of data (analog &amp; digital), signal (analog &amp; digital), transmission (analog &amp; digital) &amp; transmission media (guided &amp; unguided); Circuit switching: time division &amp; space division switch, TDM bus; Telephone Network;</p>	10L
2.	<p><b>Data link Layer:</b> Types of errors, framing (character and bit stuffing), error detection &amp; correction methods; Flow control; Protocols: Stop &amp; wait ARQ, Go-Back-N ARQ, Selective repeat ARQ, HDLC;</p> <p><b>Medium Access sub layer:</b> Point to Point Protocol, LCP, NCP, and Token Ring; Reservation, Polling, Multiple access protocols: Pure ALOHA, Slotted ALOHA, CSMA, CSMA/CD, CSMA/CA Traditional Ethernet, and fast Ethernet (in brief). FCC implementation rules.</p>	10L
3.	<p><b>Network layer:</b> Internetworking &amp; devices: Repeaters, Hubs, Bridges, Switches, Router, Gateway; Addressing: IP addressing, sub-netting; Routing: techniques, static vs. dynamic routing, Unicast Routing Protocols: RIP, OSPF, BGP; Other Protocols: ARP, IP, ICMP, and IPV6.</p> <p><b>Transport layer:</b> Process to Process delivery; UDP; TCP; Congestion Control: Open Loop, Closed Loop choke packets; Quality of service: techniques to improve QoS: Leaky bucket algorithm, Token bucket algorithm.</p>	12L



4.	<b>Application Layer:</b> Introduction to DNS, SMTP, SNMP, FTP, HTTP & WWW; Security: Cryptography (Public, Private Key based), Digital Signature, Firewalls. <b>Modern topics:</b> ISDN services & ATM, DSL technology, Cable Modem: Architecture & Operation in brief Wireless LAN: IEEE 802.11, Introduction to blue-tooth.	10L
	<b>Total:</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. of Week Reserved:</b>	<b>02</b>

#### Text/ Reference Book

- 1 Forouzan B. A. "Data Communications and Networking (3rd Ed.)" – TMH.
- 2 Tanenbaum A. S. "Computer Networks (4th Ed.)" - Pearson Education/PHI.
- 3 Stallings W. "Data and Computer Communications (5th Ed.)" - PHI/ Pearson Education.
- 4 Zheng & Akhtar, "Network for Computer Scientists & Engineers", Oxford University Press
- 5 Black, "Data & Computer Communication", PHI
- 6 Miller, "Data Communication & Network", Vikas publication.
- 7 Miller, "Digital & Data Communication", Jaico
- 8 Shay, "Understanding Data Communication & Network", Vikas publication
- 9 Kurose and Rose "Computer Networking -A top down approach featuring the internet" - Pearson Education.
- 10 Leon, Garica, Widjaja "Communication Networks" TMH
- 11 Walrand "Communication Networks" TMH.
- 12 Comer "Internetworking with TCP/IP, vol. 1, 2, 3(4th Ed.)" - Pearson Education/PHI.

#### Course outcomes:

After completion of the course, the student will able to

1. Describe the functions of each layer in OSI and TCP/IP model
2. Explain the functions of application layer and presentation layer paradigms and protocols
3. Describe the session layer design issues and transport layer services
4. Classify the routing protocols and analyze how to assign the IP addresses for the given networks
5. Describe the functions of data link layer and explain the protocols
6. Explain the types of transmission media with real time applications.

Course code	PCC-EC 653				
Category	Professional Core Course (PCC)				
Course title	Computer Networks Laboratory				
Scheme andCredits	L	T	P	Credits	Semester – VI
	0	0	2	1	
Pre-requisites (if any)					

**Laboratory Syllabus:**

Detailed Description	Practical Period
<b>List of Experiments:</b> <ol style="list-style-type: none"> <li>1. IPC (Message queue)</li> <li>2. NIC Installation &amp; Configuration (Windows/Linux)</li> <li>3. Familiarization with Networking cables (CAT5, UTP) Connectors (RJ45, T-connector) Hubs, Switches</li> <li>4. TCP/UDP Socket Programming</li> <li>5. Multicast &amp; Broadcast Sockets</li> <li>6. Implementation of a Prototype Multithreaded Server</li> <li>7. Implementation of Data Link Layer Flow Control Mechanism (Stop &amp; Wait, Sliding Window)</li> </ol> Data Link Layer Error Detection Mechanism (Cyclic Redundancy Check) Data Link Layer Error Control Mechanism (Selective Repeat, Go Back N)	
<b>Total:</b>	<b>42L</b>
<b>Total Week Required:</b>	<b>14</b>
<b>No. of Week Reserved:</b>	<b>02</b>

**Course outcomes:**

After completion of the course, the student will able to

1. Identify the different types of network devices and their functions within a network
2. Enumerate the layers of OSI model and TCP/IP
3. Characterize the function of each layer
4. Implement the protocols to assist network design.

Course code	PROJ-EC 654				
Category	Professional Core Course (PCC)				
Course Title	Electronic Design Workshop (Mini Project)				
Scheme and Credits	L	T	P	Credits	Semester – VI
	0	0	4	2	
Pre-requisites (if any)	All the relevant PCC Labs				

**Laboratory Syllabus:**

Sl No.	Details	Practical Period
1.	The mini-project is a team activity having 3-4 students in a team. This is electronic product design work with a focus on electronic circuit design.	
2.	The mini project may be a complete hardware or a combination of hardware and software. The software part in mini project should be less than 50% of the total work.	
3.	Mini Project should cater to a small system required in laboratory or real life.	
4.	It should encompass components, devices, analog or digital ICs, micro controller with which functional familiarity is introduced.	
5.	After interactions with course coordinator and based on comprehensive literature survey/need analysis, the student shall identify the title and define the aim and objectives of mini-project	
6.	Student is expected to detail out specifications, methodology, resources required, critical issues involved in design and implementation and submit the proposal within first week of the semester.	
7.	The student is expected to exert on design, development and testing of the proposed work as per the schedule.	
8.	Art work and Layout should be made using CAD based PCB simulation software. Due considerations should be given for power requirement of the system, mechanical aspects for enclosure and control panel design.	
9.	Completed mini project and documentation in the form of mini project report is to be submitted at the end of semester.	
10.	The tutorial sessions should be used for discussion on standard practices used for electronic circuits/product design, converting the circuit design into a complete electronic product, PCB design using suitable simulation software, estimation of power budget analysis of the product, front panel design and mechanical aspects of the product, and guidelines for documentation /report writing.	
	<b>Total:</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. of Week Reserved:</b>	<b>02</b>

**Course outcomes:**

After completion of the course, the student will able to

1. Conceive a problem statement either from rigorous literature survey or from the requirements raised from need analysis. Design a network for a particular application
2. Design, implement and test the prototype/algorithm in order to solve the conceived problem
3. Write comprehensive report on mini project work.

Course code	HSM-HU 601				
Category	Humanities and Social Sciences including Management courses				
Course title	Values and Ethics				
Scheme andCredits	L	T	P	Credits	Semester –VI
	3	0	0	3	
Pre-requisites (if any)					

**Theory Syllabus:**

<b>Unit no.</b>	<b>Detailed Description</b>	<b>Lecture / Tutorial Period</b>
<b>1.</b>	<b>Nature of professional ethics:</b> -Introduction, definition, morals & ethics sources of ethics, sources of ethics, relationship between ethics and management. Nature of professional ethics, importance of ethics in profession, nature and objectives of ethics, need for ethics.	4L
<b>2.</b>	<b>Engineering Ethics:</b> Senses of 'Engineering Ethics' - variety of moral issues - types of inquiry - moral dilemmas - moral autonomy - Kohlberg's theory - Gilligan's theory - consensus and controversy – Models of Professional Roles - theories about right action - Self-interest - customs and religion - uses of ethical theories. Valuing Time – Co-operation – Commitment – Nature of Engineering Ethics, Profession and Professionalism, Professional Ethics, Code of Ethics, Sample Codes – IEEE, ASCE, ASME and CSI.	8L

<b>3.</b>	<b>Effects of technological growth:-</b> Energy Crisis, Rapid technological growth, environmental degradation and pollution, human operator in Engineering projects and industries, problems of man, machine, interaction. Impact of assembly line and automation.	8L
<b>4.</b>	<b>Ethics in profession:-</b> Engineering profession, ethical issues in engineering practice, conflicts between business demands and professional ideals, social and ethical responsibilities of technologists, code of professional Ethics, Whistleblowing and beyond, effects of globalization in modern organization, case study.	8L
<b>5.</b>	<b>Ethical decision making: -</b> Values, morals, standards, corporate social responsibility, attitude and beliefs, ethical values and dimensions dilemmas- decision making, organization and power politics.	7L
<b>6.</b>	<b>Managing ethics: -</b> Building a value system, role of law enforcement, training in ethics, ethics in commercial and operational profession, ethics in finance, and ethics in HRM, ethics in Global Business, ethics and IT.	7L
	<b>Total</b>	<b>42L</b>
	<b>Total week required</b>	<b>14</b>
	<b>No. of week reserved</b>	<b>02</b>

#### **Text and/or Reference:**

1. Dr. Subir Chowdhury, "Blending the best of the East & West", EXCEL
2. Vikas Ghosh, "Ethics & Mgmt. & Indian Ethos".
3. Pherwani, "Business Ethics", EPH.
4. Balachandran, Raja, Nair, "Ethics, Indian Ethos & Mgmt.", Shroff Publishers.
5. Velasquez, "Business Ethics: concept and cases", Pearson.
6. Charles B. Fleddermann, "Engineering Ethics" Pearson / PHI, New Jersey 2004 (Indian Reprint)
7. Charles E Harris, Michael S. Protchard and Michael J Rabins, "Engineering Ethics – Concepts and Cases" Wadsworth Thompson Learning, United States, 2000 (Indian Reprint now available).

8. John R Boatright, “Ethics and the Conduct of Business”, Pearson Education, New Delhi, 2003.
9. Edmund G Seebauer and Robert L Barry, “Fundamentals of Ethics for Scientists and Engineers”, Oxford University Press, Oxford, 2001.

### Course Outcomes:

**At the end of this course, students will be able to**

1. Apply the concept of values and ethics and its application in engineering field.
2. Make themselves aware about various factors influencing ethical decisions.
3. Develop some practical views and skills, and instill in their mind certain basic points of ethical decision making with the help of case studies.
4. Convince and resolve a moral dilemma and to take an ethical decision in case of conflicting interests.
5. Develop about the social and ethical responsibilities of an engineer and his role in nation building and inclusive growth.
6. Develop the basics on when and how to play a whistleblowers role if it is essential as a social responsibility to save the public and the nation.

