DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

MODIFIED SYLLABUS
BACHELOR OF TECHNOLOGY

[Effective for 2018 batch &
2017 batch (3rd sem. onwards)]

SMIT SIKKIM MANIPAL UNIVERSITY

SIKKIM MANIPAL INSTITUTE OF TECHNOLOGY

CONTENTS:

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SCHEME OF STUDY
(B. TECH UNDER CGPA SCHEME)

FIRST/SECOND SEMESTER

B. TECH, 1st SEMESTER (GROUP-A, Physics Group)					
Sl. No.	**Sub. Code**	**Subject Name**	**Teaching Dept.**	**Credits**	**Total Credits**
1	MA 1101	Engineering Mathematics–I	MATHS	4	
2	CE 1102	Mechanics of Solids	CE	3	
3	PH 1103	Engineering Physics	PHY	4	
4	ME 1105	Engineering Graphics	ME	3	**20**
5	BA 1106	Communication Skills	MGT	3	
6	ME 1161	Workshop Practice	ME	1.5	
7	PH 1162	Engineering Physics Lab	PHY	1.5	
B. TECH, 1st SEMESTER (GROUP-B, Chemistry Group)					
1	MA 1101	Engineering Mathematics–I	MATHS	4	
2	CH 1108	Engineering Chemistry	CHEM	4	
3	EE 1109	Elements of Electrical Engineering	EE	3	
4	CS 1110	Computer Programming using C	CSE	4	**18**
5	CH 1191	Environmental Science*	CHEM	0	
6	CH 1163	Engineering Chemistry Lab	CHEM	1.5	
7	CS 1164	Computer Programming Lab	CSE	1.5	
		*Mandatory audit course			
B. TECH IInd SEMESTER (GROUP-A, Physics Group)					
1	MA 1201	Engineering Mathematics–II	MATHS	4	
2	CH 1108	Engineering Chemistry	CHEM	4	
3	EE 1109	Elements of Electrical Engineering	EE	3	
4	CS 1110	Computer Programming using C	CSE	4	**18**
5	CH 1191	Environmental Science*	CHEM	0	
6	CH 1163	Engineering Chemistry Lab	CHEM	1.5	
7	CS 1164	Computer Programming Lab	CSE	1.5	
		*Mandatory audit course			
B. TECH, IInd SEMESTER (GROUP-B, Chemistry Group)					
1	MA 1201	Engineering Mathematics–II	MATHS	4	
2	CE 1102	Mechanics of Solids	CE	3	
3	PH 1103	Engineering Physics	PHY	4	
4	ME 1105	Engineering Graphics	ME	3	**20**
5	BA 1106	Communication Skills	MGT	3	
6	ME 1161	Workshop Practice	ME	1.5	
7	PH 1162	Engineering Physics Lab	PHY	1.5	
Total credit for the 1st year (I & II):38					

THIRD SEMESTER

Sl. No.	Subject Code	Subject	Teach. Dept.	No. of hours per week			Duration of Exam		Credits
				Lec.	Tut.	Prac.	Th.	Pract.	
1	MA1307	Engineering Mathematics-III	Maths	3	-	-	3	-	**3**
2	EC 1303	Electronic Devices and Components	EC	3	-	-	3	-	**3**
3	EC 1304	Electronic Instrumentation and Measurements	EC	3	-	-	3	-	**3**
4	EC 1305	Signals and Systems	EC	3	-	-	3	-	**3**
5	EC 1306	Digital Electronics	EC	3	-	-	3	-	**3**
6	EC 1308	Network Analysis and Synthesis	EC	3	-	-	3	-	**3**
7	BP 1391	Constitution of India*		2	-	-	-	-	**0**
8	BP 1392	Indian Traditional Knowledge *		2	-	-	-	-	**0**
9	EC 1361	Electronic Devices and Components Lab.	EC	-	-	3	-	3	**1.5**
10	EC 1362	Signal and Circuit Simulation Lab.	EC	-	-	3	-	3	**1.5**
11	EC 1363	Digital Electronics Lab.	EC	-	-	3	-	3	**1.5**
		*Mandatory audit course							
Total				**18**	-	**9**	-	-	**22.5**
Note: Upto one optional audit course/online course can be taken.									

FOURTH SEMESTER

Sl. No.	Subject Code	Subject	Teach. Dept.	No. of hours per week			Duration of Exam		Credits
				Lec.	Tut.	Prac.	Th.	Pract.	
1	MA1402	Engineering Mathematics– IV	Maths	3	-	-	3	-	**3**
2	EC1403	Electromagnetic Waves	EC	3	-	-	3	-	**3**
3	EC1406	Design and Analysis of Digital Systems	EC	3	-	-	3	-	**3**
4	EC1408	Analog Electronics and Integrated Circuits	EC	3	-	-	3	-	**3**
5	EC1409	Analog Communication	EC	3	-	-	3	-	**3**
6	EC1410	Microprocessors	EC	3	-	-	3	-	**3**
7	EC1461	Analog Electronic Circuits Lab.		-	-	3	-	3	**1.5**
8	EC1462	Microprocessor Lab.	EC	-	-	3	-	3	**1.5**
9	EC1463	Digital System Lab.	EC	-	-	3	-	3	**1.5**
Total				**18**	-	**9**	-	-	**22.5**
Note: Upto one optional audit course/online course can be taken.									

FIFTH SEMESTER

Sl. No.	Subject Code	Subject	Teach. Dept.	No. of hours per week			Duration of Exam		Credits
				Lec.	Tut.	Prac.	Th.	Pract.	
1	EC1501	Antenna Theory	EC	3	-	-	3	-	**3**
2	EC1502	Linear and Digital Control System	EC	3	-	-	3	-	**3**
3	EC1505	Digital Signal Processing	EC	3	-	-	3	-	**3**
4	EC1507	Computer Networks	EC	3	-	-	3	-	**3**
5	EC1508	Object Oriented Programming with C++	EC	3	-	-	3	-	**3**
6	EC1509	Embedded Systems	EC	3	-	-	3	-	**3**
7	EC1562	Communication Lab.	EC	-	-	3	-	3	**1.5**
8	EC1563	Object Oriented Programming Lab. with C++	EC	-	-	3	-	3	**1.5**
9	EC1564	Embedded System Lab	EC	-	-	3	-	3	**1.5**
10	EC1581	Industrial Training I	EC						**0.5**
Total				**18**	**-**	**9**	**-**		**23**
Note: Upto one optional audit course/online course can be taken.									

SIXTH SEMESTER

Sl. No.	Subject Code	Subject	Teach. Dept.	No. of hours per week			Duration of Exam		Credits
				Lec.	Tut.	Prac.	Th.	Pract.	
1	EC1601	Microwave Engineering	EC	3	1	-	3	-	4
2	EC1604	Digital Communication	EC	3	1	-	3	-	4
3	EC1606	Java Programming	EC	3	-	-	3	-	3
4	EC1607	Micro Electronics and VLSI Design	EC	3	-	-	3	-	3
5	EC16**	Program Elective –I	EC	3	-	-	3	-	3
6	EC1661	Digital Signal Processing Lab.	EC	-	-	3	-	3	1.5
7	EC1664	VLSI Lab.	EC	-	-	3	-	3	1.5
8	EC1671	Mini Project	EC	-	-	3	-	3	2
Total				**15**	**2**	**9**	**-**	-	**22**
Note: Up to one optional audit course/online course can be taken.									

PROGRAM ELECTIVE LIST-I

Sl. No	Subject Code	Subject
1.	EC1638	Recent Trends in Electronics and Communication Engineering

SEVENTH SEMESTER

Sl. No.	Subject Code	Subject	Teach. Dept.	No. of hours per week			Duration of Exam		Credits
				Lec.	Tut.	Prac.	Th.	Pract.	
1	EC1705	Mobile Communication	EC	3	1	-	3	-	**4**
2	BA 1510	Industrial Management	BA	3	-	-	3	-	**3**
3	EC17**	Program Elective –II	EC	3	-	-	3	-	**3**
4	EC17**	Program Elective –III	EC	3	-	-	3	-	**3**
5	EC17**	Open Elective –I	EC	3	-	-	3	-	**3**
6	EC1762	Advanced Communication Lab.	EC	-	-	3	-	3	**1.5**
7	EC1763	Microwave Lab	EC	-	-	3	-	3	**1.5**
8	EC1781	Industrial Training II	EC	-	-	-	-	-	**1**
Total				**15**	**1**	**6**	**-**	-	**20**

PROGRAM ELECTIVE LIST-II

Sl. No	Subject Code	Subject
1.	EC 1731	Digital Image Processing
2.	EC 1732	Broadband Communication and Networking
3.	EC 1733	Advanced Digital Signal Processing
4.	EC 1734	Embedded Operating System
5.	EC 1735	Advanced Electronics Devices
6.	EC 1736	Information Theory and Coding
7.	EC 1737	Machine Learning
8.	EC 1738	Power Electronics
9.	EC 1739	Radar System and Signal Processing
10.	EC 1740	Digital Computer Architecture

PROGRAM ELECTIVE LIST-III

Sl. No	Subject Code	Subject
1.	EC 1741	Multimedia Communication System
2.	EC 1742	Internet of Things
3.	EC 1743	Satellite and Optical Communication Systems
4.	EC 1744	Speech Processing
5.	EC1745	Detection and Estimation Techniques
6.	EC 1746	Photonic Devices and Circuits
7.	EC 1747	Adaptive Signal Processing
8.	EC 1748	Wireless Sensor network
9.	EC 1749	Software Defined Network
10	EC 1750	Data Science for Engineers

OPEN ELECTIVE LIST-I

Sl. No	Subject Code	Subject
1.	EC 1721	Industrial IoT and Industry 4.0
2.	EC 1722	Automation and Robotics
3.	EC 1723	MEMS and NEMS Devices
4.	EC 1724	Nano Electronics

Industrial Training :

1. Students have to undergo an internship (Industrial Training I, EC 1581) of minimum 2 weeks from an industry of repute during the summer break between 4th semester and 5th semester.
2. Students have to undergo an internship (Industrial Training II, EC 1781) of minimum 4 weeks from an industry of repute during the summer break between 6th semester and 7th semester
3. Students have to submit completion certificate and present PPT related to training imparted at the industry.
4. **For industrial training/ viva-voce/ seminar it will be evaluated out of 100 at the end of the semester.**

Mini Project :

Sl. No.	Subject Code	Internal Marks	External Marks	Credits
1	EC1671	50	50	2

EIGHT SEMESTER

MAJOR PROJECT

Sl. No.	Subject Code	Internal Marks	Seminar/Viva	External Marks	Duration of Project	Credits
1	EC1875	50	50	50	16 Weeks	12

**** Project Evaluation:**

1. One interim evaluation to be followed [Candidate has to present PPT/demonstration].
2. Final Evaluation with PPT presentation/demonstration to be followed at the end of session.

Summary of Credits (2018-2019 Admitted Batch Onwards)

Semester	Credits	Total credit
1st Semester	20 (Group A)/18 (Group B)	38 for 1st year
2nd Semester	18 (Group A)/20 (Group B)	
3rd Semester	22.5	45 for 2nd year
4th Semester	22.5	
5th Semester	23	45 for 3rd year
6th Semester	22	
7th Semester	20	32 for 4th year
8th Semester	12	

TOTAL CREDITS = 160 [38 credits for 1st year + 122 credits for 3rd to 8th semester]

Promotion Criteria

Minimum No. of credits to be earned for promotion (2018-2019 admitted Batch)		
B. Tech		
From	To	Min. credits to be earned
I Year	II Year	23/38
II Year	III Year	55/83
III Year	IV Year	95/128
Final	Final	160/160
B. Tech (Lateral Entry)		
II Year	III Year	27/45
III Year	IV Year	60/90
Final	Final	122/122

Minimum No. of credits to be earned for promotion (2017-2018 admitted Batch)		
B. Tech		
From	To	Min. credits to be earned
I Year	II Year	25/44
II Year	III Year	60/89
III Year	IV Year	100/134
Final	Final	166/166
B. Tech (Lateral Entry)		
II Year	III Year	27/45
III Year	IV Year	60/90
Final	Final	122/122

MA 1307 (EC, EE, ME) **Credit: 3 (L-3, T-0, P-0)**

Engineering Mathematics III

Questions to be set *: Eight (Four from each unit). Each question carries 20 marks.*
Questions to be answered *: Any five selecting at least two from each unit.*

Course Objectives: The objective of this subject is to give emphasis on topics like Linear Algebra, Partial Differential Equations (PDE) and Numerical Methods. Linear algebra plays a major role in helping design and analyze electronic circuits. PDE are required for study of motion, vibrating strings etc. Many real life problems arising in communication can be modeled by numerical techniques. In many problems analytical solutions are not readily available or not easy to obtain. Therefore numerical methods are helpful to solve. Linear Algebra plays a pivotal role in many engineering branches specially electronics and communication engineering and hence they will enable students to model their problems using matrix theory.

Course Outcome: This will empower the students to build better understanding related to their problems and enhance the capability of performing critical analysis using mathematical tools contained in the syllabus.