Course code	PEC –EC 611(a)				
Category	Program Elective Course (PEC)				
Course Title	Analog VLSI				
Scheme and Credits	L	T	P	Credits	Semester – VI
	3	0	0	3	
Pre-requisites (if any)	PCC-EC 401				

<b>Unit No.</b>	<b>Detailed Description</b>	<b>Lecture/ Tutorial Period</b>
1.	<b>MOS and BJT:</b> MOS device physics and Si-Ge NPN device physics, Compact analog/RF circuit models for BiCMOS devices.	4L
2.	<b>IC design fundamentals:</b> Current mirror, Frequency response of Amplifiers, Active loads, voltage references, Feedback amplifiers.	4L

3.	<b>CMOS Op-amp design and frequency response:</b> Two-Stage CMOS Opamp, Folded-Cascode Opamp, Fully Differential Opamps, Advanced Current Mirrors, Current Mirror Opamp, small signal analysis of Op-amp, slew rate, compensation etc.	14L
4.	<b>Analog Multiplier:</b> Analysis of Gilbert cell, balanced modulator, phase detector.	4L
5.	<b>Phase-Locked Loop:</b> Basic Phase-Locked Loop Architecture, Jitter and Phase Noise, Electronic Oscillators, Jitter and Phase Noise in PLLS.	4L
6.	<b>Continuous-Time Filters:</b> Introduction to Continuous-Time Filters, Introduction to Gm-C Filters, CMOS Transconductors, Bipolar Transconductors, Active RC and MOSFET-C Filters.	4L
7.	<b>Comparators:</b> Comparator Specifications, Using an Op-amp for a Comparator, Charge-Injection Errors, Latched Comparators.	3L
8.	<b>Switched capacitor circuits:</b> Basic Building Blocks, Charge Injection, Switched-Capacitor applications.	3L
9.	<b>CMOS Layout and Design Rules:</b> Spacing Rules, Planarity and Fill Requirements, Variability and Mismatch, Analog Layout Considerations.	2L
	<b>Total:</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. of Week Reserved:</b>	<b>02</b>

#### Text / Reference Books

1. Gray, Hurst, Lewis, Meyer, "Analysis and Design of Analog Integrated Circuits," 2009
2. Leblebici and Leblebici, "Fundamentals of High-Frequency CMOS Analog IntegratedCircuits", Cambridge, 2009.
3. Razavi, "Design of Analog CMOS Integrated Circuits", McGraw-Hill,
4. Allen and Holberg, "CMOS Analog Circuit Design", Oxford Univ Press,
5. Rogers John W. M. and Plett Calvin, "Radio Frequency Integrated Circuit Design" Artech House publication.
6. Sarkar Angsuman, De Swapnadip & Sarkar Chandan Kumar "VLSI Design and EDA Tools", Scitech Publication (India) PVT, LTD.
8. Pucknell D & Eshraghian "Basic VLSI Design", PHI, 3rd Edition.
9. Neil H. E. Weste "Principle of CMOS VLSI Design", Pearson Edition, 2nd Edition.

#### Course Outcomes:

At the end of the course the students will be able to

1. Formulate problems in terms of finite elements
2. Develop solution to overcome short channel issues
3. Develop compact models appropriate for industry
4. Analyze current distribution in the CMOS devices
5. Apply the lay out rules to meet design issues.

Course code	PEC-EC 611(b)				
Category	Program Elective Course (PEC)				
Course Title	Scientific Computing				
Scheme and Credits	L	T	P	Credits	Semester – VI
	3	0	0	3	
Pre-requisites (if any)	BSC-M 301 BSC-M 402				

### Theory Syllabus:

<b>Unit no.</b>	<b>Detailed Description</b>	<b>Lecture/Tutorial Period</b>
1.	<b>Introduction:</b> 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.	2L
2.	<b>Computer Arithmetic:</b> Floating Point Numbers, Normalization, Properties of Floating Point System, Rounding, Machine Precision, Subnormal and Gradual Underflow, Exceptional Values, Floating-Point Arithmetic, Cancellation.	4L
3.	<b>System of liner equations:</b> Linear Systems, Solving Linear Systems, Gaussian elimination, Pivoting, Gauss-Jordan, Norms and Condition Numbers, Symmetric Positive Definite Systems and Indefinite System, Iterative Methods for Linear Systems.	6L
4.	<b>Linear least squares:</b> Data Fitting, Linear Least Squares, Normal Equations Method, Orthogonalization Methods, QR factorization, Gram-Schmidt Orthogonalization, Rank Deficiency, and Column Pivoting.	4L
5.	<b>Eigen values and singular values:</b> Eigen values and Eigenvectors, Methods for Computing All Eigen values, Jacobi Method, Methods for Computing Selected Eigen values, Singular Values Decomposition, Application of SVD.	6L
6.	<b>Nonlinear equations:</b> Fixed Point Iteration, Newton's Method, and Inverse Interpolation Method Optimization: One-Dimensional Optimization, Multidimensional Unconstrained Optimization, and Nonlinear Least Squares.	6L
7.	<b>Interpolation:</b> Purpose for Interpolation, Choice of Interpolating, Function, Polynomial Interpolation, Piecewise Polynomial Interpolation <b>Numerical Integration And Differentiation:</b> Quadrature Rule, Newton-Cotes Rule, Gaussian Quadrature Rule, Finite Difference Approximation.	4L
8.	<b>Initial Value Problems for ODES:</b> Euler's Method, Taylor Series Method, Runge-Kutta Method, Extrapolation Methods, Boundary Value Problems For ODES, Finite Difference Methods, Finite Element Method, Eigen value Problems Partial Differential Equations, Time Dependent Problems, Time	6L



	Independent Problems, Solution for Sparse Linear Systems, Iterative Methods.	
9.	<b>Fast Fourier Transform:</b> FFT Algorithm, Limitations, DFT, Fast polynomial Multiplication, Wavelets, Random Numbers And Simulation, Stochastic Simulation, Random Number Generators, Quasi-Random Sequences.	4L
	<b>Total:</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. of Week Reserved:</b>	<b>02</b>

**Text/ Reference Books:**

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, 1<sup>st</sup> Ed., 2006.
5. Quarteroni, Alfio, Saleri, Fausto, Gervasio and Paola, “Scientific Computing With MATLAB and Octave”, Springer, 3rd Ed., 2010.

**Course Outcomes:**

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

1. Conceive the significance of computing methods,
2. Apply the methods on suitable application areas.
3. Estimate the errors in the used methods
4. Characterize the nonlinear and linear differential equations
5. Analyze the transformation to discrete time domain.

Course code	PEC-EC 611(c)				
Category	Program Elective Course (PEC)				
Course Title	Mechatronics				
Scheme and Credits	L	T	P	Credits	Semester – VI
	3	0	0	3	
Pre-requisites (if any)	PCC-EC 401 PCC-EC 403				

**Theory Syllabus:**

Unit No.	Detailed Description	Lecture/ Tutorial Period
1.	<b>Mechatronics and the Controls:</b> Mechatronics in manufacturing, products and design. Review of fundamentals of electronics. Mechatronic Elements: Data conversion devices, sensors, micro-sensors, transducers, signal processing devices, relays & actuators, contactors and timers. Microcontrollers, PID controllers and PLCs & Other digital controllers. <i>Drives:</i> Stepper motors, Servo drives. Ball screws, linear motion bearings, cams, systems controlled by camshafts, electronic cams, indexing mechanisms, tool magazines, and transfer systems.	11L
2.	<b>Hydraulic systems:</b> flow, pressure and direction control valves, actuators, and supporting elements. Pneumatics: Production, distribution and conditioning of compressed air, system components and graphic representations, design of systems. Introduction to CNC machines. Definition of a robot, types of robotic joints and motions, classifications of robot based on: Physical configurations, actuators and motion control; Terminologies used for robotics specification and selection for industrial applications; Types of end-effectors; Applications of robotics.	12L
3.	<b>Robot Kinematics:</b> Homogeneous co-ordinates and co-ordinate transformations, kinematic parameters, use of Denavit-Hartenberg representation for finding arm equation of robotic arms, forward and inverse kinematics for basic industrial robotic configurations viz. Cartesian coordinate robot, SCARA configurations, and 5-axis and 6- axis articulated industrial robotic configurations. Introduction to Robot Dynamics.	9L
4.	<b>Robot in Work Place:</b> Work cell organization in robotics environment, function of work cell controller, robotic work cell design and control, introduction to robot trajectory planning. Introduction to Robot Vision: Sensing and digitization of vision data, image processing: image data reduction, segmentation, feature extraction, object recognition, and training of vision system. Methods of Robot Programming: Robot programming methods, introduction to basic robot programming languages, and various on-line and off-line robot programming methods.	10L
	<b>Total:</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. of Week Reserved:</b>	<b>02</b>

### Text/Reference Books:

1. Groover, M. P., Weiss, M., Nagel, R. N. and Odrey, N. G., "Industrial Robotics: Technology, Programming and Applications", McGraw Hill, New York (1986).
2. Boltan, W., "Mechatronics: electronic control systems in mechanical and electrical engineering", Longman, Singapore, 1999.

3. Lee, C.S.G., Fu, K.S and Gonzalez, “Robotics: Control, Sensing, Vision, and Intelligence”, McGraw Hill, New York (1990).
4. Deb, S. R., “Robotics technology and flexible automation”, Tata McGraw-Hill, New Delhi, 1994.
5. Asada, H. and Slotine, J. E., “Robot Analysis and Control”, John Wiley & Sons, New York (1986).
6. Schilling, R.J., “Fundamentals of Robotics Analysis & Control”, Prentice Hall of India, New Delhi (1990).

### Course Outcomes:

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

1. Interpret and use industry standard tools.
2. Follow the industry standard tools
3. Develop and troubleshoot manufacturing processes and procedures.
4. Model multi-dimensional articulated configuration
5. Program the robot for online/offline methods
6. Design and rebuilding projects.

Course Code	HSM-HU 681				
Category	Humanities and Social Sciences including Management Courses				
Course Title	Group Discussion & Personal Interview				
Scheme and credits	L	T	P	Credits	Semester—VI
	0	0	2	1	
Pre-requisites (if any)	Basic knowledge of oral & technical communication				

Unit No.	Detailed Description	Lecture/ Tutorial Period
1.	<b>Advanced Techniques in Technical Communication:</b> Using e-mail for business communication; standard e-mail practices; language in e-mail, using internet for collecting information; referencing while using internet materials for project reports; writing for media.	