Pre-requisites: MA1101, MA1201

UNIT – I

Linear Algebra

Vector Spaces, Subspaces, Span, Basis and Dimension, Linear Transformation, Matrix representation of Linear Transformation, Eigen Values and Eigen Vectors. Inner product spaces, Orthogonality, projection, Orthogonal and Ortho normal Basis, Gram Schmidt Orthogonalization Process. [12 Hrs]

Partial differential equations

Definition, degree, order of a PDE. Formation of PDE. Linear and nonlinear PDE. Solution of first order linear PDE. Derivations of one dimensional wave equation (vibrating string) and its solutions by using method of separation of variables with simple problems. [6 Hrs]

UNIT – II

Numerical Methods

Interpolation and application: finite difference, central and divided differences, Newton - Gregory and Lagrange's interpolation formulae. Inverse interpolation. Numerical differentiation. Numerical integration: Trapezoidal rule, Simpson's one third and three eight rule, Solution of systems of linear equation: Jacobi, Gauss- Seidal methods. Solution of tridiagonal systems. Eigen values and Eigen vectors of matrices and elementary properties, computation of largest Eigen value by power method. [10 Hrs]

Numerical solution of algebraic and transcendental equations using Newton Rapson’s method, Solution of nonlinear equation by Newton Raphson's method, Numerical solution of initial value problems in ordinary differential equations by Taylor series method, Runge-Kutta Fourth order Method.[8 Hrs]

Text books:

1. Erwin Kreyszig : Advanced Engineering Mathematics, Wiley
2. S. S. Sastry: Introductory Method Numerical Analysis. PHI.
3. I. Sneddon, Elements of Partial Differential Equations, Dover Publications INC

Reference Books:

1. M. K. Jain and S.R.K. Iyengar and R. K. Jain: Numerical methods for scientific and engineering computations. New Age International.
2. Conte and deBoor: Elementary Numerical Methods, an algorithmic approach, McGraw Hill.

EC-1303 **Credit: 3 (L-3, T-0, P-0)**

Electronic Devices & Components

Question to be set *: Eight (Four from each unit). Each question carries 20 marks.*
Questions to be answered *: Any five selecting at least two from each unit.*

Course Objective: This course introduces students with fundamental studies on solid state semiconductor devices and their circuit analysis. Through a theoretical and hands-on approach using multitude of electronic components and devices, students explore the fascinating world of electricity and electronics. This captivating program presents review of basic electronics, fundamental of semiconductor physics, review of transistors, working principle of Field Effect Transistor (FET), Transistor at low frequency and high frequency and introduction to integrated circuit with different basic fabrication techniques.

Pre-requisites: Knowledge of passive and active electrical components, Basic concept on electronics, Basics of Quantum mechanics, First course on graduation physics and mathematics, circuits and network theorem, Mess and node analysis.

UNIT – I

1. **Semiconductor fundamentals:** crystal structure, Fermi level, energy-band diagram, intrinsic and extrinsic semiconductor, carrier concentration, scattering and drift of electrons and holes, diffusion mechanism, Hall effect, generation, recombination and injection of carriers.[6 Hrs]

2. **Contact:** Metal-semiconductor junction: Ohmic and Schottky Contacts.[1 Hr]

3. **P-N junction:** Biasing, forward and reverse characteristics, I-V characteristics, Zener diode, Varactor diode, Diode as a switch, rectifier, regulator, clipper, clamper circuits. [5 Hrs]

4. **BJT:** Introduction, CE, CB, CC configurations, region of operation, biasing, Concept of Hybrid parameters, Analysis of a transistor amplifier using h parameters.[6 Hrs]

UNIT – II

5. **Transistor as an amplifier:-**Multistage Amplifiers- gain calculation, RC Coupled Amplifiers-functions of all components, equivalent circuit, and derivation of voltage gain, frequency response characteristics, lower and upper half frequencies, bandwidth, Distortion in Amplifiers, Darlington Amplifiers. [8 Hrs]

6. **Field Effect Transistors:** Junction field effect transistors(JFET)- Principle of operation, Static characteristics of JFET, Concept of pinch off voltage.[3 Hrs]

7. **Metal oxide semiconductor field effect transistors:** Metal-Insulator-Semiconductor junction: Accumulation, Depletion and Inversion .Enhancement and depletion type MOSFET, Static characteristics of MOSFET, MOSFET as amplifier. [7 Hrs]

Text Books:

1. Ben Streetman and Sanjay Banerjee, *Solid State Electronic Devices, 7e,*Prentice-Hall, 2015.
2. Donald A. Neamen, *Semiconductor Physics And Devices: Basic Principles*, 4e, Tata McGraw-Hill Pvt. Ltd., 2012.
3. Millman J and Halkias, *Integrated Electronics,* 2e, McGraw Hill Education (India) Pvt.Ltd, 2009.

Reference Books:

1. D Chattopadhyay and P.C. Rakshit, *Electronics Fundamentals and Applications*, 1e, NewAgeInternational Publications, 2008.
2. Boylestead and Nashelsky, *Electronic Devices and Circuits Theory*: 11e, Prentice-Hall, India, 2012.
3. J. Milman and A. Grabel, Microelectronics, 1e, Tata McGraw-Hill Education, 2001.

EC 1304 **Credit: 3 (L-3, T-0, P-0)**

Electronic Instrumentation and Measurements

Questions to be set ***: Eight (Four from each unit). Each question carries 20 marks.***
Questions to be answered ***: Any five selecting at least two from each unit.***

Course Objective: To give a brief idea about Electronic Instrumentation and Measurement& its related fundamentals and applications. The course entitles major portions namely accuracy, precision, different standards, bridges and their applications, CRO, different transducers and their applications, different methods of data transmission and telemetry, different methods for the measurement of physical quantities etc.

Pre-requisites: Knowledge in statistics, electronic devices.

UNIT – I

1. **Art of measurement:** Static and Dynamic Characteristics of measuring Devices, Accuracy and Precision, Errors: types and their statistical analysis. **[4 Hrs]**

2. **Bridges and their applications:** Wheatstone Bridge, Maxwell Bridge, Maxwell Wein Bridge, Andersons Bridge, Schering Bridge, DeSauty Bridge, Applications of AC bridges. **[4 Hrs]**

3. **Electronic Measuring Instruments:** Multimeter, Digital Voltmeter (DVM), Cathode ray oscilloscopes, Digital storage oscilloscopes and Spectrum Analyzer **[6 Hrs]**

4. **Display devices and recorders:** Light Emitting Diode, Liquid crystal devices, Data Acquisition System and Recorders. **[4 Hrs.]**

UNIT – II

5. **Introduction to Sensors and Transducers:**
Definition of sensors and Electrical transducer, Basic requirements of a transducer. Classifications of transducers, Introduction to smart transducers. [**3 Hrs]**

6. **Measurement of Non-Electrical Quantities using Transducers:**
Strain: Strain Gauge & Piezo-electric Transducers, Temperature: Thermocouple & RTD, Pressure: Bourden Tube & Diaphragm, Flow: Rotameter &Orifice, Liquid Level: Capacitive and Ultrasonic Level Detector, LVDT **[11 Hrs]**

7. **Data transmission and telemetry:**
Method of data transmission, general telemetry system, types of telemetry system, Land line telemetry, voltage T.S., current T.S., Position T.S., land line telemetry, Feedback system, R.F. telemetry, recent telemetry systems. **[4 Hrs]**

Text Books:

1. *A*. K .Sawhney, *A course in Electrical and Electronic Measurements and Instrumentation*, 19e, Dhanpat Rai and Co.(P) Ltd.,2011.
2. Helfrick & Cooper, *Modern Electronic Instrumentation & Measurement Techniques*,1e, Prentice Hall of India, 2008.

Reference Books:

1. P. H. Mansfield, *Electrical Transducers & Industrial measurements*,1e, Butterworth-Heinemann, 1973.
2. H. S. Kalsi, *Electronic Instrumentation*, Tata McGraw-Hill, 2002

EC 1305 **Credit: 3 (L-3, T-0, P-0)**

Signals and Systems

Questions to be set ***:*** *Eight (Four from each unit). Each question carries 20 marks.*
Questions to be answered ***:*** *Any five selecting at least two from each unit.*

Course Objective: To serve as a beginner course in acquiring knowledge in Signals and Systems. This course describes fundamentals of Signals and systems, Fourier series (CTFS), Fourier transform (CTFT), Laplace transform, Z transform and their application areas.

Pre-requisites: Basic Trigonometry, Coordinate geometry and thorough knowledge of: Complex analysis, Integral and differential calculus, Solution of linear differential and difference equation.

UNIT – I

1. Singularity Functions: Unit step, Unit Impulse and Unit Ramp Functions, Properties of different singularity functions, Classification of signals and their mathematical representations, Basic Operations on Signals: Time shifting, Time scaling, Time reversal. [3 Hrs]

2. Convolution Integrals and Convolution Sum, Properties of Convolution Integrals and Convolution Sum, Correlation of Signals: Cross correlation and autocorrelation of continuous and discrete time energy and power signals, Properties of cross correlation and autocorrelation.[3 Hrs]

3. Amplitude and Phase spectra of a signal, Physical significance of the exponential form of Sine and Cosine waveform (Vector diagram), Concept of negative frequency, Introduction of Orthogonal basis functions.[1 Hr]

4. Continuous Time Fourier Series(CTFS): Dirichlet conditions, Trigonometric Fourier series, Trigonometric Fourier series coefficients, Symmetry conditions, Polar form and exponential form of Fourier Series, relationship between exponential and trigonometric Fourier series, Gibb's Phenomenon. [6 Hrs]

5. Continuous Time Fourier transform (CTFT), Condition for Fourier Transform, Properties of CTFT, Parseval's theorem, Inverse Fourier Transform using Partial fraction. [3 Hrs]

6. Energy Spectral Density (ESD), Power Spectral Density (PSD), Properties of ESD and PSD, Relationship between PSD, ESD and the auto correlation function. [2 Hrs]

UNIT – II

7. Introduction to Systems, Classification of continuous and discrete time systems, Mathematical representation of Different types of systems, Linear Time Invariant (LTI) systems, system transfer functions, impulse responses. [4 Hrs]

8. Concept of Complex Frequency, Introduction to Laplace Transform, Concept of poles and zeros, System transfer function, Necessity of Laplace Transform, Unilateral and Bilateral Laplace Transform, Condition for existence of Laplace Transform, Region of convergence (ROC), ROC of finite duration signal, Necessity of Unilateral Laplace Transform, Significance of initial condition, Relationship between poles and ROC, Relationship between Laplace transform and Fourier Transform, Properties of Laplace Transform, initial value theorem, final value theorem, Inverse Laplace Transform using partial fraction method. [8 Hrs]

9. Sampling, Discrete signals, Z transform, relation between s – plane and z – plane, Properties of ROC, ROC of causal and Anti causal signals, Condition for existence of Z transform, Properties of z-transforms, Shifting theorem, Initial and final value theorem, Inverse – Z transforms using long division method and partial fraction method, Transfer function of delay unit, realization of z-domain transfer function, Solution of difference equations using z-transform. [6 Hrs]

Text Books:

1. A.V. Opponheim, A.S.Willsky, *Signals and Systems*, 2e, PHI, 1997.
2. Robert A. Grabel and Richard A. Roberts, *Signals and Linear System*, 3e, Wiley 2009.

Reference Books:

1. B.P.Lathi, *Principles of Linear Systems and Signals*, 2e, Oxford University Press, 2009.
2. H P Hsu, *Signals and Systems*, Schaum Outline Series, 3e, Tata McGraw Hill,2014.
3. T.K. Rawat, *Signals and Systems*, 1e, Oxford University Press, 2010.
4. 2010P. Rameshbabu, R. Anandanatarajan, *Signals and Systems*, 4e, Scitech Publication, 2011.

EC 1306 **Credit: 3 (L-3, T-0, P-0)**

Digital Electronics

Questions to be set *: Eight (Four from each unit). Each question carries 20 marks.*
Questions to be answered *: Any five selecting not more than three from each unit.*

Course Objective: To introduce the students with the Digital Electronics and designing of combinational and Sequential circuits. In this subject, students are introduced with digital electronics and the various design methodologies of combinational logic circuits. Brief about Number systems with special emphasis on binary system are encompassed in the subject. In this subject, students learn how to design logic circuits like adder, subtractor, code converters, multiplexers, decoders etc. Students are also introduced to sequential digital circuits.

Pre-requisites: Basics of number systems, Basics of electronics.

UNIT – I

1. **Review of Number systems:** Number Systems, Codes in Binary system, Weighted and Non-weighted codes - Straight binary code, BCD code, Excess 3 code, Gray code. Negative number representation, Subtraction using 1's complement and 2's complement. [3 Hrs]

2. **Boolean algebra:** Boolean theorems. Forms of Expressions SOP, POS, Logic gates. Universal gates. [3 Hrs]

3. **Combinational logic circuits design:** Introduction to K-map, MEV technique and Quine-McCluskey method. Design of combinational logic circuits: Half adder, Half Subtractor, Full adder, Full Subtractor, Code Converters, Multiplexers, Demultiplexers, Encoders, Decoders, Comparators, Parity Checker/ generator, Look Ahead Carry Adder.[12 Hrs]

UNIT – II

4. **Introduction to sequential logic:** Need for sequential circuits.Latches and flip-flops. Circuits and characteristics RS, JK, Master-Slave JK, D & T flip flops. Conversion of Flip-flops. [4 Hrs]

5. **Synchronous sequential circuit design:** Fundamentals of Synchronous sequential circuits.Design of Synchronous and Asynchronous Counters. Shift registers. [10 Hrs]

6. **Logic families:** Introduction to RTL, TTL, CMOS, ECL logic families. Interfacing of TTL and CMOS. Circuits of TTL family logic gates. Characteristics of digital ICs (transfer characteristics, noise margin, propagation delay, fan in, fan out, power dissipation, figure of merit). [4 Hrs]

Text Books:

1. Morris Mano, "*Digital Logic and Computer Design,* Pearson Education India", 1st Edition, 2016.

2. William I. Fletcher, "*An Engineering Approach to Digital Design",* Pearson Education India, 1st Edition, 2015.

Reference Books:

1. Ronald J. Tocci, Neal S. Widmer, and Gregory L. Moss, "*Digital Systems: Principles and Applications",* Pearson Education, 11th Edition, 2010.

2. R. P. Jain, "*Modern Digital Electronics"*, Tata McGraw-Hill Publishing Company Ltd., 3rd Edition, 2006.

EC-1308 **Credit: 3 (L-3, T-0, P-0)**

Network Analysis and Synthesis

Questions to be set *: Eight (Four from each unit). Each question carries 20 marks.*
Questions to be answered *: Any five selecting at least two from each unit.*

Course Objective: To enrich the knowledge of the students with a sound understanding of various techniques of network analysis and synthesis.

Pre-requisites: Basics of circuit theory, Laplace Transform, Integration, first and second order homogenous and non-homogeneous solution.

UNIT – I

1. **Basics of Electrical Network:** Circuit Elements (R, L, C**,** Mutual Inductance, Independent and Dependent Current and Voltage Sources), Classification of Networks (Passive and Active N/W, Lumped and Distributed N/W, Linear and Non-Linear N/W),Star-Delta Transformation, RC integrator (LPF), differentiator (HPF) and response studies.[4 Hrs]

2. **Network Theorems**: Superposition, Thevenin's, Norton's and Maximum Power Transfer. [4 Hrs]

3. **Initial conditions:** Initial conditions in elements, Procedure for evaluating initial conditions. [4 Hrs]

4. **Applications of Differential equations and Laplace Transform in Electrical Network:** steady and transient analysis, Application of Laplace transform in network analysis. [3 Hrs]

5. **Network Functions:** 1 port and 2 port Network functions, Poles and zeroes of network functions.[3 Hrs]

UNIT – II

6. **Two Port Parameters**: 2 port variables, short circuit and open circuit parameters , transmission and hybrid parameters.[5 Hrs]

7. **Graph Theory:** Graph of a network, Concepts of tree and links, Incidence matrix, Tie- set and cut-test schedules, Solution of Networks, Principles of duality. [4 Hrs]

8. **Passive network synthesis**: Positive real functions, synthesis of R-L, R-C and L-C network.[5 Hrs]

9. **Filters Design:** Characteristic impedance, propagation constant and Constant K-Type filter Design (Low pass, High pass Draw backs & remedies of K filters.[4 Hrs]

Text Books:

1. M.E. Van Valkenburg, *Network Analysis*, PHI, 3rd edition, 2014.
2. D. Roy Choudhury, *Networks and Systems*, 2e, New Age international Publisher,2011.

Reference Books:

1. Franklin.F.Kuo, *Network Analysis and Synthesis*, Wiley Edition, 2e, 2012.
2. Ravish R Singh, *Network Analysis and Synthesis* , McGraw Hill Education, 2013.
3. A. Sudhakar, SS Palli, *Circuits and Networks Analysis and Synthesis*, McGraw Hill, 5e,2015.

BP-1391 **Credit: 0 (L-2, T-0, P-0)**

Constitution Of India

Questions to be set *: Eight (Four from each unit). Each question carries 20 marks.*
Questions to be answered *: Any five selecting at least two from each unit.*

UNIT I

Meaning of constitution law and constitutionalism

Evolution of Indian Constitution- Nationalist Movement and Philosophical Foundations; Preamble of Indian constitution.

Indian Federation- Features of federation; Centre – State Relations – Recent Trends; Fundamental Rights and Duties and Directive Principals of state policy.

Parliamentary form of government: Executive: President; Prime Minister and Council of Ministers -Election, Powers and Functions; **Legislature**: Lok Sabha and Rajya Sabha– Composition, Powers and Functions

Judiciary– Supreme Court, Composition, Powers, Functions and Judicial Review- Judicial Activism.

UNIT II

Amendment of the constitution: Powers and procedure; State Government – Governor, Chief Minister and Council of Ministers – Powers and Functions.

Party System: National and regional Parties; Trends in Party System Election Commission – Electoral Reforms and voting Behavior.

Rural Local Government: Evolution Structure and Function**;** Gram Sabha; Gram Panchayat; Panchayat Samiti; Zila Panchayat.

Urban Local government: Evolution structure and function; Municipal corporation**;** Nagar panchayat.

Text books:

1. **Our Constitution: An Introduction to India's Constitution and Constitutional law** by Kashyap Subhash
2. **Introduction to the Constitution of India** by D. D. Basu
3. **Encyclopedia of Social Sciences** (Vol.4, 1931)
4. **History of Political Theories from Luther to Montesquieu** by Dunning
5. **The Indian Constitution: Cornerstone of a Nation** by Austin Graville
6. **Indian Government and Politics** by S. S. Awasthy
7. **Contemporary Indian Politics** by Limaye Madhu
8. **Indian polity** by M. Laxmikanth

BP-1392 **Credit: 0 (L-2, T-0, P-0)**

Indian Traditional Knowledge

Questions to be set *: Eight (Four from each unit). Each question carries 20 marks.*
Questions to be answered *: Any five selecting at least two from each unit.*

UNIT I

Basic structure of Indian knowledge system. Basic features and importance of Vedic knowledge; Astadash Vidhya- 4 Vedas, (Rig-Veda, Sama-Veda, Yajur-Veda, and Atharva) 4 Upa Vedas (Dhanurveda, Gandharvaveda, Ayurveda and Arthasastra), 6 Vedangs (Siksha, Chhanda, Vyakarana, Nirukta, Jyotisha and Kalpa) And 4 Upangas (Dharma Sastra, Memangsa, Purana and Tarka Sastra)

Modern Science and Indian Knowledge: Basic features, significance and relevance in modern society.

The Idea of Zero, the Decimal System, Numeral Notations, Fibonacci Numbers, Binary Numbers, a Theory of Atom, Plastic Surgery and Ayurveda.

Yoga and holistic health care: Origin of Yoga & its brief development, Meaning of Yoga & its importance, Yoga as a Science of Art (Yoga Philosophy), Meaning of meditation and its types and principles.

Principles of Yogic Practices: Meaning of Asana, its types and principles, meaning of Pranayama, its types and principles, Meaning of Kriya its types and principles.

Case Study

UNIT II

Philosophical Traditions:
Serve Darsana Sangraha: meaning features and significance (Charvaka System,Bauddha System, Arhata or ,Jaina System, Ramanuja System, Purna-prajna System, Nakulis-Pasupata System,Saiva System, Pratyabhijna or Rcognitive System, Rasesvara or Mercurial System, Vaiseshika or Aulukya System, Akshapada or Nyaya System, Jaiminlya System, Papiniya System, Sankhya System)

Indian Linguistic Tradition: **Theoretical**:

Phonetics: Sounds of a language–Phonology: Sound patterns–Morphology: Word formation and structure–Syntax: Sentence structure–Semantics: Study of meaning. **Applied**–Understanding and teaching other languages, translation, speech therapy.

Indian Artistic Tradition: Basic features, significance and importance and region associated: Chitra Kala , Murti Kala, Bastu Kala, and Sangit, (The Famous Traditional Art Forms in India: Warli Art, Gond Art, Madhubani, Miniature Paintings ,Tanjore Paintings, Kalamkari , Kalighat Pats Phad Pai)

Case Study

Text books:

1. V Shivakrishnan (Ed) : Cultural Heritage Of India Course Material Vidhya Bhawan Mumbai 5th Edition ,2014
2. The Sarva-Darsana-Samgraha, Or Review Of The Different Systems Of Hindu Philosophy By Madhava Acharya Publication Date 1882 ,Topics Hinduism ,Publisher London, Contributor Robarts - University Of Toronto.
3. K.S Subrahmanialyer, Vakyapadiya Of Bhartrihari(Brahman Kanda) Deccan College Pine 1965.
4. Panini Shiksha, Motilal Banarasidas
5. V.N Jha , Language, Thoughts And Reality.
6. Pramod Chandra, Indian Arts , Abhinav Publications 1897
7. Light on Yoga by B.K.S. Iyengar
8. The Heart of Yoga: Developing a Personal Practice by T.K.V. Desikachar
9. The Seven Spiritual Laws of Yoga by Deepak Chopra
10. The Secret Power of Yoga: A Woman's Guide to the Heart and Spirit of the Yoga Sutras by Nischala Joy Devi
11. Yoga: The Iyengar Way by Silva, Mira, and Shyam Mehta
12. Yoga: The Iyengar Way by Silva, Mira, and Shyam Mehta

EC 1361 **Credit : 1.5 (0L+0T+3P hrs/week)**

Electronic Devices and Components Lab.

Minimum No. of Experiments to be carried out: 12.

Course Objective: To familiarize the students with the electronics circuits. Students will design and construct various electronic circuits like rectifier, clipper, clamper, voltage regulator, JFET etc. both using discrete components and Multisim software.

Pre-requisites: Basic Electronics.

List of Experiments:

0. Familiarization of Basic Electronics Components, Study of the Lab instruments: Oscilloscope, Function Generator, Multimeter, Resistor Colour Codes, Recognition of PN transistors. etc.

Part-I

1. Study the Characteristics of diodes: Zener, Germanium, Silicon.
2. Study of Voltage Regulator.
3. Study of Rectifiers: Half wave Rectifier, Full wave Rectifier and Bridge Rectifier.
4. Study of Clipper and Clamper Circuit.
5. Study of voltage multiplier.
6. Study of passive filters: C- filter, pi- filter
7. Study of Bipolar Junction Transistor characteristics: CB, CC configuration
8. Study of Bipolar Junction Transistor characteristics: CE configuration
9. Study of Bipolar Junction Transistor biasing: fixed bias, voltage divider bias
10. Study of Field Effect Transistor characteristics
11. Study the characteristics of photovoltaic components: Photo diode, LDR, LED, Photo Transistor.

Part-II

12. Case Study: Hardware implementation and validation of any basic electronics circuit using Vero board.
13. Study of Network Theorems: - Thevenin's Theorem, Norton's Theorem, Superposition Theorem, Maximum Power Transfer Theorem.

EC 1362 **Credit: 1.5 (0L+0T+3P hrs/week)**

Signal and Circuit Simulation Lab.

Minimum No. of Experiments to be carried out: 12

Course Objective: To familiarize the students with the basics of MATLAB programming. Students will be able to (i) generate various types of signals (ii) calculate Fourier series approximation of a periodic signal(iii) calculate convolution and correlation of discrete time signals and (iv) Analyze a system using Fourier Transform, Laplace and z – transform (v) verify the basic network circuits using MULTISIM.

Pre-requisites: Signal and Systems, Basic network theorems, Basic electronics.

CYCLE – I: MATLAB BASED SIMULATIONS

1. Generation of Continuous and Discrete Time Impulse signal

1.1 Introduction to R/ MATLAB.

1.2 Generation of standard Impulse (continuous and discrete) signal.

1.3 Generation of Impulse (continuous and discrete) signal with user defined delay and strength.

2. Generation of Continuous and Discrete Time Step, Ramp and Gate signals

2.1 Generation of Standard Step (continuous and discrete) signal.

2.2 Generation of Step (continuous and discrete) signal with user defined delay and step size.

2.3 Generation of Standard Ramp (continuous and discrete) signal.

2.4 Generation of Ramp (continuous and discrete) signal with user defined delay and slope.

2.5 Generation of Gate (continuous and discrete) signal with user defined delay and step size.

3. Concept of sampling and Generation of sinusoid waveform

3.1 Basic concept of sampling and its effect on reconstruction of waveform

3.2 Generation of standard sine wave with amplitude 10 volts (peak to peak) and frequency 100 Hz.

3.3 Generation of sine wave with user define amplitude, frequency and phase.

3.4 Generation of composite waveform produced by two sine wave with different amplitude and frequency.

4. Fourier series approximation of (i) Unipolar square wave (ii) Bipolar square wave, the amplitude and frequency of the waveform is user defined

5. Fourier series approximation of (i) Saw tooth wave (ii) Triangular wave, the amplitude and frequency of the waveform is user defined

6. Complex Fourier series approximation using 3-D plot of all the waveform mention in experiments 4 and 5.

7. Discrete time Linear Convolution and Deconvolution.

7.1 Write a function which calculates the linear convolution of two discrete sequences and plot the result. Also find the convolution length. Compare the obtained sequence with the sequence obtained by using R/Matlab in built function.

7.2 Write a function which calculates the linear deconvolution of two discrete sequences and plot
the result.

8. Discrete time Circular Convolution and Deconvolution

8.1 Write a function which calculates the circular convolution of two discrete sequences and plot the result. Also find the convolution length. Compare the obtained sequence with the sequence obtained by using R/Matlab in built function.

8.2 Write a function which calculates the circular deconvolution of two discrete sequences and plot the result.

9. Discrete time Linear Correlation and Decorrelation

9.1 Write a function which calculates the correlation (auto and cross) of two sequences and plot the result. Also find the convolution length. Compare the obtained sequence with the sequence obtained by using R/Matlab in built function.

9.2 Write a function which calculates the linear decorrelation of two discrete sequences and plot the result.

10. **Fourier transform analysis of signals and systems**

11. S-Domain analysis of signals and systems

12. Z- domain analysis of signals and systems

13. Application of sampling and reconstruction on image processing.

CYCLE – II: MULTISIM BASED SIMULATIONS

1. **Objective1:** Study of network theorems
2. **Objective2:** Study of steady state and transient response of a RC, RL and RLC circuits.
3. **Objective3:** Study of clipper, clamper.
4. **Objective4:** Study of Half wave, full wave and bridge rectifier.
5. **Objective5:** To study first order LPF, HPF using RC circuits
6. **Objective6:**To study Band pass and Band reject filters using RC circuits.