2.	<b>Presentation:</b> Techniques of effective presentations by using various audio-visual aids	
3.	<b>Interview:</b> methods and Etiquettes; practice of mock interview; interview through telephone/ video-conferencing	
4	<b>Group Discussion:</b> Model group discussion through the choice of appropriate programmers.	
5.	Interaction with experts.	
	<b>Total</b>	<b>28P</b>
	<b>Total week required</b>	<b>14</b>
	<b>No. of week reserved</b>	<b>02</b>

#### **Text Books:**

1. Hari Mohan Prasad, Rajnish Mohan, “How to Prepare for Group Discussion & Interview”, Tata McGraw Hill Education, New Delhi: 2012.
2. Dinesh Mathur, “Mastering Interviews and Group Discussions”, CBS Publication, 2017.
3. Anil Kumar Maini, “Technical Interviews”, Excel with Ease. Pearson, 2011.

#### **Reference Books:**

1. Group Discussions and Interviews, Anand Ganguly RPH, 2014.
2. The Interview Book: Your Definite Guide to the Perfect Interview Technique, James Innes. Prentice Hall Business, 2009.

#### **Course outcomes:**

On completion of the course students will be to:

1. Learn structure and format for effective communications, using e-mail for business communication; standard e-mail practices; language in e-mail, using internet for collecting information; referencing while using internet materials for project reports; writing for media.

2. Deliver effective power-point presentation.
3. Take part in Interview through telephone/video-conferencing.
4. Become proficient to face interviews and model group discussions through the choice of appropriate programmers.

SEMESTER VII (Fourth Year)								
Branch/Course Electronics and Communication Engineering								
Sl. No	Types of Course	Code	Course Title	Hours per week			Credits	Marks
				L	T	P		
1.	Program Elective Course	PEC-EC 711(a-c)	Program Elective III	3	0	0	3	100
2.	Program Elective Course	PEC-EC 712(a-c)	Program Elective IV	3	0	0	3	100
3.	Program Elective Course	PEC-EC 713(a-c)	Program Elective V	3	0	0	3	100
4.	Open Elective Course	OEC-xxx 721(a-e)	Open Elective III	3	0	0	3	100
5.	Humanities and Social Science	HSM-HU 701	Industrial Management and Entrepreneurships	3	0	0	3	100
6.	Project and Internship	PROJ-INT 791	Internship	0	0	4	2	100
7.	Project	PROJ-EC 792	Project Work I	0	0	10	5	100
<b>Total</b>							<b>22</b>	<b>700</b>

Subject Pool For Program Elective Courses PEC III,7th SEM			
Sl. No.	Code	Course Title	Credits
1.	PEC- EC 711(a)	Antenna Engineering	3
2.	PEC- EC 711(b)	Adaptive Signal Processing	3
3.	PEC- EC 711(c)	Mixed Signal Circuit Design	3

Subject Pool For Program Elective Courses PEC IV,7th SEM			
Sl. No.	Code	Course Title	Credits
1.	PEC- EC 712(a)	Microwave Theory and Techniques	3
2.	PEC- EC 712(b)	Embedded Systems	3
3.	PEC- EC 712(c)	Wavelets	3

Subject Pool For Program Elective Courses PEC V,7th SEM			
Sl. No.	Code	Course Title	Credits
1.	PEC- EC 713(a)	Digital Image and video Processing	2
2.	PEC- EC 713(b)	Error Correcting Codes	2
3.	PEC- EC 713(c)	Digital VLSI	2

**Subject Pool For Open Elective Courses OEC III,7th SEM**

<b>Sl. No.</b>	<b>Code</b>	<b>Course Title</b>	<b>Credits</b>
1.	OEC-HU 721(a)	Introduction to Comparative literature	3
2.	OEC-HU 721(b)	Economic Policies in India	3
3.	OEC-M 721(c)	Mathematical Formulation & Approximations	3
4.	OEC-HU 721(d)	Soft Skills & Interpersonal Communication	3
5.	OEC-EI 721(e)	MEMS	3
6.	OEC-EC 721(f)	Nano Electronics	3

Course code	PEC-EC 711(a)				
Category	Program Elective Course (PEC)				
Course Title	Antenna Engineering				
Scheme and Credits	L	T	P	Credits	Semester – VII
	3	0	0	3	
Pre-requisites (if any)	PCC-EC 601				

**Theory Syllabus:**

<b>Unit no.</b>	<b>Detailed Description</b>	<b>Lecture / Tutorial Period</b>
1.	<b>Fundamental Concepts-</b> Physical concept of radiation, Radiation pattern, near-and far-field regions, reciprocity, directivity and gain, effective aperture, polarization, input impedance, efficiency, Friis transmission equation, radiation integrals and auxiliary potential functions.	3L
2	<b>Radiation from Wires and Loops-</b> Infinitesimal dipole, finite-length dipole, linear elements near conductors, dipoles for mobile communication, small circular loop.	6L
3.	<b>Aperture and Reflector Antennas-</b> Huygens' principle, radiation from rectangular and circular apertures, design considerations, Babinet's principle, Radiation from sectoral and pyramidal horns, design concepts, prime-focus parabolic reflector and cassegrain antennas. Microwave Antennas- Antenna parameters, Antenna for ground based systems, Antennas for airborne and satellite borne systems, Planar Antennas	5L
4.	<b>Broadband Antennas-</b> Log-periodic and Yagi-Uda antennas, frequency independent antennas, broadcast antennas.	4L
5.	<b>Micro strip Antennas-</b> Basic characteristics of micro strip antennas, feeding methods, methods of analysis, design of rectangular and circular patch antennas. FSS antennas	8L
6.	<b>Antenna Arrays-</b> Analysis of uniformly spaced arrays with uniform and non-uniform excitation amplitudes, extension to planar arrays, and synthesis	10L

	of antenna arrays using Schelkunoff polynomial method, Woodward-Lawson method.	
7.	<b>Basic Concepts of Smart Antennas-</b> Concept and benefits of smart antennas, fixed weight beam forming basics, Adaptive beam forming.	6L
	<b>Total :</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>Total Week Reserved:</b>	<b>02</b>

#### Text/Reference Books:

1. J.D. Kraus, "Antennas", McGraw Hill, 1988.
2. C.A. Balanis, "Antenna Theory - Analysis and Design", John Wiley, 1982.
3. R.E. Collin, "Antennas and Radio Wave Propagation", McGraw Hill, 1985.
4. R.C. Johnson and H. Jasik, "Antenna Engineering Handbook", McGraw hill, 1984.
5. I.J. Bahl and P. Bhartia, "Micro Strip Antennas", Artech House, 1980.
6. R.K. Shevgaonkar, "Electromagnetic Waves", Tata McGraw Hill, 2005
7. R.E. Crompton, "Adaptive Antennas", John Wiley

#### Course Outcomes:

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

1. Identify fundamental antenna parameters
2. Estimate the radiation parameters and power patterns from radiated fields
3. Design and analyze antenna arrays to achieve desired directional property
4. Characterise high frequency antennas
5. Design and develop patch antennas
6. Analyze adaptive beam formation.

Course code	PEC-EC 711(b)				
Category	Program Elective Course (PEC)				
Course title	Adaptive Signal Processing				
Scheme and Credits	L	T	P	Credits	Semester – VII
	3	0	0	3	
Pre-requisites (if any)	PCC-EC 502				



**Theory Syllabus:**

<b>Unit No.</b>	<b>Detailed Description</b>	<b>Lecture/Tutorial Period</b>
<b>1.</b>	General concept of adaptive filtering and estimation, applications and motivation, Review of probability, random variables and stationary random processes, Correlation structures, properties of correlation matrices.	4L
<b>2.</b>	Optimal FIR (Wiener) filter, Method of steepest descent, extension to complex valued The LMS algorithm (real, complex), convergence analysis, weight error correlation matrix, excess mean square error and mis-adjustment.	6L
<b>3.</b>	Variants of the LMS algorithm: the sign LMS family, normalized LMS algorithm, block LMS and FFT based realization, frequency domain adaptive filters, Sub-band adaptive filtering. Signal space concepts - introduction to finite dimensional vector space theory, subspace, basis, dimension, linear operators, rank and nullity, inner product space, orthogonality, Gram- Schmidt orthogonalization, concepts of orthogonal projection, orthogonal decomposition of vector spaces.	10L
<b>4.</b>	Vector space of random variables, correlation as inner product, forward and backward projections, Stochastic lattice filters, recursive updating of forward and backward prediction errors, relationship with AR modelling, joint process estimator, gradient adaptive lattice.	10L
<b>5.</b>	Introduction to recursive least squares (RLS), vector space formulation of RLS estimation, pseudo-inverse of a matrix, time updating of inner products, development of RLS lattice filters, RLS transversal adaptive filters. Advanced topics: affine projection and subspace based adaptive filters, partial update algorithms, QR decomposition and systolic array.	12L
	<b>Total:</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. of Week Reserved:</b>	<b>02</b>

**Text/Reference Books:**

1. S. Haykin, "Adaptive filter theory", Prentice Hall, 1986.
2. C.Widrow and S.D. Stearns, "Adaptive signal processing", Prentice Hall, 1984.

**Course Outcomes:**

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

1. Comprehend design criteria and modelling adaptive systems and theoretical performance evaluation
2. Represent the "adaptability requirement" mathematically
3. Design linear adaptive processor
4. Apply mathematical model for error performance and stability

5. Apply adaptive model to real-time situation.
6. Design based on recursive algorithm.

Course code	PEC-EC 711(c)				
Category	Program Elective Course (PEC)				
Course Title	Mixed Signal Circuit Design				
Scheme and Credits	L	T	P	Credits	Semester – VII
	3	0	0	3	
Pre-requisites (if any)	PCC-EC 502				

### Theory Syllabus:

<b>Unit no.</b>	<b>Detailed Description</b>	<b>Lecture/Tutorial Period</b>
1.	<b>Analog and discrete-time signal processing, introduction to sampling theory:</b> Analog continuous time filters: passive and active filters; Basics of analog discrete-time filters and Z-transform.	6L
2.	<b>Switched-capacitor filters:</b> -Non idealities in switched-capacitor filters; Switched-capacitor filter architectures; Switched-capacitor filter applications.	12L
3.	<b>Basics of data converters:</b> Successive approximation ADCs, Dual slope ADCs, Flash ADCs, Pipeline ADCs, Hybrid ADC structures, High-resolution ADCs, DACs.	8L
4.	<b>Mixed-signal layout:</b> Interconnects and data transmission; Voltage-mode signalling and data transmission; Current-mode signalling and data transmission.	8L
5.	<b>Introduction to frequency synthesizers and synchronization:</b> Basics of PLL, Analog PLLs; Digital PLLs; DLLs.	8L
	<b>Total:</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. of Week Reserved:</b>	<b>02</b>

### Text/Reference Books:

1. R. Jacob Baker, "CMOS mixed-signal circuit design", Wiley India, IEEE press, reprint2008.
2. Behzad Razavi, "Design of analog CMOS integrated circuits", McGraw-Hill, 2003.
3. R. Jacob Baker, "CMOS circuit design, layout and simulation", revised second edition, IEEE press, 2008.
4. Rudy V. DePlassche, "CMOS Integrated ADCs and DACs", Springer, Indian edition, 2005.