EC1363 **Credit: 1.5 (0L+0T+3P hrs/week)**

Digital Electronics Laboratory

Minimum No. of experiments to be carried out: *12 (At least 6 experiments from each cycle)*

Course Objective: To familiarize the students with the basic Digital Electronics ICs. Students will design and construct various combinational circuits like adder, subtractor, code converters, multiplexers, decoders etc. in the laboratory. The students will also get the ideas of design and implementation of digital sequential circuits. The students will be introduced with the working of various synchronous and asynchronous digital logic circuits like counters, shift registers, sequence generator, sequence detector etc.

Pre-requisites: Basics of Electronics

List of Experiments:

CYCLE - I

1. Design of a (i) Full adder circuit and (ii) Full subtractor circuit
2. Design of a (i) parity generator and (ii) parity checker circuit
3. Design of a binary to gray code converter circuit
4. Design of a BCD to excess-3 code converter circuit
5. Design of a decoder/de-multiplexer using logic gates
6. Design of a multiplexer circuit using logic gates
7. Design of a combinational circuit using a (i) decoder IC and (ii) multiplexer IC
8. Design of a full adder/full subtractor with a control line using 4-bit adder IC

CYCLE - II

9. Construction and verification of Flip-Flops
10. Conversion of flip-flops
11. Design of a (i) mod 16 asynchronous up counter and (ii) decade asynchronous up counter
12. Design of a mod 16 synchronous up counter.
13. Design of a (i) ring counter and (ii) twisted ring counter
14. Design of a self-correcting counter
15. Construction of shift register in (i) SISO (ii) SIPO (iii) PIPO & (iv) PISO modes
16. Design of a sequence generator using universal shift register IC
17. Design of different mod counters using a counter IC and display its output in 7-segment LEDs through a decoder IC
18. Design of a sequence detector circuit to detect a particular sequence of input bits

MA 1402 (EC) **Credit: 3 (L-3, T-0, P-0)**

Engineering Mathematics IV

Questions to be set *: Eight (Four from each unit). Each question carries 20 marks.*
Questions to be answered *: Any five selecting at least two from each unit.*

Course Objectives: Objective of teaching Probability is to provide some basic idea on Probability and Random processes (or Stochastic Processes) its applications in the field of Science and Engineering. Random process has enormous applications in Digital Communications & Modeling of physical problems. Complex numbers are applied to study control theory, signal analysis, electromagnetism and electrical engineering etc.

Course Outcome: This will equip students to tackle problems which are non-deterministic in nature and arrive at solutions of physical problems which require a very high degree of precision.

Pre-requisites: MA1101, MA1201, MA1307

UNIT – I

Probability Theory

Basic concepts on Borel sets and measure, Axiomatic definition, conditional probability and independence, Baye's theorem. One and Two dimensional random variables with moments (up to second order), covariance, correlation coefficients. Distributions: Binomial, Poisson, Uniform, Normal, Gamma, and Exponential distribution. Central Limit Theorem.[18 Hrs]

UNIT – II

Stochastic Processes

Random Processes: Definitions, Classifications. Auto Correlation and Covariance functions, Weak sense and Strong sense stationary processes. Discrete Parameter Markov chain: Basic ideas, Computation of n step transition probabilities using Chapman Kolmogorov Theorem. (Restricted to two state problems). [8 Hrs]

Complex Analysis

Complex variables, functions, continuity, differentiability, analyticity -Cauchy Riemann equations and properties of analytic functions. Line integrals in complex plane and basic properties of Cauchy's integral theorem and Cauchy's integral formula -derivatives of analytic functions. Taylor, Maclaurin and Laurent's series, residue theorem, evaluation of standard real integrals using contour integrals.[10 Hrs]

Text Boks:

1. P.L. Meyer, Introductory *Probability theory and statistical Applications*, Second Ed. Oxford & IBM Publishers.
2. R. V. Churchill and J. W. Brown, *Complex variables and applications*, McGraw Hill.
3. K.S. Trivedi, *Probability & Statistics with Reliability, Queuing and Computer Science Applications*, PHI.

Reference Books:

1. Murray R. Spigel , *Complex variable*, Schaum's Outline Series
2. Erwin Kreyszig, *Advanced Engineering Mathematics*, Wiley Eastern.
3. William Feller, *Introduction to Probability Theory and its Applications*, (Vol I & II) 2008, Wiley

EC 1403 **Credit: 3 (L-3, T-0, P-0)**

Electromagnetic Waves

Questions to be set ***:*** *Eight (Four from each unit). Each question carries 20 marks.*
Questions to be answered ***:*** *Any five selecting at least two from each unit.*

Course Objective:

To serve as a beginner course in acquiring knowledge in Electromagnetic waves. This course describes fundamentals of Coordinate systems, Vector Calculus, Static Electric Fields, Electric and Magnetic flux, Electric Current density, Magnetic fields, Maxwell's equations, Solution of Maxwell's equation in different medium conditions.

Pre-requisites: Differential and Integral Calculus, concept of vectors, coordinate geometry, Basic idea on electric and magnetic field.

UNIT – I

1. **Review of vector Algebra:** Scalars and vectors, Unit vector, Vector addition and subtraction, Position and distance vector, Vector multiplication: dot product and cross product, Projection of a vector, components of a vector. [2 Hrs]

2. **Fundamentals of Coordinate systems:** Basic condition for orthonormal coordinate systems, Cartesian coordinates, circular cylindrical coordinates, spherical coordinates and their transformations. [3 Hrs]

3. **Introduction to Vector calculus:** Differential length, area and volume, Line, surface and volume integrals, Del operator, Gradient, Divergent, Curl and their physical explanation, Divergence and Stokes's Theorem, Other useful vector identities. [4 Hrs]

4. **Static Electric Fields:** Coulomb's law and field intensity, Electric fields due to continuous charge distribution, Electric Flux density, Gauss's Law – Maxwell's Equation, Application of Gauss's law, Electric potential, Relation between electric field and electric potential, Poisson's and Laplace equation, Energy density in electrostatic fields. [6 Hrs]

5. **Electric Fields in Material Space:** Properties of materials, Convection and conduction current, Current density, Types of dielectric medium: Linear, Isotropic and Homogeneous dielectrics, Continuity equation and Relaxation time, Boundary conditions. [3 Hrs]

UNIT—II

6. Magnetostatic Fields: Biot – Savart's law, Applications of Biot- Savart's law, Ampere's Circuit law – Maxwell's equation, Application of Ampere's law, Magnetic flux density – Maxwell's equation, Maxwell's equation for static EM fields, Magnetic scalar and vector potential, Coulomb gauge condition, vector Poisson's equation. [7 Hrs]

7. **Maxwell's Equation in Time varying condition:** Faraday's law, Lenz's law, Trans former and Motional EMFs, Displacement current and modification of Maxwell's equation, Displacement current through capacitor, Final form of Maxwell's equation, Time-Harmonic electric and magnetic fields, Time-Harmonic Maxwell's equation. [5 Hrs]

8. **Electromagnetic Wave Propagation:** Wave propagation in Lossy Dielectrics, Plane wave in Lossless Dielectrics, Plane wave in free space, Intrinsic impedance of free space, Plane wave in good conductor, Skin effect and skin depth, Power and Poynting vector, Related problems. [6 Hrs]

Text Books:

1. Matthew N. O. Sadiku,*Elements of Electromagnetics*, 3e,Oxford University Press,2002.

2. Nathan Ida, *Engineering Electromagnetics*, 1e, Springer, 2005.

Reference Books:

1. E. C. Jordan and K. G. Balmain*, Electromagnetic Waves and Radiating Systems*, 2e,Prentics Hall of India, 2006.

2. W. H. Hayt and J. A. Buck, *Enginnering Electromagnetics* , 7e, Tata Mcgraw Hill, 2011.

3. Joseph A. Edminister, *Electomagnetics,* 2e, Schaums' outline series, 2004.

4. David J. Griffiths, *Introduction to Electrodynamics,* Pearson, 2013.

5. David K. Cheng, *Field and Wave Electromagnetics*, 2e, Tsinghua University Press, 2007

EC 1406 **Credit: 3 (L-3, T-0, P-0)**

Design and Analysis of Digital Systems

Question to be set ***:*** *Eight (Four from each unit). Each question carries 20 marks.*
Questions to be answered ***:*** *Any five selecting not more than three from each unit.*

Course Objective: To give the ideas of design and analysis of digital circuits to the students. In this subject, students are introduced with the various design and analysis methodologies of synchronous and asynchronous digital logic circuits. They will be taught to analyze sequential logic circuits and to suggest remedial measures to rectify and improve those. In this subject, students learn how to design multi input multi output circuits. Then they will be introduced to FPGA architectures and different fault models for testing digital systems. At the end of the course the student will be able to analyze, design, and evaluate digital circuits and programmable logic devices.

Pre-requisites: Basics of Digital Electronics

UNIT – I

1. **Review of counter design:** Design of synchronous, asynchronous and hybrid counters. Concept of programmable counter. **[3** Hrs**]**

2. **Design and Analysis of Synchronous Sequential circuits:** Fundamentals of Synchronous sequential circuits, Classification of synchronous machines, Design of Synchronous Sequential circuits - design approaches, state reduction, design of next state decoder and output decoder. ASM charts. **[10** Hrs]

3. **Design and Analysis of Asynchronous Sequential circuits:** Need for asynchronous circuits, approaches in asynchronous design. **[3** Hrs**]**

4. **Multivibrators:** Astable, Monostable and Bistable mutivibrators **u**sing logic gates and digital ICs**. [2** Hrs**]**

UNIT – II

5. **Semiconductor memory and programmable logic devices:** Read Only Memory (ROM) - PROM, EPROM, EEPROM, random access memory (RAM)-static, dynamic, memory characteristics, memory organization and applications. Architecture of PAL, PLA, PLD and their application. **[4** Hrs**]**

6. **VLSI Design Concepts:** Moore's Law, Scale of Integration (SSI, MSI, LSI, VLSI, ULSI – basic idea only), Types of VLSI Chips (Analog & Digital VLSI chips, General purpose, ASIC, PLA, FPGA), Design principles (Digital VLSI – Concept of Regularity, Granularity etc), Design Domains (Behavioral, Structural), Introduction to DSP chips.

[7 Hrs**]**

7. **Reconfigurable logic Devices:** FPGA and its internal architecture, computing elements, LUT, BRAM, interconnect, I/O Blocks, programming of FPGA and interfacing case study. **[4** Hrs**]**

8. **Digital testing and testability:**
   Different fault models, fault simulation, design for testability-controllability and observability, Scan test, Boundary scan test, built in self-test, automatic test pattern generation. **[3** Hrs**]**

Textbooks:

1. William J. Fletcher, *An Engineering approach to Digital Design,* 1e, PHI, 1997.
2. Wakerly, *Digital Design: Principles and Practices*, 4e, PHI, 2005.
3. F. P. Frosser and D.E. Winkel, *The Art of Digital Design*, 2e, Prentice-Hall, 1995.
4. D. H. Green, *Modern Logic Design*, 1e, Addison-Wesley Publishing Company, 1986.
5. Morant M. J. *Integrated Circuit Design and Technology*, 4e, champion and Hall, 1990

Reference Books:

1. M. J. S. Smith, *Application Specific ICs*, 1e, Pearson 1997.
2. C. H. Roth, *Digital System Design using VHDL*, 4e, PWS, 1998.
3. Michael L. Bushnell, Vishwani D. Agrawal, *Essential of Electronic testing for digital, memory and mixed VLSI signal*, 1e, Kluwer Academic Publishers, 2002.
4. Parag K. Lala, *Fault tolerant and Fault testable hardware design*, 2e, BS publication, 2008.
5. Alexander Miczo, Russell D. Lambert, Miczo, *Digital logic testing and simulation*, 2e, Wiley-interscience, 2003.

EC 1408 **Credit: 3 (L-3, T-0, P-0)**

Analog Electronics and Integrated Circuits

Question to be set *: Eight (Four from each unit). Each question carries 20 marks.*
Questions to be answered *: Any five selecting not more than three from each unit.*

Course Objective: To enrich the knowledge of the students with a sound understanding of analog electronic circuit, this will help them in the further course of their studies. It exposes the students to various types of analog electronic circuit which will help them to relate this with the other courses which they have in their future semesters, as well as its importance from industrial point of view.

Pre-requisites: Basic idea on Electrical and Electronic Circuits. Engineering Physics.

UNIT – I

1. **Feedback Amplifiers & Oscillators:-** Basic principles and types of feedback, feedback topology, derivation of expression for gain, effect of negative feedback in gain, stability, distortion and bandwidth of an amplifier, Barkhaushen criterion, Different oscillator circuits- RC Phase Shift, Wien-Bridge, Hartley, Colpitt and Crystal. [8 Hrs]

2. **Power Amplifiers:** - Class A, B, AB, C, Conversion Efficiency, Push-Pull Amplifiers, Tuned Amplifiers. [2 Hrs]

3. **Operational Amplifiers and its applications:-** Characteristics of an ideal operational amplifier and its block diagram, Differential amplifiers and its characteristics-CMRR, Slew-Rate, Offset Voltage and Current, Gain-Bandwidth Product, Open & Closed loop operation, inverting and non-inverting amplifier, voltage follower, Summing amplifier, Differentiator, Integrator, Comparator, Schmitt trigger, Precision rectifiers, Sample and Hold circuits, Instrumentation amplifier.[8 Hrs]

UNIT – II

5. **Active Filters:** - Design and analysis of first and second order low pass, high pass, band pass, band reject filters and notch filters, Gain-Frequency Curve. [8 Hrs]

6. **Multivibrators: -**Implementation of Multivibrators using Transistor and 555 Timer. [6 Hrs]
7. **Special Functional Circuits:** -Introduction of VCO and PLL.[2 Hrs]
8. **Applications:** A-to-D Converter, D-to-A Converter. [2 Hrs]

Text Books:

1. Robert L. Boylestad, Louis Nashelsky, *Electronic devices and circuit theory*, Pearson Education, 11th Edition, 2013.
2. Jacob Millman, Christos Halkias, Chetan Parikh, *Integrated Electronics*, McGraw Hill Education, 2nd Edition, Paperback, 2009.
3. RamakantGayakwad, *Opamps& Linear Integrated Circuits*, PHI, 4th Edition, 2004.
4. V S KanchanaBhaaskaran , Salivahanan, *Linear Integrated Circuits*, Tata Mcgraw Hill Education Private Limited 2nd Edition, 2008.