5. Arthur B. Williams, "Electronic Filter Design Handbook", McGraw-Hill, 1981.
6. R. Schauman, Design of analog filters by, Prentice-Hall 1990 (or newer additions).
7. M. Burns et al., An introduction to mixed-signal IC test and measurement by, OxfordUniversity Press, first Indian edition, 2008.

### Course Outcomes:

At the end of the course, students will demonstrate the ability to

1. Apply principles of hierarchical mixed signal CMOS VLSI from transistors
2. Design simulated experiments to verify the integrity
3. Analyze mixed signal circuits in CMOS
4. Apply mixed signal layout
5. Develop frequency synthesizer using feedback

Course code	PEC-EC 712(a)				
Category	Program Elective Course (PEC)				
Course title	Microwave Theory and Techniques				
Scheme and Credits	L	T	P	Credits	Semester – VII
	2	0	1	3	
Pre-requisites (if any)	PCC-EC 601				

### Theory Syllabus:

<b>Unit no.</b>	<b>Detailed Description</b>	<b>Lecture/Tutorial Period</b>
1.	<b>Waveguides:</b> Wave propagation in parallel plane waveguide, Analysis of waveguide general approach, Rectangular waveguide, Modal propagation in rectangular waveguide, Surface currents on the waveguide walls, Field visualization, Attenuation in waveguide, Modes in rectangular waveguide; TE, TM boundary conditions; cut-off frequencies, attenuation, intrinsic impedance; dominant mode, surface current, electric and magnetic field distribution in different modes.	8L
2.	<b>Resonators and Filters :</b> <b>Resonators:</b> Rectangular & Circular cavity resonator, Re-entrant cavity, Microstrip resonator. <b>Microwave Filter:</b> Filter parameters, Insertion loss method, Coupled line filter, Resonator filter	8L

3.	<b>High Frequency Circuit and Network:</b> High frequency behavior of circuit elements, S- parameter and S-matrix, Properties of S-Matrix, E-plane Tee, H-plane Tee , S-matrix representation: Magic Tee, directional coupler, hybrid ring, Corners, Bends & Twists	8L
4.	<b>Microwave Tubes and Devices:</b> Review of Vacuum tube microwave devices, <b>Vacuum Tubes:</b> Parallel Field types: Two cavity Klystron, Reflex klystron, Helix TWT, Cross Field Types -Magnetron; <b>Active Devices:</b> GUNN diode, tunnel diode and PIN diode. IMPATT diode, TRAPATT diode, RF and Microwave transistors. <b>Ferrite Devices :</b> Faraday Rotation, Phase Shifter, circulator, Isolator, attenuators. <b>Meta-materials:</b> Brief introduction to Meta-material	8L
5.	<b>RF &amp; Microwave amplifier design:</b> Basic consideration in the design of RF amplifier- Transistor S-parameter, Stability, matching network, noise figure, Matching network design using lumped elements and L-Section. Brief introduction to NBA, LNA.	4L
6.	<b>Microwave Systems-</b> Radar, Terrestrial and Satellite Communication, Radio Aidsto Navigation, RFID, and GPS. Modern Trends in Microwaves Engineering- Effect of Microwaves on human body, Medical and Civil applications of microwaves, Electromagnetic interference and Electromagnetic Compatibility (EMI & EMC), Monolithic Microwave ICs, RFMEMS for microwave components, Microwave Imaging. <b>Microstrip Circuits:</b> Microstrip lines, Coupled microsrtpip lines, Coplanar waveguide, slotline structures, field pattern, propagation characteristics, comparative analysis and design consideration.	6L
	<b>Total:</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. of Week Reserved:</b>	<b>02</b>

#### Text/ Reference Book:

1. S. Liao, "Microwave Devices & Circuits", PHI, 2003
2. D.M. Pozar, "Microwave Engineering, 2nd edition", John Wiley & Sons, 1998
3. Sisodia & Gupta , "Microwave: Introduction to circuits devices & Antennas"
4. Skolnik, "Radar Handbook".
5. G. Gonzales, "Microwave Transistor Amplifiers – Analysis and Design", Prentice-Hall, Inc
6. Matthew M Radmanesh, "Radio Frequency and Microwave Electronics Illustrated", Pearson Education

**Course Outcomes:**

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

1. Comprehend the methods of microwave analysis
2. Apply analysis methods to determine circuit properties of passive/active microwave devices.
3. Model performance characteristics of microwave circuits
4. Analyze microwave networks and measurements
5. Characterize and design the modern day applications of microwave.

Course code	PEC-EC 712(b)				
Category	Program Elective Course (PEC)				
Course Title	Embedded Systems (Theory)				
Scheme and Credits	L	T	P	Credits	Semester – VII
	3	0	0	3	
Pre-requisites (if any)	PCC-EC 602				

**Theory Syllabus:**

<b>Unit No.</b>	<b>Detailed Description</b>	<b>Lecture/Tutorial Period</b>
1.	The concept of embedded systems design, Embedded microcontroller cores, embedded memories. Examples of embedded systems, Technological aspects of embedded systems:	10L
2.	Interfacing between analog and digital blocks, signal conditioning, digital signal processing. Sub system interfacing, interfacing with external systems, user interfacing.	12L
3.	Design trade-offs due to process compatibility, thermal considerations, etc., Software aspects of embedded systems: real time programming languages and operating systems for embedded systems.	20L
	<b>Total:</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. of Week Reserved:</b>	<b>02</b>

**Text/Reference Books:**

1. J.W. Valvano, "Embedded Microcomputer System: Real Time Interfacing", Brooks/Cole, 2000.
2. Jack Ganssle, "The Art of Designing Embedded Systems", Newness, 1999.
3. V.K. Madiseti, "VLSI Digital Signal Processing", IEEE Press (NY, USA), 1995.

4. David Simon, "An Embedded Software Primer", Addison Wesley, 2000.
5. K.J. Ayala, "The 8051 Microcontroller: Architecture, Programming, and Applications" Penram Intl, 1996.

### Course Outcomes:

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

1. Characterize internal architecture of peripherals with microcontrollers.
2. Program the microcontrollers to real-life situations.
3. Design interfacing of the systems with other data handling / processing systems.
4. Develop OS for system
5. Appreciate engineering constraints like energy dissipation, data exchange speeds etc.

Course code	PEC-EC 712(c)				
Category	Program Elective Course (PEC)				
Course Title	Wavelets				
Scheme and Credits	L	T	P	Credits	Semester – VII
	3	0	0	3	
Pre-requisites (if any)	PCC-EC 303				

### Theory Syllabus:

<b>Unit no.</b>	<b>Detailed Description</b>	<b>Lecture/Tutorial Period</b>
<b>1.</b>	Introduction to time frequency analysis; the how, what and why about wavelets, Short-time Fourier transform, Wigner-Ville transform.	6L
<b>2.</b>	Continuous time wavelet transform, Discrete wavelet transform, tiling of the time-frequency plane and wave packet analysis.	10L
<b>3.</b>	Construction of wavelets. Multi resolution analysis. Introduction to frames and Bi-orthogonal wavelets, Multi rate signal processing and filter bank theory.	10L
<b>4.</b>	Application of wavelet theory to signal de-noising, image and video compression, multi-tone digital communication, transient detection.	16L
	<b>Total:</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. of Week Reserved:</b>	<b>02</b>

**Text/Reference Books:**

1. Y.T. Chan, "Wavelet Basics", Kluwer Publishers, Boston, 1993.
2. I. Daubechies, Ten "Lectures on Wavelets", Society for Industrial and Applied Mathematics, Philadelphia, PA, 1992.
3. C. K. Chui, "An Introduction to Wavelets", Academic Press Inc., New York, 1992.
4. Gerald Kaiser, "A Friendly Guide to Wavelets", Birkhauser, New York, 1995.
5. P. P. Vaidyanathan, "Multirate Systems and Filter Banks", Prentice Hall, New Jersey, 1993.
6. A.N. Akansu and R.A. Haddad, "Multiresolution signal Decomposition: Transforms, Subbands and Wavelets", Academic Press, Oranld, Florida, 1992.
7. B.Boashash, "Time-Frequency signal analysis", In S.Haykin, (editor), Advanced Spectral Analysis, pages 418--517. Prentice Hall, New Jersey, 1991.

**Course Outcomes:**

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

1. Understand time-frequency nature of the signals.
2. Apply the concept of wavelets to practical problems.
3. Mathematically analyze the systems
4. Process the signals using appropriate wavelet functions.
5. Design wavelets based systems to meet real time issues.

Course code	PEC-EC 713(a)				
Category	Program Elective Course (PEC)				
Course Title	Digital Image and Video Processing				
Scheme and Credits	L	T	P	Credits	
	3	0	0	3	
Pre-requisites (if any)	PCC-EC 502				

**Theory Syllabus:**

<b>Unit no.</b>	<b>Detailed Description</b>	<b>Lecture/ Tutorial Period</b>
<b>1.</b>	<b>Digital Image Fundamentals:</b> Elements of visual perception, image sensing and acquisition, image sampling and quantization, basic relationships between pixels – neighbourhood, adjacency, connectivity, distance measures.	6L

2.	<b>Image Enhancements and Filtering:</b> Grey level transformations, histogram equalization and specifications, pixel-domain smoothing filters – linear and order-statistics, pixel-domain sharpening filters – first and second derivative, two-dimensional DFT and its inverse, frequency domain filters – low-pass and high-pass.	6L
3.	<b>Colour Image Processing:</b> Colour models–RGB, YUV, HSI; Colour transformations– formulation, colour complements, colour slicing, tone and colour corrections; Colour image smoothing and sharpening; Colour Segmentation. <b>Image Segmentation:</b> Detection of discontinuities, edge linking and boundary detection, thresholding – global and adaptive, region-based segmentation.	10L
4.	<b>Wavelets and Multi-resolution image processing:</b> Uncertainty principles of Fourier Transform, Time-frequency localization, continuous wavelet transforms, wavelet bases and multi-resolution analysis, wavelets and sub-band filter banks, wavelet packets.	8L
5.	<b>Image Compression-Redundancy:</b> Inter-pixel and psycho-visual; Lossless compression–predictive, entropy; Lossy compression- predictive and transform coding; Discrete Cosine Transform; Still image compression standards – JPEG and JPEG-2000.	6L
6.	<b>Fundamentals of Video Coding:</b> Inter-frame redundancy, motion estimation techniques – full search, fast search strategies, forward and backward motion prediction, frame classification – I, P and B; <b>Video sequence hierarchy:</b> Group of pictures, frames, slices, macro-blocks and blocks; Elements of a video encoder and decoder; Video coding standards – MPEG and H.26X. <b>Video Segmentation:</b> Temporal segmentation–shot boundary detection, hard-cuts and soft-cuts; spatial segmentation – motion-based; Video object detection and tracking.	6L
	<b>Total:</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. of Week Reserved:</b>	<b>02</b>

### Text/Reference Books:

1. R.C. Gonzalez and R.E. Woods, “Digital Image Processing, Second Edition”, Pearson Education 3rd edition 2008
2. Anil Kumar Jain, “Fundamentals of Digital Image Processing”, Prentice Hall of India. 2<sup>nd</sup> edition 2004
3. Murat Tekalp, “Digital Video Processing”, Prentice Hall, 2nd edition 2015

### Course Outcomes:

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

1. Explain the need of image processing
2. Mathematically represent the various types of images and analyze them.



3. Process these images for the enhancement of certain properties or for optimized use of the resources.
4. Develop algorithms for image compression and coding.
5. Develop algorithm for image compression
6. Analyze video coding and decoding.

Course code	PEC-EC 713(b)				
Category	Program Elective Course (PEC)				
Course title	Error Correcting Codes				
Scheme andCredits	L	T	P	Credits	Semester – VII
	3	0	0	3	
Pre-requisites (if any)	PCC-EC 302 BSC-M 301				

### Theory Syllabus:

<b>Unit No.</b>	<b>Detailed Description</b>	<b>Lecture/Tutorial Period</b>
<b>1.</b>	Linear block codes: Systematic linear codes and optimum decoding for the binary symmetric channel; Generator and Parity Check matrices, Syndrome decoding on symmetric channels; Hamming codes; Weight enumerators and the McWilliams identities; Perfect codes, Introduction to finite fields and finite rings; factorization of $(X^n-1)$ over a finite field	10L
<b>2.</b>	Cyclic Codes, BCH codes; Idempotent and Mattson-Solomon polynomials; Reed-Solomon codes, Justesen codes, MDS codes, Alterant, Goppa and generalized BCH codes; Spectral properties of cyclic codes.	10L
<b>3.</b>	Decoding of BCH codes: Berlekamp's decoding algorithm, Massey's minimum shift register synthesis technique and its relation to Berlekamp's algorithm. A fast Berlekamp - Massey algorithm. Convolution codes	10L
<b>4.</b>	Wozencraft's sequential decoding algorithm, Fann's algorithm and other sequential decoding algorithms; Viterbi decoding algorithm	12L
	<b>Total:</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. of Week Reserved:</b>	<b>02</b>

### Text/Reference Books:

1. F.J. McWilliams and N.J.A. Sloane, "The theory of error correcting codes", 1977.
2. R.E. Balahut, "Theory and practice of error control codes", Addison Wesley, 1983.

### Course Outcomes:

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

1. Characterize the error sources

2. Apply Block codes, Cyclic codes
3. Develop the decoding algorithm
4. Implement error control coding in digital communication
- 5.

Course code	PEC-EC 713(c)				
Category	Program Elective Course (PEC)				
Course title	Digital VLSI				
Scheme and Credits	L	T	P	Credits	Semester – VII
	3	0	0	3	
Pre-requisites (if any)	PCC-EC 303 PEC-EC 611(a)				

### Theory Syllabus:

<b>Unit no.</b>	<b>Detailed Description</b>	<b>Lecture/ Tutorial Period</b>
1.	<b>Introduction:</b> Types and principles of MOSFETs, Introduction to large signal MOS models (long channel) for digital design. MOS Inverters, Static and Dynamic characteristics, Resistive, Depletion and Enhancement load NMOS inverters, the basic CMOS inverter, voltage transfer characteristics, logic threshold, Noise margins. Dynamic behavior, transition time, Propagation Delay, Power Consumption.	2L
2.	<b>MOS Circuit Layout &amp; Simulation:</b> Stick diagrams, Layout design rules, MOS device layout, Transistor layout, Inverter layout, CMOS-circuits layout & simulation, Circuit Compaction, Euler's Rule, Circuit extraction and post-layout simulation.	3L
3.	<b>Combinational CMOS Logic Design:</b> Boolean to CMOS conversion, Ratioed logic, Pass Transistor logic, Complex logic circuits, DSL, DCVSL, Transmission gate logic. Dynamic MOS design, Dynamic logic families and their performance.	3L
4.	<b>CMOS Memory design:</b> Design of ROM, SRAM and DRAM cells, 6-Transistor SRAM model, Sequential MOS Logic Design, Static and dynamic latches, flip flops & registers, CMOS Schmitt trigger, Mono stable sequential and Astable circuits, adders and multiplier circuits.	2L
5.	<b>Sequential CMOS Logic Design:</b> Regenerative property, Condition for regeneration, Bi-stable circuits, Flip-Flop, Latches and Race problem, Master Slave based ET Flip-flop Implementation, Setup and Hold time calculation, Propagation Delay Calculation. Different types of Standard Cell: Process Voltage Temperature (PVT) Characterization. Delay Calculation: Logic Effort.	8L
6.	<b>Semicustom Design:</b> <b>ASIC flow:</b> HDL Basic, Verilog, System Verilog, Synthesis Techniques, Test bench writing. <b>VLSI Testing: Design for Test</b> (Sequential circuit test:	8L

	Scan chains techniques, BIST, ATPG (D algorithm etc.), ATE, Post silicon analysis: Yield.	
7.	<b>PNR:</b> Partitioning, Floor Planning, Cell Placement, Power Plan, Routing, Clock Tree Synthesis. <b>Static Timing Analysis:</b> Setup and Hold time, Timing constraints (SDC) clock balancing, calculation and problem solving, CRPR. Synchronous and asynchronous clocks and timing problems. On chip Variation: AOCV/POCV. Timing ECOs (Engineering change order)	8L
8.	<b>Physical Verification:</b> Design Rule Check, Crosstalk (Noise), Logic Vs. Schematic (LVS), Power integrity-Redhawk analysis, Logic equivalence check (LEC),	4L
9.	<b>Low Power Design:</b> Clock Gating Cell, Unified Power Format (UPF): Multiple Voltage and Power domains.	4L
	<b>Total:</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>12</b>
	<b>No. of Week Reserved:</b>	<b>02</b>

#### Text and/or Reference Books:

1. S.M. Kang & Y. Leblibici, “CMOS Digital Integrated Circuits-Analysis & Design”, TMH.
2. J.M. Rabey, “Digital Integrated Circuits Design”, Pearson Education.
3. N.H.EWeste & K. Eshraghian, “Principles of CMOS VLSI Design: A System Perspective”, McGraw Hill Pub.
4. B.G. Streetman & S. Baneerjee, “Solid State Electronic Devices”, PHI.
5. Uyemera, “CMOS Logic Circuit Design”, Springer India Pvt. Ltd. New Delhi.
6. Eshraghian & Pucknell, “Introduction to VLSI”, PHI.
7. DavidA. Hodges, Horace G. Jackson, R. Saleh, “Analysis & Design of Digital Integrated Circuits”, McGraw Hill.
8. H.M. Rashid, “Introduction to PSPICE”, PHI.

#### Course Outcomes:

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

1. Classify IC, static, dynamic VLSI design
2. Characterize and verify different MOS based logic system
3. Implement physical layout of the designed circuit.
4. Estimate the delays in layout
5. Design of low power modules.

Course Code	HSM-HU701 (For Theory)				
Category	Humanities and Social Sciences including Management Courses				
Course title	Industrial Management & Entrepreneurship (Theory)				
Scheme and Credits	L	T	P	Credits	Semester –VII
	3	0	0	3	
Pre-requisites (if any)					

### Theory Syllabus:

<b>Module</b>	<b>Detailed Description</b>	<b>Lecture/ Tutorial Period</b>
01.	<b>Introduction:</b> Management: Its Nature, Purpose and Importance in Modern Organizations-Functions of Management- Types of Managerial Decisions-Information Processing -Importance of Ethics in Workplace-Basic idea about the Social Responsibility.	04L
02.	<b>Strategic management:</b> Business Mission, Vision, Formulation of objectives, Assessment of the external environment, Assessment of external competences, Strategic alternatives, portfolio analysis, methods, strategic choice.	06L
03.	<b>Leading-Human Factors and Motivation in Enterprises:</b> Maslow's Hierarchl' of Needs theory, Herzberg's Two factor theory, Mc Gregor's X Theory and Y Theory-Leadership: Trait approaches-Leadership Behavior and Styles(overview),Group behavior, Stages in GroupDevelopment	05L

04.	<b>Human Resource Management:</b> Meaning of human Resource and Human Resource management, Understanding Human Behavior in Modern Organizations- Overall idea about the Operative Functions of Human Resource Management- Recruitment and Selection-Performance Appraisal-Training and Development-Compensation management-Employee Relations: Brief Overview of each of these, Industrial grievance Management.	05L
05.	<b>Marketing Management:</b> Marketing as a Concept and Process-Role of Marketing in Modern Organizations-Concept of Marketing Mix-Product, Product Mix and Product line-Pricing: Meaning and Objectives-Basic idea about Promotion and Promotion Mix	05L
06.	<b>Financial Management:</b> Importance and Scope of Financial Management- Management of Working Capital- Dividend Policy- Capital Budgeting- Cost of capital & Capital Structure: functional ratios. Brief Overview of each of these	05L
07.	<b>Productivity, Operations Management and Total Quality Management:</b> Production and Operations Management: - -Productivity Problems and Measurement-Tools and Techniques for Improving Productivity- Basic Idea about Total Quality Management: Material handling, inventory control, JIT manufacturing, waste management.	07L
08.	<b>Entrepreneurship and Small Business:</b> Forms of Ownership The Nature of Entrepreneurship -Entrepreneurial Scopes and Opportunities- - New Venture Creation: Developing Business Plan, Forms of ownership, Different forms of entrepreneurship, partnership ventures, creativity in entrepreneurship, need for financing of new ventures.	05L
	<b>Total</b>	<b>42L</b>
	<b>Total week required</b>	<b>14</b>
	<b>No. of week reserved</b>	<b>02</b>

**Text and/or Reference:**

1. H. Koontz and H. Weihrdr, "Essentials of Management" Tata McGraw-Hill
2. S. P. Robbins and M. Coulter, "Management" Prentice Hall India
3. J. R. Sdrermerhorn, Jr., "Management", Wiley-India
4. J. A. F. Stoner, R. E. Freeman and D. R. Gilbert, Jr., "Management", Prentice Hall
5. C B Gupta, "Management Theory and Practice".
6. Azhar Kazmi, "Strategic Management and Business Policy".
7. Richard L. Daft, "Principles of Management"
8. Dr. S. S. Khanka, "Human Resource Management"
9. S. Anil Kumar and N. Suresh, "Production and Operations Management".
10. Pranam Dhar, "Fundamentals of Entrepreneurship Development & Business Communication".
11. Dilip Roy, "Discourses of Strategic Management".