Reference Books:

1. Donald Schilling, Charles Belove, *Electronic Circuits: Discrete and Integrated*, McGraw Hill Education (India) Private Limited; 3rd Edition, 2002.
2. S Salivahanan, N. Suresh Kumar, *Electronic Devices and Circuit*, McGraw Hill Education (India) Private Limited; 3rd Edition, 2012.
3. D. Chattopadhyay, P.C. Rakshit, *Foundations of Electronics*, New Age International Publishers Ltd., 2nd Edition, 2015.
4. Choudhury D. Roy, Shail B. Jain, *Linear Integrated Circuits*, New Age International Publishers Ltd., 4th Edition, 2010.
5. David A. Bell, *Electronic Devices and Circuits*, Oxford Publications, 5th Edition, 2008.
6. Albert Malvino, David Bates, *Electronic Principles*, McGraw Hill Education (India) Private Limited; 7th Edition, 2006.

EC 1409 **Credit: 3 (L-3, T-0, P-0)**

Analog Communication

Questions to be set ***:*** *Eight (Four from each unit). Each question carries 20 marks.*
Questions to be answered ***:*** *Any five selecting at least two from each unit.*

Course Objective: This course is designed to teach the analysis and design of analog communication systems. Topics include amplitude modulation, angle modulation and pulse modulation techniques, their generation as well as demodulation. Analysis of random signals and the comparison of receivers based on their noise performances is also included.

Pre-requisites: Fourier series and Fourier Transforms and Signals and Systems.

Course Objective: This course is designed to teach the analysis and design of analog communication systems. Topics include amplitude modulation, angle modulation and pulse modulation techniques, their generation as well as demodulation. Analysis of random signals and the comparison of receivers based on their noise performances is also included.

Pre-requisites: Fourier series and Fourier Transforms and Signals and Systems.

UNIT – I

1. **Introduction to Analog Communication [4** Hrs**]**
   Types and reasons for modulation. Transmitters, transmission channels and receivers.

2. **Continuous wave linear modulators [14** Hrs**]**
   Amplitude Modulation (AM) Time & Frequency domain expression, Single tone AM, Demodulation of AM signals-envelope detectors. Double side band suppressed carries (DSB) modulation, time and frequency domain expressions. Bandwidth and transmission power for DSB. Square law modulators, Ring modulators. Generation of SSB using a side band filter, indirect generation of SSB. Vestigial side band modulation (VSB).

UNIT – II

3. **Frequency Modulation (FM) and Phase Modulation (PM) [12** Hrs**]**
   Overview of Instantaneous frequency and instantaneous phase, FM and PM, Phasor diagram for FM and PM. FM and PM signals for a single tone message, the modulation index and phasor diagrams, Spectral representation of FM and PM for a single tone message, Bessel's functions and the Fourier series. Transmission bandwidth for FM, Carson's rule, narrowband and wide band FM and PM signals. Generation of FM using Armstrong method, Commercial FM requirements. Demodulation of FM and PM signals, the limiter discriminator, PLL

4. **Representation of random signals and noise in communication system [2** Hrs**]**
   Different categories of Noise. Calculation of Noise Power and Noise Figure, Significance of Noise Figure, The noise bandwidth of a linear time invariant systems and its use in communication.

5. **Noise performance of Analog Communication system [3** Hrs**]**
Signal to noise ratio in linear modulation, synchronous detection of DSB. Signal to noise ratio for AM & SSB, comparison of DSB, SSB and AM. Signal to noise ratio for FM, SNR improvement using pre-emphasis & de-emphasis networks.

6. **Overview of Pulse Modulation[1** Hr**]**
PAM, PPM,PWM

Text Books:

1. S. Haykin , An Introduction to Analog and Digital communications,4e, Willey Eastern. New York, 1989.
2. B.P.Lathi, Communication systems, oxford series, 4e, 2009

Reference Books:

1. C.W. Couch II. "Digital and Analog Communication Systems" 2e, Macmillan publishing company, New York, 1987.
2. Taub ,D.L.Shelling , Principles of Communication Systems, 2e, McGraw Hill Book Co**.,** 2005.

EC 1410 **Credit: 3 (L-3, T-0, P-0)**

Microprocessors

Questions to be set ***:*** *Eight (Four from each unit). Each question carries 20 marks.*
Questions to be answered ***:*** *Any five selecting at least two from each unit.*

Course Objective: To serve as a course in acquiring knowledge in microprocessor. After the completion of the course, students should be able to understand the working of microprocessors as well as design and analyze microprocessor based circuits.

Pre-requisites: Digital Circuits & Logic Design, PC Hardware and peripherals and Computer Organization & Architecture.

UNIT – I

1. **Introduction to computer:**
   Basic Structure of computer systems, Introduction to general purpose CPU architecture. [1 Hr]

2. **Introduction to 8085:**
   CPU architecture – register organization, 8085 instruction set, addressing modes. Instruction cycle, machine cycle, timing diagrams. [8 Hrs]

3. **Programming using 8085 instruction set** [2 Hrs]

4. **Hardware interfacing :**
   Interfacing memory: Interfacing I/O – memory mapped I/O and I/O mapped I/O [3 Hrs]

5. **Interrupts** [2 Hrs]

6. **Peripherals** :
   Interfacing A/D and D/A converters.
   8257 – Direct Memory Access Controller (DMAC) [2 Hrs]

UNIT – II

7. 8086 architecture and addressing mode. Instructions and assembly language programming. [8 Hrs]

8. Interrupts of 8086. Intel 8086 bus cycles, instruction queue, read/write cycle in MIN and MAX mode, reset operation, wait state, halt state, hold state, lock operation, interrupt processing. DOS interrupt 21 h functions [8 Hrs]

9. Introduction to 80286 , 80386, 80486 & Pentium Microprocessors.[1 Hr]

10. Introduction of 8051 microcontroller [1 Hr]

Text Books:

1. Ramesh Gaonkar, Microprocessor Architecture, Programming and Applications with the 8085, Penram International, , Sixth Edition, 2013.
2. Douglas V.Hall, "Microprocessor & interfacing programming and hardware", Tata McGraw Hill. 2nd Edition,1992

Reference Books:

1. B. Ram, Fundamentals of Microprocessors and Microcontrollers, Seventh Edition, Dhanpat Rai Publications, 2010.
2. . Bary B. Brey, "The Intel Microprocessors: 8086/8088, 80286, 80386, 80486" , Prentice Hall,2nd Edition ,1996.

EC 1461 **Credit : 1.5 (0L+0T+3P hrs/week)**

Analog Electronic Circuits Lab.

Minimum No. of Experiments to be carried out: 12.

Course Objective: To familiarize the students with the electronics circuits design. Students will design and construct various electronic circuits like power supply, oscillators, multivibrator and uses of operational amplifier.

Pre-requisites: Basic Electronics, Electronic Devices And Circuit.

List of Experiments:

Part-I

1. Design of amplifiers: Transistor amplifiers with and without feedback, FET amplifier, I.F amplified transistor, power amplifier.
2. Design of oscillators: RC Phase Shift Oscillator, Wein Bridge Oscillator, Hartley and Colpitts, Crystal Oscillator (using BJTs and FETs).
3. Op-amp linear applications: (Inverting & Non-Inverting Adders, Subtractors)
4. Op-amp linear applications: (Integrator, Precision Amplifier, Voltage to Current and Current to Voltage Converter).
5. Op-amp non-linear applications: (Comparators, Square Wave Generators, Monostable Multivibrators, Precision Rectifier).
6. Function generator using op-amps.
7. Op-amp R-C phase shift and Wein bridge oscillator.
8. Op-amp based D-A converters.
9. Op-amp based active filters.
10. IC voltage regulators (3 terminal fixed, variable and 723 or equivalent).
11. 555 timer: - Astable Multivibrator and Monostable Multivibrator
12. Schmitt Trigger
13. A/D and D/A converter ICs.

Part-II

14. Case Study: Hardware implementation and validation of any basic electronics circuit using PCB (Printed Circuit Board).

EC 1462 **Credit : 1.5 (0L+0T+3P hrs/week)**

Microprocessor Lab.

Minimum No. of Experiments to be carried out: 12.

Course Objective: To give the students the practical implementation and programming knowledge of various circuitries with IC 8085 & 8086 microprocessor and its interfacing. In this subject, students are introduced with various microprocessors and its interfacing related design, flow chart and the 8085 programming concept.

Pre-requisites: Basics of Digital Electronics

Cycle1:(8085 processor)

1. Familiarization with the 8085 micro-processor kit.

2. Binary & BCD addition of two bytes stored in (i) consecutive and (ii) non-consecutive locations.

3. Binary & BCD addition of more than two bytes stored in consecutive locations.

4. Finding difference between two bytes/packed BCDs stored either in

   (i) Consecutive locations and (ii) non-consecutive locations.

5. To check whether a given number is even or odd.

6. To check whether a byte has even parity or odd parity.

7. Conversion of binary to BCD or BCD to binary code.

8. Developing a 8 bit binary up counter using 8 LEDs by interfacing logic controller card.

9. Rotating the shaft of the stepper motor by interfacing the stepper motor control card.

10. Controlling all the signals of ADC(IC-0809) during analog to digital conversion and display the digital o/p at the display section of the MP kit.

Cycle2:(8086 processor)

1. Introduction of Debug to familiar with 8086 processor by developing &executing a small program.
2. Subtraction of two signed bytes.
3. Signed multiplication (with formats **byte × byte =Word, word × word = double word**)
4. Signed division (with formats **word/byte =byte, double-word/word=word**)
5. Displaying “Hello World!” on the screen using INT-21H.
6. Entering a string & after checking for palindrome displaying massage i.e. whether it is palindrome or not using INT-21H.

EC 1463 **Credit : 1.5 (0L+0T+3P hrs/week)**

Digital System Lab.

***Minimum No. of Experiments to be carried out**: 12.*

Course Objective: To give the students the ideas of designing and implementation of digital sequential circuits. In this subject, students are introduced with working of various synchronous and asynchronous digital logic circuits like counters, shift registers, sequence generator, sequence detector etc.

Pre-requisites: Basics of Digital Electronics

List of Experiments:

1. Construction and verification of Flip-Flops
2. Conversion of flip-flops.
3. Design of a mod 16 asynchronous
4. Design of a decade asynchronous up counter
5. Design of a mod 8 asynchronous up/down counter with a control line
6. Design of a mod 16 synchronous up counter using JK FFs
7. Design of a mod 4 synchronous up/down counter with a control line using D FFs
8. Design of a ring counter using D FFs
9. Design of a twisted ring counter using D FFs
10. Design of a ring counter using JK FFs
11. Design of a twisted ring counter using JK FFs
12. Design of a self-correcting counter using D FFs
13. Design of a self-correcting counter using JK FFs
14. Design of different mod counters using IC 74190
15. Construction of shift register in (i) SISO (ii) SIPO (iii) PIPO & (iv) PISO modes
16. Design of a sequence generator using D FFs
17. Design of a sequence generator using IC 7495
18. Design of a sequence detector circuit to detect a particular sequence of input bits

EC 1501 **Credit: 3 (L-3, T-0, P-0)**

Antenna Theory

Questions to be set ***: Eight (Four from each unit). Each question carries 20 marks.***
Questions to be answered ***: Any five selecting at least two from each unit.***

Course Objectives: The main objective of the subject "**Antenna**" is to provide fundamental knowledge in the theory and practice of antenna design and application in wireless communication. The theory of electromagnetic radiation is introduced and the fundamental antenna parameters are explained. Basic antenna measurement techniques are introduced. Classical radiating elements are studied: dipoles/monopoles, loops, apertures, horns, reflectors, microstrip and slot elements, etc. Matching techniques are presented. The principles of analysis and design of antenna arrays are discussed. Special attention is paid to antennas popular in broadband application.

Pre-requisites: Electromagnetic waves, vector calculus

UNIT – I

1. **Fundamentals of Antennas:** 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.[8 Hrs]

2. **Linear Wire and Loop Antennas** : Infinitesimal, small, finite, length and half wave length dipoles, analysis of radiation fields, radiation patterns, radiation resistance, directivity and input impedance of dipoles, dipoles for mobile communication, small circular loop. [6 Hrs]

3. **Conventional Antennas:** Huygens' principle, Horn Antenna, Yagi Uda Antenna, Log Periodic antenna and Parabolic Reflector Antenna. [4 Hrs]

UNIT – II

4. **Microstrip Patch Antenna:** Basic Characteristics, Feeding Methods, Method of Analysis, Design and Analysis of Rectangular and Circular Patch Antennas: Quality Factor, Bandwidth, Efficiency, Coupling, Input Impedance and Circular Polarization. [9 Hrs]

5. **Antenna arrays:** Two elements array, N- element linear array, broadside end fire, phased, binomial, Dolph-Tschebyschef, and determination of array patterns, planar and circular arrays. Microstrip Array antenna. [9 Hrs]

Text Books:

1. C.A. Balanis ,*AntennaTheory: Analysis and Design*, 4th Edition,Wiley Publishers, Jan 2016.
2. J.D. Kraus,Ronald J Marhefka and Ahmad S Khan, *Antennas for all Applications*, Tata McGraw Hill Publishing Co. Ltd., 3rd edition 2008.
3. *Microstrip patch antennas: A Designer's guide*, Springer, 1st edition, 2003.