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

1. Understand the concept of management and its different functions and how management concepts can be applied to practices as a member and leader in a team in a multidisciplinary environment to make management effective.
2. Develop an understanding of professional, ethical, legal, and social issues and responsibilities of an industrial engineer to accomplish a common goal.
3. Acquire certain knowledge about how to motivate people to work efficiently in industry.
4. Make them possess the skill set required to make an appropriate staffing decision and to design, implement and evaluate training programmes for the successful completion of a project.
5. Know the dynamics of marketing in business and to apply theoretical marketing concepts to the practical situations like marketing research, marketing mixes and selling propositions etc.
6. Know the concepts of financial management and how top management exercises financial control relating to capital structure, investment, dividend decisions etc.
7. Make them understand management of manufacturing and production system and to use different techniques and tools to improve productivity.
8. Instill some leadership and entrepreneurial and risk bearing attributes to enable them to start up their own ventures.

Course code	PROJ-EC 791				
Category	Project				
Course title	Internship				
Scheme andCredits	L	T	P	Credits	Semester – VII
	0	0	4	2	
Pre-requisites (if any)	All the relevant PCC Labs				

Minimum of six weeks in an Industry in the area of Electronics and Communication Engineering. The summer internship should give exposure to the practical aspects of the discipline. In addition, the student may also work on a specified task or project which may be assigned to him/her. The outcome of the internship should be presented in the form of a report.

Course code	PROJ-EC 792				
Category	Project				
Course title	Project Work I				
Scheme andCredits	L	T	P	Credits	Semester – VII
	0	0	10	5	
Pre-requisites (if any)	All the relevant PCC Labs				

### Course Objective:

The object of Project Work I is to enable the student to

1. Take up investigative studies in the broad field of Electronics & Communication Engineering
2. Comprehend planning of execution of project work.
3. Develop the methods theoretically and practically under the supervisor
4. Enable for feasibility analysis and time estimation
5. Motivate the students in R&D work.

The assignment to normally include:

1. Survey and study of published literature on the assigned topic;
2. Working out a preliminary Approach to the Problem related to the assigned topic;
3. Conducting preliminary Analysis/Modelling/Simulation/Experiment/Design/Feasibility;
4. Making and assembling of sub modules
5. Preparing a written Report on the study and works conducted for presentation to the Department

**Course Outcomes:**

At the end of the course, students will demonstrate the ability to

1. Characterize the various stages of project work
2. Comprehend to feasibility and project organization
3. Analyze the technical implementations and planning
4. Develop the prototype
5. Estimate the errors and limitations
6. Optimize the accuracy and cost of the designed prototype

Course code	PEC-EC 762(a)				
Category	Program Elective Course (PEC)				
Course title	Applied Electromagnetic and Microwave Lab				
Scheme andCredits	L	T	P	Credits	Semester – VII
	0	0	2	1	
Pre-requisites (if any)	RF and Microwave Theory				

**Laboratory Syllabus:**

<b>Detailed Description</b>	<b>Practical Period</b>
<ol style="list-style-type: none"><li>1. Study of V-I Characteristics of Gunn Diode.</li><li>2. Determination of Voltage Standing Wave Ratio (VSWR) and Reflection Co-efficient of a Waveguide and Microstrip Transmission line</li><li>3. Measurement of Wavelength, Signal Frequency, Phase Velocity, Group Velocity, Cut-Off Wavelength of a Wave Guide.</li><li>4. Study of Reflex Klystron Characteristics:<ol style="list-style-type: none"><li>a) Beam voltage verses reflector voltage.</li><li>b) Frequency verses reflector voltage.</li><li>c) Power verses reflector voltage.</li></ol></li><li>5. Characterization of an Attenuator. Study of transmission and reception of Microwave signal by using Horn Antenna and to plot the Gain and Polar Curve.</li><li>6. Study of Circulator and Isolator.</li><li>7. Study of Multi hole Directional Coupler.</li><li>8. Study of E-Plane &amp; H-Plane Tee &amp; Magic Tee.</li><li>9. Study and design of planner Filters.</li><li>10. Study and design of planner antenna.</li><li>11. Study and design of LNA.</li><li>12. Study and design of RF and Microwave Oscillators.</li></ol>	
<b>Total:</b>	<b>42P</b>



<b>Total Week Required:</b>	<b>14</b>
<b>No. Of Week Reserved:</b>	<b>02</b>

**Course outcomes:**

After completing the course, the student will be able to:

1. Analyze the RF, Microwave active and passive components
2. Characterize the active and passive components of RF, Microwave circuits
3. Measure the RF, Microwave circuit parameters
4. Design the active and passive RF, Microwave circuits

SEMESTER VIII (Fourth Year)								
Branch/Course Electronics and Communication Engineering								
Sl. No	Types of Course	Code	Course Title	Hours per week			Credits	Marks
				L	T	P		
1.	Program Elective Course	PEC-EC 811(a-c)	Program Elective VI	3	0	0	3	100
2.	Program Elective Course	PEC-EC 812(a-c)	Program Elective VII	3	0	0	3	100
3.	Open Elective Course	OEC-XX 821(a-f)	Open Elective IV	3	0	0	3	100
4.	Open Elective Course	OEC-XX 822(a-f)	Open Elective V	3	0	0	3	100
5.	Project	PROJ-EC 891	Project Stage II	0	0	12	6	100
<b>Total</b>							<b>18</b>	<b>500</b>

Subject Pool For Program Elective Courses PEC VI, 8 <sup>th</sup> SEM			
Sl No.	Code	Course Title	Credits
1.	PEC- EC 811(a)	Medical Electronics & Applications	3
2.	PEC- EC 811(b)	Fiber Optic Communication	3
3.	PEC- EC 811(c)	High Speed Electronics	3

Subject Pool For Program Elective Courses PEC VII, 8 <sup>th</sup> SEM			
Sl. No.	Code	Course Title	Credits
1.	PEC- EC 812(a)	Radar and Navigation Engineering	3
2.	PEC- EC 812(b)	Wireless Sensor Networks	3
3.	PEC- EC 812(c)	Mobile Communication and Networks	3

Subject Pool For Open Elective Courses OEC IV, 8 <sup>th</sup> SEM			
Sl No.	Code	Course Title	Credits
1.	OEC-M 821(a)	Advanced Operations Research	3
2.	OEC-EE 821(b)	Advanced Topics in Power Systems	3
3.	OEC-HU 821(c)	Quality Control & Management	3
4.	OEC-HU 821(d)	Cyber Law and Computer Ethics	3
5.	OEC-EC 821(e)	Satellite Communication	3
6.	OEC-EE 821(f)	Energy Audit & Management	3

Subject Pool For Open Elective Courses OEC V, 8 <sup>th</sup> SEM			
Sl. No.	Code	Course Title	Credits
1.	OEC-HU 822(a)	Digital Marketing	3
2.	OEC-HU 822(b)	Human Resource Development & Organizational Behavior	3
3.	OEC-EC 822(c)	Machine Learning	3
4.	OEC-EI 822(d)	Sensor Technology	3
5.	OEC-EE 822(e)	Automotive Control & Robotics	3
6.	OEC-ME 822(f)	Power Plant Engineering	3

Course code	PEC-EC 811(a)				
Category	Program Elective Course (PEC)				
Course Title	Medical Electronics & Applications				
Scheme and Credits	L	T	P	Credits	Semester – VIII
	3	0	0	3	
Pre-requisites (if any)	PCC-EC 401 PCC- EC 502 BSC-M 301				

### Theory Syllabus:

Unit No.	Detailed Description	Lecture/ Tutorial Period
1.	<b>Biomedical Sensors &amp; Instruments:</b> <b>Basic Transducer Principle:</b> Active and Passive Transducers. There applications in biomedical instrumentation, Weight Measurement using Load Sensors, Hearing Aids, Pacemaker etc.	8L
2.	<b>Heart Health measurement:</b> ECG, EMG and EEG instruments, working principles, Halter Monitoring. <b>Cardiac System Measurement</b> & Analysis using Imaging and Murmurs. <b>Non Invasive Blood Parameter Measurement:</b> Measurement of blood pressure, blood flow, Hemoglobin, Sugar, Pulse Rate, SpO <sub>2</sub> , Plethysmography, Bio Impedance.	14L
3.	<b>Medical Imaging:</b> Diabetes Retinopathy, Liver Function Test (LFT), Hypertension, CDR., Orthopedic Measurement, CT Scan, Ultra-sonography, Bacteria Characterization using UV, Cancer Cell Detection. <b>Measurements of the respiratory system:</b> Electronic Stethoscope. <b>Temperature measurement:</b> Principles of Ultrasonic Measurement and	18L

	Ultrasonic Diagnosis.	
4.	<b>Biomedical Safety &amp; Standards:</b> Application of computer in bio-instrumentation, Bio-telemetry, bio-sensors-techniques and applications. Safety and precautions of biomedical equipment's.	2L
	<b>TOTAL:</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. Of Week Reserved:</b>	<b>2</b>

**Text/Reference Books:**

1. L. Cromwell, "Biomedical Instrumentation and Measurements", Pearson Education.
2. J.J. Carr, "Introduction to Biomedical Equipment Technology", Pearson Education.
3. R.S.Khandpur, "Handbook of Biomedical Instrumentation", TMH, New Delhi.
4. N.Pandey, "Bio-Medical Electronics and Instrumentation", Katson books, New Delhi.

**Course Outcomes:**

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

1. Characterize the nature of signals of human anatomy
2. Compare the physiological parameters of different bio medical signals
3. Identify and measure of non-electrical parameters
4. Use the sensors for corresponding purposes
5. Use and analyze the multimedia tools for better diagnostics and therapy.