Reference Books:

1. R.E. Collin, *Antennas and Radio Wave Propagation*, 1e , McGraw Hill Book Co, 1985.
2. KD Prasad, Antenna *and wave propagation*, 3e, Satya Prakashan, 2005.
3. Ramesh. Garg, Prakash Bhartia, InderBahl and ApisakIttipiboon, *Microstrip Antenna Design Handbook*, Artech House Publishers, 2000

EC 1502 **Credit: 3 (L-3, T-0, P-0)**

Linear and Digital Control Systems

Questions to be set *: Eight (Four from each unit). Each question carries 20 marks.*
Questions to be answered *: Any five selecting at least two from each unit.*

Course Objectives:

1. Understanding the mathematical modeling concepts for dynamical systems.
2. Able to find solve the differential equation using Laplace transform method.
3. Interpret the solution of the system and link it with the system performance.
4. Develop the skill for assessing the stability of the dynamical system using various stability tools in time-domain and in frequency-domain.
5. Develop the skill to solve a case based control system problem.
6. Understand the use of controller and compensator for controlling the behavior of the system.
7. Learn the basic concept of digital control system.
8. Able to use the digital control paradigm to assess the stability and solve digital control problem as an application problem.
9. Develop soft computing skill for numerically solving various problems arising in control system problem using MATLAB.
10. Should be able to take up independently project (mini or major) at later pert of the course.

Pre-requisites: Laplace Transform, Fourier Transform, Network Analysis & Synthesis

UNIT – I

1. **Introduction to control systems and system modeling:** Basic elements of control system, open loop control system, closed loop control system, control system terminology, Mathematical models- modeling electrical systems, mechanical system elements, Analogy of electrical and mechanical systems. **[2** Hrs**]**

2. **Transfer Function Representation**: Block diagram representation of systems considering electrical systems as examples -Block diagram algebra – Representation by Signal flow graph (SFG) - Reduction using mason's gain formula, Developing SFG from the given system differential equations, Use of Masons Gain formula for evaluating the overall transfer function from SFG.**[6** Hrs**]**

3. **Time Domain Analysis**: Type and order of the systems, pole-zero plot of the system from given transfer function, time- response computation of second order continuous systems for standard test signals (like unit step) -under-damped, over-damped and critically damped cases), transient specifications of time-domain response, steady-state error analysis, error coefficient and steady state error computation for different types of systems, Generalized steady state error series, Performance Index. **[8** Hrs**]**

4. **Analog Controllers:**, P, I, PI, PD and PID controller analysis for second order systems affecting the system response. **[2** Hrs**]**

UNIT – II

5. **Frequency-domain analysis:** Introduction, determination of various frequency response specifications, second order prototype systems. Polar-plot—Gain Margin and Phase margin computation. **[3** Hrs**]**

6. **Stability Analysis**: The concept of stability – Routh's stability criterion – qualitative stability and conditional stability – limitations of Routh's stability. Root-locus technique—properties and rules for construction, numerical examples. Nyquist stability criterion, construction of Nyquist-plot, stability assessment from the plot. Bode-plot—Gain Margin and Phase margin calculations and corresponding stability assessment. **[9** Hrs**]**

7. **Design of Control systems:** Design specifications, series compensation, phase- lag and phase- lead compensation, lag-lead compensation, different types of compensators, design of lag, lead, lag-lead compensators using root locus and Bode diagrams. **[3** Hrs**]**

8. **State-Space Analysis:** Concepts of state, state variables and state model, derivation of state models from block diagrams, Diagonalization- Solving the Time invariant state Equations, State Transition Matrix and it's Properties – Concepts of Controllability and Observability. **[3** Hrs**]**

Text Books:

1. B.C. Kuo, "Automatic Control Systems", 7th ed., PHI, 1995.
2. K. Ogata – "Modern Control Engineering", 2nd Edition PHI, 1998.

Reference Books:

1. J.C.D. Azzo& C.H. Houpis, "Linear Control System Analysis & Design", 2e, McGraw Hill 1988.
2. Nagrath&Gopal – "Control System Engineering", 4e, NEW AGE 2009.

EC 1505 **Credit: 3 (L-3, T-0, P-0)**

Digital Signal Processing

Questions to be set *: Eight (Four from each unit). Each question carries 20 marks.*
Questions to be answered *: Any five selecting at least two from each unit.*

Course Objective:
The course is intended to give students a clear idea of signal processing methodologies in modern digital devices. The course is divided into two units. The DSP course offers a brief introduction to the digital signal processing tools like discrete time Fourier transform, discrete Fourier transforms and Fast Fourier transforms. These are the scope of unit I. The unit I ended with an introduction to analog filter design. In unit II, the digital filter design technologies are elaborated. At the end of unit II, the basic DSP processors are introduced.

Pre-requisites: Basic signals & systems, Fourier Transforms and Z-Transforms.

UNIT – I

1. **Review of signals and systems:** Basic signals, Importance of impulse response, Types of systems, Sampling, Discrete Time Fourier Transform(DTFT) and its properties. [2 Hrs]

2. **Discrete Fourier Transform:** Definition of DFT, Properties of DFT: Linearity, Circular shift of a sequence, Symmetry properties, Circular convolution, Linear Convolution using DFT, Relation among Z-Transform, DTFT and DFT, Computation of DFT. [5 Hrs]

3. **Fast Fourier Transform:** FFT algorithms-Divide and conquer approach, Decimation in time and Decimation in frequency (radix-2 only), Computation of FFT, Signal Flow Graph. [5 Hrs]

4. **Analog filters Design:** Butterworth, Chebyshev (T-I and T-II) and Frequency transformation. [6 Hrs]

UNIT—II

5. **IIR Filter design:** Comparison between analog and digital filter; Mapping from analog domain to digital domain using Impulse invariance method, Bilinear transformations and Approximation of derivative; Matched z-transform; Design of IIR filters from analog filters. [8 Hrs]

2. **FIR Filter design:** Comparison between IIR and FIR filter; Different types of windows: Rectangular, Bartlett, Hanning, Hamming and Blackman windows; Design of FIR filters using windows; Design of FIR filters using Frequency sampling method; Linear phase FIR filter.[7 Hrs]

7. **Digital Filter structures:** Basic IIR filter structures: Direct forms (I&II), Cascade and parallel realizations. Basic FIR filter structures: Direct form FIR structures.[3 Hrs]

Text Books:

1. John G. Proakis and Dimitris G. Manolakis, *Digital Signal Processing*, 4e, Pearson,2007.

2. A V Oppenheim and R.W Schafer, *Digital Signal Processing*, 1e, Pearson Education, 2015.

3. P. Ramesh Babu, *Digital Signal Processing*, 4e, Scitech, 2010.

Reference Books:

1. Sanjit K Mitra, *Digital Signal Processing:A Computer based Approach*, 4e, Mcgraw Hill Education, 2013.

2. Tarun Kumar Rawat, *Digital Signal Processing*, 2e, Oxford University Press, 2015.

EC 1507 **Credit: 3 (L-3, T-0, P-0)**

Computer Networks

Questions to be set ***: Eight (Four from each unit). Each question carries 20 marks.***
Questions to be answered ***: Any five selecting at least two from each unit.***

Course Objectives:

1. Identify the different approaches towards computer networking
2. Compare and contrast the underlying technologies and
3. Problem solving based on case studies.

Pre-requisite: Probability

UNIT—I

1. **Introduction to computer networks and layered architecture**
   Network Topology, The Layered Architecture (OSI, TCP/IP), Peer-to-Peer Processes, Physical Addresses, Logical Addresses, Port Addresses, Basics of Internet, Switching circuits. [2 Hrs]

2. **Data Link Layer**

   Error Detection and Correction: Checksum-One's Complement, Internet Checksum. Data Link Control-Framing: Fixed-Size Framing, Variable-Size Framing. Flow Control, Error Control, Private addressing. [2 Hrs]
   Data Link Control: Noiseless channels: Simplest Protocol, Stop-and-Wait Protocol.
   Noisy channels: Stop-and-Wait ARQ, Go-Back- N ARQ, Selective Repeat ARQ, Piggybacking. [2 Hrs]
   Multiple Access: Random access-ALOHA, slotted ALOHA, CSMA, CSMA/CD and CSMA/CA. [2 Hrs]

3. **Network Layer**

   Logical Addressing: IPv4 addresses, Address Space, Notations, Classfull Addressing, Classless Addressing, IPv6 addresses Structure, Address Space, Subnets.[2 Hrs]
   Internet Protocol: Internetworking. [2 Hrs]
   Address Mapping, Error Reporting and Multicasting: Mapping Logical to Physical Address, ARP, ICMP, IGMP. [2 Hrs]
   Delivery, Forwarding and Routing: Unicast routing protocols, Intra and Inter-domain Routing, Distance Vector Routing, Dijkstra's Algorithm, Shortest Path Algorithm, Link State Routing-OSPF, Path Vector Routing. [3 Hrs]

UNIT—II

4. **Transport Layer**
   Process to process delivery: Client/Server Paradigm, Multiplexing and Demultiplexing, Connectionless Versus Connection-Oriented Service, Reliable Versus Unreliable. [2 Hrs]

UDP: Well-Known Ports for UDP, User Datagram, Checksum, UDP Operation, Use of UDP. [2 Hrs]
TCP:TCP Services, TCP Features, Segment, ATCP Connection, Flow Control, Error Control, Congestion Control, Process-to-Process Delivery: UDP, TCP. [3 Hrs]
Congestion Control: Open-Loop Congestion Control, Closed-Loop Congestion Control, Three-way-Handshake. [3 Hrs]

5. **Application Layer**
   Protocols SMTP, POP, FTP, HTTP. [5 Hrs]

6. **Application**
   Recent Trends in Protocols, Introduction to mobile IP, Basics of Wi-Fi, Basics of Network Security Authentication, firewalls, digital signatures and certificates.[4 Hrs]

Text Books:

1. Andrew S. Tanenbaum, David J. Wetherall. *Computer Networks, 5e,* Pearson 2014
2. Forouzan, A. Behrouz. *Data communications & networking*, 2e, Tata McGraw-Hill Education 2006.

Reference Books:

1. Stallings, William. *Local Networks*, 3e, Prentice Hall PTR, 1990.
2. James F. Kurose and Keith W. Ross. *Computer Networking: A Top-Down Approach,* 6e, Pearson, 2012.

EC 1508 **Credit: 3 (L-3, T-0, P-0)**

Object Oriented Programming with C++

Questions to be set ***:*** *Eight (Four from each unit). Each question carries 20 marks.*
Questions to be answered ***:*** *Any five selecting at least two from each unit.*

Course Objectives: The student should be able to define the objects and classes. The student should be able to find the various functions. The student should be able to recognize the need of polymorphism and encapsulation. The student should be able to be aware of function overloading. The student should be able to discriminate the various types of inheritance.

Pre-requisites: The basic knowledge of computer fundamentals and experience with a procedural programming language (e.g. C Programming) are expected.

UNIT –I

1. **Introduction[3 Hrs.]**
   Procedure-Oriented programming, Object-oriented programming, Benefits and Application of OOP, Simple C++ program, Tokens, Keywords, constants, Basic data types, User defined data types and Derived data types, Function prototyping, Call by reference.

2. **Overview of OOP in C++[7 Hrs.]**

   Classes, Class scope, Nested classes,Member functions, Nesting of member functions and basic Object-Oriented features (encapsulation), overloading, namespace and using structure and union, Array of objects, Member functions, Friend function, Pointers to members, Constructors, Copy Constructors, Destructors.

3. **Links Lists [4 Hrs.]**
   Operation – Creations, insertion, Deletion, Circular Lists, Doubly Linked List Sorting.

4. **Inheritance [4 Hrs.]**
   Generalization / Specialization of Object Modeling in C++ Pointer, Virtual Functions

UNIT –II

5. **Polymorphism[6 Hrs.]**
   Static and Dynamic Binding, pointers to objects, this pointer, pointers to derived class, Abstract class, Friend function, Virtual functions, Method Overloading, Method Overriding

6. **Type Casting, Exceptions**, **Templates&STL** [**5 Hrs.]**
   C++ cast operators; C++ Exceptions & standard exception classes, Function and Class templates and using STL like containers.

7. **Files/ exception handling [7 Hrs.]**
   Classes for file stream operations, Accessing files, Sequential I/O operations, Random access, Command- line arguments, Exception handling (throw, try, and catch).

Textbooks:

1. Robert Lafore, *Object-oriented programming in C++,* 4e ,Sams Publishing, 2001.
2. Bjarne Stroustrup, The C++ Programming Language, 4e, Pearson education, edition,2013.

Reference Books:

1. Cay Horstmann, *Computing Concepts with C++ Essentials,* 2e, John Wiley & Sons, 1997.
2. John Hubband, *Programming with C++,*2e., Schaum's outline series, McGraw Hill, 2017.

EC 1509 **Credit: 3 (L-3, T-0, P-0)**

Embedded System

Questions to be set **:** Eight (Four from each unit). Each question carries 20 marks.
Questions to be answered **:** Any five selecting at least two from each unit.

Course Objective: The objective of this course is to impart a solid understanding of the role of embedded systems and embedded systems design and development. This course delves into the processes of Real Time Embedded Systems to provide the basic foundation in embedded systems. All detailed basics required are covered.

Pre-requisites: Basic knowledge in Microprocessor Micro controller, operating system and computer networking, Digital Logic, Microelectronics, microprocessor, computer organization, C programming.