Course code	PEC-EC 811(b)				
Category	Program Elective Course (PEC)				
Course Title	Fiber Optic Communication				
Scheme and Credits	L	T	P	Credits	Semester – VIII
	3	0	0	3	
Pre-requisites (if any)					

**Theory Syllabus:**

<b>Unit no.</b>	<b>Detailed Description</b>	<b>Lecture/Tutorial Period</b>
1.	Introduction to vector nature of light, propagation of light, propagation of light in a cylindrical dielectric rod, Ray model, wave model.	4L
2.	Different types of optical fibers, Modal analysis of a step index fiber. Signal degradation on optical fiber due to dispersion and attenuation.	8L

	Fabrication of fibers and measurement techniques like OTDR.	
3.	Optical sources - LEDs and Lasers, Photo-detectors - pin-diodes, APDs, detector responsively, noise, optical receivers. Optical link design - BER calculation, quantum limit, power penalties.	10L
4.	Optical switches - coupled mode analysis of directional couplers, electro-optic switches. Optical/ Optoelectronic modulations.	8L
5.	Optical amplifiers - EDFA, Raman amplifier.	4L
6.	WDM and DWDM systems. Principles of WDM networks.	4L
7.	Nonlinear effects in fiber optic links. Concept of self-phase modulation, group velocity dispersion and solution based communication.	4L
	<b>Total</b>	<b>42L</b>
	<b>Total Week Required</b>	<b>14</b>
	<b>No. of Week Reserved</b>	<b>02</b>

### Text/Reference Books

1. J. Keiser, "Fibre Optic communication", McGraw-Hill, 5th Ed. 2013 (Indian Edition).
2. T. Tamir, "Integrated optics", (Topics in Applied Physics Vol.7), Springer-Verlag, 1975.
3. J. Gower, "Optical communication systems", Prentice Hall India, 1987.
4. S.E. Miller and A.G. Chynoweth, eds., "Optical fibres telecommunications", Academic Press, 1979.
5. G. Agarwal, "Nonlinear fibre optics", Academic Press, 2nd Ed. 1994.
6. G. Agarwal, "Fiber optic Communication Systems", John Wiley and sons, New York, 1997
7. F.C. Allard, "Fiber Optics Handbook for engineers and scientists", McGraw Hill, New York (1990).

### Course Outcomes:

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

1. Comprehend principles of optical path and components.
2. Characterize the properties of the optical fibers and optical components.
3. Analyze operation of lasers, LEDs, and detectors.
4. Analyze system performance of optical communication systems.
5. Design optical networks and understand non-linear effects in optical fibers.

Course code	PEC-EC 811(c)				
Category	Program Elective Course (PEC)				
Course Title	High Speed Electronics				
Scheme and Credits	L	T	P	Credits	Semester – VIII
	3	0	0	3	
Pre-requisites (if any)					

**Theory Syllabus:**

Unit No.	Detailed Description	Lecture/Tutorial Period
1.	<b>Transmission line theory (basics) crosstalk and non-ideal effects; signal integrity:</b> impact of packages, bias, traces, connectors; non-ideal return current paths, high frequency power delivery, methodologies for design of high speed buses; radiated emissions and minimizing system noise; Noise Analysis: Sources, Noise Figure, Gain compression, Harmonic distortion, Inter modulation, Cross-modulation, Dynamic range	8L
2.	<b>Devices:</b> Passive and active, Lumped passive devices (models), Active (models, low vs. high frequency)	6L
3.	<b>RF Amplifier:</b> Design, Stability, Low Noise Amplifiers, Broadband Amplifiers (and Distributed) Power Amplifiers, Class A, B, AB and C, D E Integrated circuit realizations, Cross-over distortion Efficiency RF power output stages.	10L
4.	<b>Mixers:</b> –Up conversion Down conversion, Conversion gain and spurious response. Oscillators Principles.PLL Transceiver architectures.	8L
5.	<b>Printed Circuit Board Anatomy:</b> CAD tools for PCB design, Standard fabrication, Micro via Board,. Board Assembly, Surface Mount Technology, Through Hole Technology, Process Control and Design challenges.	10L
	<b>Total</b>	<b>42L</b>
	<b>Total Week Required</b>	<b>14</b>
	<b>No. of Week Reserved</b>	<b>02</b>

**Text/Reference Books:**

1. Stephen H. Hall, Garrett W. Hall, James A. McCall “High-Speed Digital System Design: A Handbook of Interconnect Theory and Design Practices”, August 2000, Wiley-IEEE Press
2. Thomas H. Lee, “The Design of CMOS Radio-Frequency Integrated Circuits”, Cambridge University Press, 2004, ISBN 0521835399.
3. Behzad Razavi, “RF Microelectronics”, Prentice-Hall 1998, ISBN 0-13-887571-5.
4. Guillermo Gonzalez, “Microwave Transistor Amplifiers”, 2nd Edition, Prentice Hall.
5. Kai Chang, “RF and Microwave Wireless systems”, Wiley.
6. R.G. Kaduskar and V. B. Baru, “Electronic Product design”, Wiley India, 2011

**Course Outcomes:**

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

1. Characterize the areas of application of high-speed electronics circuits.
2. Analyze the properties of various components used in high speed electronics
3. Implement the layout of high speed electronics
4. Design High-speed electronic system using appropriate components.

Course code	PEC-EC 812(a)				
Category	Program Elective Course (PEC)				
Course title	Radar and Navigation Engineering				
Scheme and Credits	L	T	P	Credits	Semester – VIII
	3	0	0	3	
Pre-requisites (if any)	PCC-EC 501 PCC-EC 501 PCC-EC 502				

### Theory Syllabus:

<b>Unit No.</b>	<b>Detailed Description</b>	<b>Lecture/Tutorial Period</b>
1.	<p><b>Range Equation and Performance:</b> Introduction, Basic concept of principle of operation, schematic block diagram, Radar frequencies, and applications.</p> <p>Radar equation, prediction of range performance, minimum detectable signal, receiver noise and SNR, integration of radar pulses, radar cross section of targets, transmitter power, PRF and range ambiguities, system losses(qualitative approach).</p> <p>Detection criteria, derivation of response characteristics of matched filter, correlation function, cross correlation receiver, efficiency of non-matched filters.</p> <p>FM CW radars</p>	10L
2.	<p><b>MTI and Pulse Doppler radar:</b> Basic principle of MTI radar, schematic block diagram, power amplifier transmitter and power oscillator transmitter, delay line canceller, filter characteristics, blind speed, double cancellation, staggered PRFs, range gated Doppler filter. MTI radar parameters, MTI radar performance, non-coherent MTI, comparison with pulse Doppler radar.</p>	10L
3.	<p><b>Tracking radars and Navigation:</b> Fundamentals of tracking radar, monopulse tracking (amplitude and phase), sequential lobing, conical scanning, tracking in range, acquisition and scanning patterns. Comparison of trackers.</p> <p>Brief over view on navigation and systems.</p>	10L
4.	<p><b>Radar transmitter, receiver, antenna and display:</b> Radar transmitters, Magnetron Oscillator, Hard tube and live pulse Radar receivers, mixer amplifiers, receiver noise and Duplexers (branch type and balanced type), circulators as duplexer.</p>	12L

	Introduction to phased array antenna, radiation pattern, beam steering, series vs. parallel feeds. Displays, Clutter, Weather and Interference. Electronically scanning Radar systems.	
	<b>Total</b>	<b>42L</b>
	<b>Total Week Required</b>	<b>14</b>
	<b>No. of Week Reserved</b>	<b>02</b>

**Text/Reference Books:**

1. Introduction to Radar Systems – Merrill I. Skolnik, SECOND EDITION, McGraw-Hill, 2001
2. Radar Systems – Peyton Z. Peebles, Wiley,.
3. Fundamentals of Radar engineering- P. C. Sen.
4. Microwave and Radar Engineering-A. K. Gautam.

**Course Outcomes:**

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

1. Comprehend the aspects of navigation and ranging
2. Characterize the processing techniques of signal to locate any objects
3. Characterizing the signals to extract information's
4. Analyze various purpose based navigation devices

Course code	PEC-EC 812(b)				
Category	Program Elective Course (PEC)				
Course Title	Wireless Sensor Networks				
Scheme and Credits	L	T	P	Credits	Semester – VIII
	3	0	0	3	
Pre-requisites (if any)	PCC-EC 501 PCC-EC 602				

**Theory Syllabus:**

<b>Unit No.</b>	<b>Detailed Description</b>	<b>Lecture/ Tutorial Period</b>
1.	<b>Introduction to Sensor Networks:</b> unique constraints and challenges, Advantage of Sensor Networks, Applications of Sensor Networks, Types of wireless sensor networks	4L
2.	<b>Mobile Ad-hoc Networks (MANETs) and Wireless Sensor Networks:</b> Enabling technologies for Wireless Sensor Networks. Issues and challenges in wireless sensor networks	8L
3.	<b>Routing protocols:</b> MAC protocols: Classification of MAC Protocols, S-MAC Protocol, B-MAC protocol, IEEE 802.15.4 standard and ZigBee,	6L
4.	<b>Dissemination protocol for large sensor network:</b> Data dissemination,	8L



	data gathering, and data fusion; Quality of a sensor network; Real-time traffic support and security protocols.	
5.	<b>Design Principles for WSNs:</b> Gateway Concepts Need for gateway, WSN to Internet Communication, and Internet to WSN Communication.	8L
6.	<b>Single-node architecture:</b> Hardware components & design constraints, Operating systems and execution environments, introduction to TinyOS and nesC.	8L
	<b>Total</b>	<b>42L</b>
	<b>Total Week Required</b>	<b>14</b>
	<b>No. of Week Reserved</b>	<b>02</b>

### Text/Reference Books:

1. Waltenegus Dargie , Christian Poellabauer, “Fundamentals Of Wireless Sensor Networks”
2. “Theory And Practice”, By John Wiley & Sons Publications ,2011
3. Sabrie Soloman, “Sensors Handbook" by McGraw Hill publication. 2009
4. Feng Zhao, Leonidas Guibas, “Wireless Sensor Networks”, Elsevier Publications,2004
5. Kazem Sohrby, Daniel Minoli, “Wireless Sensor Networks”: Technology, Protocols an Applications, Wiley-Inter science
6. Philip Levis, And David Gay "Tiny OS Programming" by Cambridge University Press 2009

### Course Outcomes:

At the end of the course the students will be able to

1. Design wireless sensor networks for a given applications
2. Comprehend emerging research areas in the field of sensor networks
3. Analyze MAC protocols used for different communication standards used in WSN
4. Explore new protocols for WSN

Course code	PEC-EC 812(c)				
Category	Program Elective Course (PEC)				
Course Title	Mobile Communication Networks				
Scheme and Credits	L	T	P	Credits	Semester – VIII
	3	0	0	3	
Pre-requisites (if any)	PCC-EC 501 PCC-EC 601				