Scope: Capable to design embedded product and implement through Real time operating system

UNIT – I

1. **Introduction of embedded system [2 Hrs]**
   Introduction .Definition, Categories of embedded systems, components, requirements of embedded systems, Challenges and issues in embedded system.
2. **Embedded hardware and Firmware Design [8 Hrs]**
   Internal architecture of 8051, Programming and Different interface with 8051, Basic knowledge in ARM , PIC and Digital Signal Processor, Architecture of embedded memory, Basic structure and applications of Latch, Buffer, Crystal , Reset circuit, Watch dog timer, Display unit and key pad.
3. **Case study of embedded system [3 Hrs]**
   Contact less Smart card, SoC for cell phone, Networks on Chip (NoC).
4. **Overview of Linux [5 Hrs]**
   Concepts of Linux Programming, I/O programming, Process and memory management programming, cell programming, development tools, gcc,g++,gdb, GNU.

UNIT – II

5. **Embedded software and tools [5 Hrs]**
   Introduction, Basic features description of Layer model and Kernel operations for general operating system and real time operating system, concept of Task, Process and Thread , Task Scheduling, Tasksynchronization, concept of Semaphores ,interrupt latency, Device driver, inter process communication.

6. **Embedded software development Process [4 Hrs]**

   Embedded software development process, Conversion of ALP and high level language into ROM image, ICE, IDE, Linking and locating software.

7. **Programming in Embedded C** [5 **Hrs**]

   Embedded programming in C for relay, stepper motor, opto-coupler, serial port ,timer, interrupt, project study in C for LCD, Keyboard interfacing, elevator.

8. **Design implementation of Advanced Embedded system [4 Hrs]**

   Java enabled information appliances. Internet of Things, Robotic ARM, Multitasking programming using ARM processor and Micro C/OS II.

Textbooks:

1. Raj Kamal, *Embedded system: Architecture, programming and Design* ,3e, McGraw Hill Education, 2017.
2. Shibu K V, *An introduction to Embedded system*, 2e, McGraw Hill Education India Private Limited, 2017.
3. Mazidi, Muhammad Ali, *The 8051 microcontroller and embedded systems Using Assembly And C, 2e,* Pearson, 2008.

Reference Books:

1. Dreamtech Software Team, *Cracking the Code Programming For Embedded Systems* 1e, Wiley, 2002.

EC 1562 **Credit : 1.5 (0L+0T+3P hrs/week)**

Communication Lab.

Minimum No. of Experiments to be carried out: 12.

Course Objective: To give the students the basic ideas on analog communication. In this subject, students are introduced with topics like filters design using OPAMP and various modulation techniques used in analog communication.

Pre-requisites: signal and systems**.**

Group-1

1. Realization of Band pass filter using Op-AMP
2. Realization of wide Band reject filter using Op-AMP
3. Realization of Notch filter using Op-AMP

Group-2

4. Study of Continous Time Domain signal spectrum using FOURIER spectrum trainer/ Simulation
5. Amplitude Modulation & Demodulation
    a. Simulation (Time Domain/Spectral Characteristics of AM)
    b. Hardware Experiment
6. Frequency Modulation & Demodulation
    a. Simulation(Time Domain/Spectral Characteristics of FM)
    b. Hardware Experiment
7. Pulse Amplitude Modulation & Demodulation
    a. Simulation
    b. Hardware Experiment
8. Pulse Width Modulation
    a. Simulation
    b. Hardware Experiment
9. Pulse Position Modulation & Demodulation
    a. Simulation
    b. Hardware Experiment

Group-3

10. Frequency Division Multiplexing & Demultiplexing
    a. Simulation
    b. Hardware Experiment
11. Time Division Multiplexing & Demultiplexing
    a. Simulation
    b. Hardware Experiment

Group-4

12. Signal Sampling and reconstruction
    a. Simulation
    b. Hardware Experiment
13. Experiments on line coding and decoding of signal.
14. Study of Pulse Code Modulation and Demodulation.
15. a) Delta modulation
    b) Adaptive delta Modulation
    c) Study of Delta Pulse Code Modulation and Demodulation.
16. FSK,PSK, DPSK and QAM Modulation through simulation
17. Study of QAM through hardware kits.

EC 1563 **Credit : 1.5 (0L+0T+3P hrs/week)**

Object Oriented Programming Lab

Minimum No. of Experiments to be carried out: 12.

Course Objective: To give the students the ideas on object oriented programming language. In this subject, students are introduced with topics like class, linked list, stack, pointers etc. After completion of this subject, students are able to develop some system with the knowledge of object oriented programming, able to debug and fix the errors.

Pre-requisites: The basic knowledge of computer fundamentals and experience with a procedural programming language (e.g. C Programming) are expected.

N. B - Experiments should be chosen as per the coverage of the theory subject.

List of Experiments:

A. The Basic Language

1. Programs with range of different built in data types, loops.
2. Programs with one dimensional array, two dimensional arrays.
3. Program with sorting techniques: Bubble sort, Insertion sort, Selection sort.
4. Programs with string manipulating functions.
5. Programs with Pointer.
6. Programs with Functions: Call by value and call by reference.

B. Procedural- Based Programming

7. Programs with structure and union.
8. Programs to maintain employee record using structure.

C. Object –Based Programming

9. Programs with Class and objects, Array of objects.
10. Program with Linked List: insertion and deletion of nodes.
11. Programs with function overloading, passing object as arguments.
12. Programs with class and constructors/destructors.
13. Programs with linked list using C++.
14. Programs with operator overloading by member functions.
15. Programs with Friend functions, operator overloading by friend functions.
16. Programs with different types of inheritances.
17. Programs with Polymorphism, Abstract class, runtime polymorphism.
18. Programs with template functions.
19. Programs with template classes.

EC 1564 **Credit : 1.5 (0L+0T+3P hrs/week)**

Embedded System Lab.

Minimum No. of Experiments to be carried out: 12 (minimum 9 from Cycle I and 3 from Cycle II)).

Course Objective: To familiarize the students with the basics of VHDL & Verilog programming language. Students will be able to design the digital electronics circuitry, acquire knowledge on above programming language, RTL synthesis, simulation and finally able to implement it on FPGA (**Spartan /Vertex) Board**. Student can also able to write embedded C program for current widely used microcontrollers.

Pre-requisites: Digital electronics.

Programming and Implementation on Spartan /Vertex Board.

List of Experiments:

Ex No **Title of the experiments:**

Cycle-I

0. Introduction to VHDL & Verilog modeling technique and process for writing VHDL & Verilog code, Brief descriptions of FPGA 3e (Spartan /Vertex) Board & Future scope.

1. Write VHDL code for logic gates and using dataflow, behavioral and structural modeling.

2. Design and Write VHDL code for full adder using half adder.

3. Design and Write VHDL code 4:1 Mux using dataflow, behavioral and structural modeling

4. Design and Write VHDL code for 3:8 line decoder using case statement

5. Design and Write VHDL code for 4-2 line encoder.

6. Design and Write VHDL code for 3-bit comparator using 1-bit comparator and basic gates.

7. Design and Write Verilog code for 4-bit parallel adder structural modeling.

8. Design and Write Verilog code for 4-bit parallel adder/ sub tractors using generate statement.

9. Design and Write Verilog code for SR flip flop.

10. Design and Write Verilog code for asynchronous 4-bit UP counter using J-K FF.

11. Design and Write Verilog code for 4 bit register.

12. Design and Write Verilog code for 16 bit ALU.

Cycle-II

13. Write an embedded C program to interface servo motor with ARM processor.

14. Write an embedded C program using PIC microcontroller to interface environment monitoring.

15. Write an embedded C program for an ARM processor to interface camera module showing image processing application.

16 Write an embedded C program for temperature & pressure measurement & to display on LCD display.

17 Write an embedded C program for PWM based speed control of motor using PIC Microcontroller.

18 Write ALP To interface the stepper motor with 8051microcontroller.

19 Write ALP To interface the relay and opto coupler with 8051 microcontroller.

20 Write ALP To interface the keypads and display unit with 8051 microcontroller.

EC 1581

INDUSTRIAL TRAINING I

Sl No	Subject	Objectives	Total Credits
1	Industrial Training/ Industrial Visit I	The students are required either to undergo 2 weeks after 4th semester in the summer break/ Vacation Straining in industries or to attend summer training course on courses beyond the scope of normal curriculum organized by the Department by calling experts from outside or to visit in industry for gaining valuable knowledge.	0.5
		Total Credits	**0.5**

EC 1601 **Credit: 4 (L-3, T-1, P-0)**

Microwave Engineering

Questions to be set ***: Eight (Four from each unit). Each question carries 20 marks.***
Questions to be answered ***: Any five selecting at least two from each unit.***

Course Objective: To understand the basic principles, characteristics and applications of commonly used microwave devices for designing microwave circuits/systems.

Pre-requisites: Students should have previous courses in (a) electro-magnetic and solid state electronics and (b) basic transmission line theory.

UNIT – I

1. **Introduction to Microwave Engineering:** General overview of microwave, Advantages and disadvantages of Microwave. A generic Microwave system. **[2Hrs]**

2. **Transmission lines:** Transmission line equations and their solution for different types, characteristic impedance, reflection coefficient, Transmission lines at high frequencies, standing wave pattern, SWR, Line impedance and Admittance. Introduction to Smith chart. **[9 Hrs]**

3. **Microwave Waveguides:** Rectangular Wave guide- Theory of guided waves and solutions of wave equations in rectangular coordinates, Transverse electric, Transverse magnetic and Transverse electromagnetic waves in conducting planes, characteristics of TE,TM and TEM waves, wave impedance, Reflection of E-M waves, Excitation of modes in rectangular waveguide, characteristics of standard rectangular waveguide. **[13 Hrs]**

UNIT – II

4. **Waveguide Passive Components and their S-matrix Representation:** Properties of S-matrix, Microwave passive components and their S matrix representation: Working principle and application of- Attenuators, Phase shifter, Directional coupler, E-plane Tee, H-plane Tee, Magic tee, Gyrators, Circulators, Isolators. **[6 Hrs]**

5. **Microwave Tubes:** Limitations of conventional vacuum tube devices. Two cavity klystrons, Reflex klystron, Traveling Wave Tube, Magnetron. **[6 Hrs]**

6. **Semiconductor Microwave devices:** TED (Gunn diode) & Avalanche Transit Time (IMPATT) device, Working Principle of: Tunnel diode, Introduction to MMIC. **[4 Hrs]**

7. **Microwave Amplifier Design**: Basic consideration in the design of RF amplifier-Transistor S-parameter, Stability, matching network, noise figure. Brief introduction to NBA, LNA, Link Budget. **[8 Hrs]**

Text Books:

1. Jordan Edward, C Balmain Keith G., *Electromagnetic wave and Radiating System*, 2e, Prentice Hall, 2013.
2. Liao S., *Microwave Devices and Circuit*, 3e, Prentice Hall, 2013.
3. M.L.Sisodia and Vijaylaxmi Gupta, *Microwaves, Introduction to Circuits, devices and antenna,* 1e, New Age Publishers, 2001.

Reference Books:

1. Ryder J., *Networks, lines and Fields*, 2e, PHI, 2007.
2. David M.Pozar, *Microwave Engineering*, John Wiley & Sons, 2e, 2008.
3. Zhouyue Pi and Farooq Khan,"*An Introduction to Millimeter-Wave Mobile Broadband Systems*", IEEE Communications Magazine, pp- 101-107, June 2011.

EC 1604 **Credit: 4(L-3, T-1, P-0)**

Digital Communication

Questions to be set ***:****Eight (Four from each unit). Each question carries 20 marks.*
Questions to be answered ***:****Any five selecting at least two from each unit.*

Course Objective: To give a brief idea about Digital Communication & its related fundamentals. The course entitles major portions namely Digital Sources, Transmitters, Receivers, Nyquist Sampling theory, Quantization & Companding in PCM, Concept of PSK, FSK, DPSK and Information theory & Coding.

Pre-requisites: Analog modulation techniques, probability and random process, and Signal and systems.

UNIT – I

1. **Introduction to Digital Communication Systems** [4 Hrs]:

   1.1. Basic block diagram of Digital communication systems, Basic functionality of each block,
   1.2. Analog to digital conversion technique: Sampling, Quantizing and Encoding
   1.3. Nyquist sampling theory, Spectrum of a sampled signal, Aliasing, Effects of aliasing
   1.4. Reconstruction of sampled signals, Anti-aliasing filter, Interpolation filter.

2. **Waveform coding Techniques** [8 Hrs] :
   2.1. Pulse code modulation(PCM), Block diagram, Transmitter and Receiver, Quantizer, Types of quantizer, Working principle of quantizer, Bandwidth of PCM, Quantization Noise in PCM, Signal to Quantization Noise Ratio, Effect of noise in PCM. Application of PCM. The Differential PCM (DPCM), Adaptive DPCM, delta modulation.
   2.2. Necessity of non-uniform quantizing, Companding, μ-law and A-law.
   2.3. Multiplexing(M) and Multiplexing Access (MA) Techniques: FDM/CDM/SDM and comparison of TDM and TDMA, CDM and CDMA, FDM and FDMA

3. **Base band digital data transmission** [10 Hrs]:

   3.1. Types of Line codes: Unipolar and bipolar NRZ and RZ format, Alternate Mark Inversion (AMI) format, Split phase Manchester code format, Polar quaternary NRZ format.
   3.2. Overview of Wireless Channel: AWGN,Rayleigh, Rician
   3.3. Base band digital communication systems, Intersymbol interference (ISI), Pulse shaping and band width consideration, Raised Cosine filter, Nyquist condition for zero ISI, band limited Nyquist pulses, the eye diagram.
   3.4. Optimum detection of a pulse in additive white noise, Probability of error of Optimum Filter, the matched filter, impulse response of matched filter, Probability of error of matched filter, properties of match filter.
   3.5. Integrate and Dump filter, SNR of integrates and dump filter, Probability of error of integrate and dump filter.