**Theory Syllabus:**

Unit No.	Detailed Description	Lecture/ Tutorial Period
1.	<b>Cellular concept-:</b> Cell structure, frequency reuse, cell splitting, channel assignment, handoff, interference, capacity, power control; Wireless Standards: Overview of 2G and 3G cellular standards.	4L
2.	<b>Signal propagation:</b> Propagation mechanism- reflection, refraction, diffraction and scattering, large scale signal propagation and lognormal shadowing. Fading channels-Multipath and small scale fading- Doppler shift, statistical multipath channel models, narrowband and wideband fading models, power delay profile, average and rms delay spread, coherence bandwidth and coherence time, flat and frequency selective fading, slow and fast fading, average fade duration level crossing rate	8L
3.	<b>Antennas:</b> Antennas for mobile terminal monopole antennas, PIFA, base station antennas and arrays. Capacity of flat and frequency selective channels.	6L
4.	<b>Multiple access schemes:</b> FDMA, TDMA, CDMA and SDMA. Modulation schemes- BPSK, QPSK and variants, QAM, MSK and GMSK, multicarrier modulation, OFDM.	8L
5.	<b>Receiver structure:</b> Diversity receivers- selection and MRC receivers, RAKE receiver, equalization: linear-ZFE and adaptive, DFE. Transmit diversity-Altamonte scheme.	8L
6.	<b>MIMO and space time signal processing:</b> Spatial multiplexing, diversity/multiplexing trade-off. Performance measures- Outage, average SNR, average symbol/bit error rate. System examples- GSM, EDGE, GPRS, IS-95, CDMA 2000 and WCDMA	8L
	<b>Total</b>	<b>42L</b>
	<b>Total Week Required</b>	<b>14</b>
	<b>No. of Week Reserved</b>	<b>02</b>

**Text/Reference Books:**

1. WCY Lee, Mobile Cellular Telecommunications Systems, McGraw Hill, 1990.
2. WCY Lee, Mobile Communications Design Fundamentals, Prentice Hall, 1993.
3. Raymond Steele, Mobile Radio Communications, IEEE Press, New York, 1992.
4. AJ Viterbi, CDMA: Principles of Spread Spectrum Communications, Addison Wesley, 1995.
5. VK Garg & JE Wilkes, Wireless & Personal Communication Systems, Prentice Hall, 1996.

**Course Outcomes:**

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

1. Comprehend the working principles of the mobile communication systems.
2. Characterize the relation between the user features and underlying technology.
3. Analyze mobile communication systems for improved performance.

Course code	PROJ-EC 891				
Category	Project				
Course Title	Project Work II & Dissertation				
Scheme and Credits	L	T	P	Credits	Semester – VIII
	0	0	12	6	
Pre-requisites (if any)	All the relevant PCC Labs				

### Course Objective:

The object of Project Work II and Dissertation is to enable the student to

1. Take up investigative studies in the broad field of Electronics & Communication Engineering
2. Comprehend planning of execution of project work.
3. Develop the methods theoretically and practically under the supervisor
4. Enable for feasibility analysis and time estimation
5. Motivate the students in R&D work.
6. Design a full-fledged prototype

The assignment to normally include:

1. Survey and study of published literature on the assigned topic;
2. Working out a preliminary Approach to the Problem related to the assigned topic;
3. Conducting preliminary analysis/Modelling/Simulation/Experiment/Design/Feasibility;
4. Making and assembling of all sub modules to complete the prototype
5. Preparing a written Report on the study and works conducted for presentation to the Department

### Course Outcomes:

At the end of the course, students will demonstrate the ability to

1. Characterize the various stages of project work
2. Comprehend to feasibility and project organization
3. Analyze the technical implementations and planning
4. Estimate the errors and limitations
5. Optimize the accuracy and cost of the designed prototype
6. Developing product/process, testing, results, conclusions and future directions;
7. Prepare a paper for Conference presentation/Publication in Journals, if possible;

8. Prepare a Dissertation in the standard format for being evaluated by the Department.
9. Present before a Departmental Committee

### MOOCs (Massive Open Online Courses):

The Curriculum for Bachelor of Engineering programme consists of total 160 credits in the entire 4 years programme in Electronics and Communication Engineering. A student will be eligible to get Under Graduate degree with Honours, if he/she completes an additional 20 credits during his/her tenure. These could be acquired through any online courses (MOOCs) (not offered in his/her entire 4-year syllabus) as per AICTE in consultation with his/her mentor if needed.

4 Credit points will be offered for 12 weeks or more than 12 weeks course

3 Credit points will be offered for 8 weeks to less than 12 weeks course

2 Credit points will be offered for 4 weeks to less than 8 weeks course

#### List of \*MOOCs for ECE 2<sup>nd</sup> to 4<sup>th</sup> year

No	List of Courses	Offered by
1.	Entrepreneurship in Emerging Economies	edX
2.	Programming, Data Structures and Algorithms using Python	NPTEL
3.	Introduction to Internet of Things	NPTEL
4.	IoT Programming and Big Data	edX
5.	Robotics: Aerial Robotics	Coursera
6.	Deep learning in Computer Vision	Coursera
7.	Natural Language Processing	Edx
8.	Embedded Systems	NPTEL
9.	Introduction to Industry 4.0 and Industrial Internet of Things	NPTEL
10.	IoT System Design: Software and Hardware Integration	edX
11.	Data Science with Python	edX
12.	Convolution Neural Network	Coursera
13.	Deep Learning	NPTEL
14.	AWS Fundamental: Going Cloud Native	Coursera
15.	Remote Sensing and Digital Image Processing of Satellite Data	NPTEL
16.	Leadership for Engineers	edX
17.	Fuzzy Sets, Logic and System Application	NPTEL
18.	Electronic Systems for Cancer Diagnostics	NPTEL
19.	Data Analytics with Python	NPTEL
20.	Optical Engineering	NPTEL
21.	Machine Learning	NPTEL
22.	Introduction to Machine Learning	NPTEL
23.	An Introduction to Artificial Intelligence	NPTEL
24.	Artificial Intelligence: Knowledge Representation and Reasoning	NPTEL
25.	Privacy and Security in Online Social Media	NPTEL
26.	Deep Learning	NPTEL
27.	Data Science for Engineers	NPTEL
28.	Embedded Systems Design	NPTEL
29.	Introduction to Internet of Things	NPTEL

30.	User-Centric Computing for Human-Computer Interaction	NPTEL
31.	VLSI Physical Design	NPTEL
32.	Hydraulic Engineering	NPTEL
33.	High Voltage Engineering	NPTEL
34.	Data Analysis and Presentation Skills: the PwC Approach Specialization	NPTEL
35.	Digital Signal Processing	NPTEL
36.	Electronics Equipment Integration and Prototype Building	NPTEL
37.	Advanced Power Electronics and Control	NPTEL
38.	Power Quality Improvement Technique	NPTEL
39.	Microwave Integrated Circuits	NPTEL
40.	VLSI Signal Processing	NPTEL
41.	CMOS Digital VLSI Design	NPTEL
42.	Principles of Digital Communication	Coursera
43.	Remote Sensing and GIS	Coursera
44.	Mathematical Methods and Techniques in Signal Processing	NPTEL
45.	Statistical Signal Processing	Coursera
46.	Multirate DSP	Coursera
47.	High Power Multilevel Converters – Analysis, Design and Operational Issues	NPTEL
48.	Power Management Integrated Circuits	NPTEL
49.	Nonlinear System Analysis	NPTEL
50.	Biomedical Signal Processing	NPTEL
51.	Electronic Systems for Cancer Diagnosis	NPTEL
52.	Fuzzy Sets, Logic and Systems & Applications	NPTEL
53.	Medical Image Analysis	NPTEL
54.	Electric Vehicles	NPTEL
55.	A brief Introduction to Micro-sensors	NPTEL
56.	Design and Simulation of Power Conversion using Open Source Tools	NPTEL
57.	Recent Advances in Transmission Insulator	NPTEL
58.	Data Analytics with Python	NPTEL
59.	Embedded System Design with ARM	NPTEL
60.	Real Time Operating System	edX
61.	Deep Learning	edX
62.	Introduction to scripting in Python	edX
63.	Introduction to Soft Computing	NPTEL
64.	Programming, Data Structures and Algorithms using Python	NPTEL
65.	Ethical Hacking	NPTEL
66.	Entrepreneurship in Emerging Economies	NPTEL
67.	Energy Efficiency, Acoustics and daylighting in Building	edX
68.	Big Data Analytics	NPTEL
69.	Robotics: Aerial Robotics	NPTEL
70.	Deep learning in Computer Vision	edX
71.	Process Automation & PLC	NPTEL
72.	Fuzzy Logic and Neural Networks	NPTEL
73.	Machine Analysis	NPTEL

74.	Switched Mode Power Conversion	NPTEL
75.	Electric Drives Systems	NPTEL
76.	Advanced Power Electronics Applications	NPTEL
77.	Mathematical Modeling and Analysis of Electrical Machines	NPTEL
78.	Embedded Systems	edX
79.	PIC Microcontroller and Applications	NPTEL
80.	Advanced Power Systems	NPTEL
81.	Special Electro-mechanical Devices	NPTEL
82.	Sliding Mode Control	NPTEL
83.	Electromagnetic Fields Applied to Electrical Machines	NPTEL
84.	Analysis and Control of Electric Drives	NPTEL
85.	Special Electrical Machines	NPTEL
86.	Power Electronic Converter-I	NPTEL
87.	Power Electronic Converter-II	NPTEL
88.	Digital Control Systems	NPTEL
89.	AI Applications in Power Electronics	NPTEL
90.	Advanced Protection of Power Apparatus and System	NPTEL
91.	CAD and Analysis of Electrical Machines	NPTEL
92.	Dynamics of Electric Machines	NPTEL
93.	Power Semiconductor Controlled Drives	NPTEL
94.	Special Operational and Design Features of Electrical Machines	NPTEL
95.	Electric Traction Systems	NPTEL
96.	Converter Applications	NPTEL
97.	Solar and Wind Power Technologies	NPTEL
98.	Control Techniques in Power Electronics	NPTEL
99.	Smart Grid	NPTEL
100.	Advanced Power System Stability	NPTEL
101.	Microwave Integrated Circuits	NPTEL
102.	Microprocessors and Interfacing	NPTEL
103.	Sensors and Actuators	NPTEL
104.	Photonic integrated circuit	NPTEL
105.	Spread Spectrum Communications And Jamming	NPTEL

*\* List is indicative only. Subject can be selected from the platform other than NPTEL with consultation of mentor.*