UNIT – II

Pass band digital communication systems

4. **Digital modulation techniques** [7 Hrs]**:**
   Generation and detection of ASK, FSK, PSK, DPSK, QPSK,QAM and MSK; Signal space representation, Bandwidth requirement and probability of error calculation of BPSK and QPSK , concept of BER and throughput

5. **Information Theory and coding**

   Source coding [7 Hrs]:

   5.1. Introduction to Information Theory, definition of information, Information sources, Measure of information, Entropy, Information rate, Shannon's Theorem and Channel capacity.

   5.2. Basic terminologies of Source coding: code length, code efficiency, code rate, Classification of codes: Fixed length code, Variable length code, Distinct code, Prefix free code, Uniquely decipherable code, Instantaneous codes, Optimal codes, Kraft Inequality, Entropy coding: Shannon-Fano coding, Huffman coding,

   Channel coding [8 Hrs]:

   5.3. Basic terminologies of Error control coding: Codeword, Block length, Code vectors, Channel Data rate, Code weight, Code efficiency.

   5.4. Parity coding: Even parity and odd parity, Vertical Redundancy Check (VRC), Longitudinal Redundancy Check (LRC), Check Sum.

   5.5. Linear Block codes: Hamming Codes, Hamming distance, Syndrome decoding, Hadamard code, Cyclic Codes, Convolution coding and Viterbi decoding.

6. **Equalization Techniques** [4 Hrs.]**:**

   Basics followed by Zero forcing, MMSE.

Text Books:

1. S. Haykin , *Communication Systems.* 4e, John Wiley & Sons, 2001
2. H.Taub and C. L. Schilling, *Principles of Communication Systems.* 2e., McGraw Hill Book Co., 1986

Reference Bookss:

1. Lathi B.P., *Modern Digital and Analog Communication Systems*, 3e., Oxford University Press, 1998.
2. Edward A. Lee, David G Messerschmitt, *Digital Communication*, 2e., Kluwer Academic Press, 2005.
3. Sanjay Sharma, *Communication Systems (Analog and Digital),* 5e., S.K. Kataria & Sons, 2013.
4. P. Chakrabarty, *Analog and Digital Communication Systems*, 1e., reprint 2013, Dhanpat Rai & Co.
5. Paul L. Meyer, *Introductory Probability and Statistical Applications*, 2e, Addison Wesley,1980.

EC 1606 **Credit: 3 (L-3, T-0, P-0)**

Java Programming

Questions to be set *: Eight (Four from each unit). Each question carries 20 marks.*
Questions to be answered *: Any five selecting at least two from each unit.*

Objectives: This course offers an introduction to the Java programming language. Basic fundamental topics are considered Also Writing and testing applets for potential inclusion in web pages.

UNIT – I

1. Overview Of Java: Object Oriented Programming, A First Simple Program, Two Control Statements, Using Blocks of Code, The Java Class Library. [3 Hrs.]

2. Data Types, Variables, Array and Operators: Integers, Floating-Point Types, Characters, Booleans, Variables, Type Conversion and Casting, Arrays, Arithmetic operators, Bitwise operators, Relational operators, Boolean Logical operators, Assignment operator, ternary operator, operator precedence. [2 Hrs.]

3.Classes And Methods: Class Fundamentals, Declaring Objects, Introducing Methods, Constructors, Garbage Collection, The finalize () Method, A Stack Class, Overloading Methods, Using Objects as Parameters, Introducing Access Control, Understanding Static, Introducing Nested and Inner Classes, Exploring the String Class, Using Command Line Arguments. [5 Hrs.]

4.Inheritance: Inheritance Basics, Using Super, Creating a Multilevel Hierarchy, Calling Constructors, Method Overriding, Dynamic Method Dispatch, Using Abstract Classes, Using Final with Inheritance, The Object Class. [5 Hrs.]

5. Packages And Interfaces: Packages, Access Protection, Importing Packages, Interfaces. [3 Hrs.]

UNIT – II

6. Exception Handling and [5 Hrs.]:

Fundamentals, Exception Types, Uncaught Exceptions, Using Try and Catch, Java Built-in Exception, Chained Exception, Using Exception,

7.Multithreaded Programming[5 Hrs.]:

Java Thread Model, Main Thread, Creating a Thread, Creating Multiple Threads, Synchronization, Inter-thread Communication, Suspending,
Resuming, and Stopping Threads, Using Multithreading.

8. I/O [4 Hrs.]:

I/O Basics, Reading Console Input, Writing Console Output, Print Writer Class Reading and Writing Files,

9. **Applets**[4 Hrs.]

Applet Fundamentals, java applet life cycle, advantages and disadvantages of applets, application project using applet

Text Book:

1. Herbert Schildt, *Java: The Complete Reference*, 7e, McGraw Hill, 2007.

Reference Books

1. Ken Arnold, James Gosling & David Holmes, *The Java Programming Language*, Pearson Education, 2000.
2. Cay S. Horstmann& Gray Cornell, *Core Java: Vol I & II Fundamentals*, Pearson Education, 2008.
3. Kathy Sierra & Bert Bates, *Head First Java: A Brain-Friendly Guide*, 2e, Shroff, 2009.

EC 1607 **Credit: 3 (L-3, T-0, P-0)**

Microelectronics & VLSI Design

Questions to be set *: Eight (Four from each unit). Each question carries 20 marks.*
Questions to be answered *: Any five selecting at least two from each unit.*

Course Objective: The course is intended to give students a good understanding of MOS transistor and introduction to Scaling of MOS circuits which will help them to design Very Large Scale Integrated circuits. The student will have thorough and in depth knowledge of CAD tools and Physical Design Automation.

Pre-requisites: Digital logic circuits, Basic of transistors, CMOS based digital logic design.

UNIT-I

1. **Introduction to VLSI:** Introduction**,** Design flow, Modern trends in VLSI, Device Scaling and its classifications, short channel effects and remedies. [4 Hrs.]
2. **Combinational and Dynamic Logic circuit:** CMOS inverter, Complex logic circuit, Pass transistors, Transmission gate, Complementary passes logic circuit, Dynamic CMOS circuit, NORA logic, Domino Logic, Pseudo NMOS. [5 Hrs.]
3. **Sequential MOS and Semiconductor Memory**
   CMOS logic circuits (SR latch, D flip flop), ratioed and ratioless Register circuit, DRAM, SRAM, Arithmetic building blocks.[5 Hrs.]
4. **Analog and Low power VLSI circuit** - Single stage amplifier, Differential Stage amplifier, CMOS Op-AMP, calculation of power consumptions.[4 Hrs.]

UNIT-II

5. **Microelectronics process for VLSI:** An overview of clean room, single crystal wafer formation, oxidation, ion implantation and metallization, photolithography.[4 Hrs.]
6. **Basic CMOS technology & Design rule**: n-well, p-well, Silicon on insulator .Stick diagram, with specific examples, layout rules.[5 Hrs.]
7. **Physical design**; Basic concept of Floor paining, Placement and routing methods and their important algorithms. [7 Hrs.]
8. **Design for Manufacturability and Testability:** Basic concept and definitions, Fault types and models, concept of Built in Self Test. **[3** Hrs.]

Text Books:

1. S.M Kang, CMOS Digital Integrated Circuits, Tata McGraw Hill,3e, 2003
2. Behzad Razavi, Design of analog CMOS integrated Circuit , McGraw Hill Education, 3e, 2011
3. S.M Sze, VLSI Technology, McGraw Hill,2e , 2003
4. J. D. Plummer, M D. Deal, P B. Griffin, Silicon VLSI Technology, Pearsons India,2000

Reference Books:

1. Rabaey-Chandrakasan, Digital Integrated Circuits, Pearson,2nd edition,2003.
2. Mead and Conway, Introduction to VLSI systems, , Addison Wesley.
3. Amar Mukherjee, Introduction to NMOS and CMOS VLSI design, PHI.
4. Pucknell and Eshrangian, Basic VLSI Design Systems and Circuits, , PHI

EC 1638 **Credit: 3 (L-3, T-0, P-0)**

Program Elective I- Recent Trends in Electronics and Communication Engineering

Questions to be set **:** *Eight (Four from each unit). Each question carries 20 marks.*
Questions to be answered **:** Any five selecting at least two from each unit.

Course Objective: This course is designed to teach the different use cases of 5G-IoT Communication System. This course contains latest case studies of Advanced Communication System where majority of the Electronics & Communication Engineering core subjects are involved. This course is aimed for providing a complete knowledge of design and development of a implementable embedded system to cater for modern 5G, IoT, IoV Machine to Machine communications to realize a Smart City. This definitely creates interests and motivations in students and in other way, this course will fetch a large scope of job and research opportunities in India as well abroad.

Pre-requisites: Signals & Systems, Digital Signal Processing, Electromagnetic Waves, Antenna, Analog & Digital Communication, Embedded System

UNIT – I

1. **Introduction to 5G-IoT Communication Signals & System**

DSP used in 5G for Enhanced Mobile Broadband (eMBB) Use Cases [2 Hrs]- Orthogonal Frequency Division Multiplexing, Generalized Frequency Division Multiplexing (GFDM), Universal Filtered OFDM, Filter Bank Multi Carrier (FBMC),

Antennas and Electromagnetic Waves For 5G [2 Hrs]- Smart Antenna Beamformation Techniques in 5G

Millimeter Wave, Adaptive Signal Processing and Power Electronics For Enhanced Machine Type Communication Use Cases [4 Hrs]-5G IoT Evolution, Millimeter Wave Communication for 5G IoT Applications, Implementing 5G IoT Using Cognitive Radio, Energy Harvesting and Sustainable Machine To Machine (M2M) Communication In 5G Mobile Technologies

5G Ultra-Reliable and Low Latency Communication (URLLC) Use Cases [4 Hrs]- 5G Wireless and its operating regions, Elements of Ultra-Reliable Communication, Types of Ultra-Reliable Communication Problems, Wireless Reliability Impairments, Ultra-Fast Signal Processing, 5G Ultra-Reliable and Low-Latency System Design, Emerging URLLC Applications- Internet of Vehicles, Tele-Surgery

2. **Data Era: Data Analytic and Security**

Distributed Machine Learning in Big Data Era for Smart City [4 Hrs]- The Stochastic Gradient Descent (SGD) in Parallelization, The Newton Method in Parallelization, The Petuum Framework

Security In Smart Grids [2 Hrs]- Concerns, Trends and Requirements

UNIT II

3. Embedded Systems Towards Smart World from Interfaces to Homes to Cities: Use Cases [6 Hrs]

Smart Energy Monitoring System, Smart Lighting System, Seamless Home Automation System, Future Smart Automotive System

4. **Implementation of 5G-IoT Communication System Through FPGA, DSP and Microprocessor - 'From Test Bed To Commercial'**

5G-IoT Test Bed System [4 Hrs]- Testing 5G Physical Layer Characteristics And Data Throughput, Analyzing 5G Radio Frame Structure, 5G Throughput Calculation, Testing eMBB Using Keysight's 5G Protocol R&D Toolset

Software Defined Radio (SDR) Based System [4 Hrs]- SDR Hardware & Software architecture for LTE IoT system, Wireless Network prototyping using SDR

LTE-IoT Commercial Systems [4 Hrs]- Complementary Narrowband Technologies for Low Power Wide Area IoT Use cases, Commercial LTE IoT device like Qualcomm MDM9206 Flexible LTE IoT chipset platform for Cat - M1 / Cat - NB1 / E-GPRS

Text Books:

1. Constandinos X. Mavromoustakis, George Mastorakis, Jordi Mongay Batalla, Internet of Things (IoT) in 5G Mobile Technologies, Volume 8, Springer International Publishing, Switzerland, 2016
2. Hongjian Sun, Chao Wang, Bashar I. Ahmad, From Internet of Things to Smart Cities-Enabling Technologies, CRC Press, 1e, 2018

References:

1. Mehdi Bennis, M´erouane Debbah and H. Vincent Poor, Ultra-Reliable and Low-Latency Wireless Communication: Tail, Risk and Scale, arXiv:1801.01270 [cs.IT], January 8, 2018
2. Petar Popovski, Ultra-reliable communication in 5G wireless systems arXiv:1410.4330v1 [cs.IT], 16 Oct, 2014
3. He Chen, Rana Abbas, Peng Cheng, Mahyar Shirvanimoghaddam, Wibowo, Hardjawana, Wei Bao, Yonghui Li and Branka Vucetic, Ultra-Reliable Low Latency Cellular Networks: Use Cases, Challenges and Approaches, arXiv:1709.00560 [cs.IT]
4. https://literature.cdn.keysight.com/litweb/pdf/5992-2519EN.pdf?id=2920715
5. https://www.qualcomm.com/system/files/document/files/leading-the-lte-iot-evolution-to-connect-the-massive-internet-of-things.pdf
6. https://www2.ee.washington.edu/events/wns3_2016/slides/Ekbal-presentation.pdf
7. https://www.nutaq.com/picosdr4x4

EC 1661 **Credit : 1.5 (0L+0T+3P hrs/week)**

Digital Signal Processing Lab.

Minimum No. of Experiments to be carried out: 12

Course Objective: To familiarize the students with the digital signal processing task using MATLAB. Students will be able to(i) generate various types of signals (ii) calculate DTFT and DFT of the signals and (iii) design different types of analog and digital filters using MATLAB.
Pre-requisites: Signal and Systems, Digital Signal Processing.

List of Simulations:

1. **Objective1:Generation of Sine wave -** Generation of Continuous and Discrete time Sine wave & its delayed version. Also display the signal spectra.

2. **Objective2: Discrete Time Fourier Transform (DTFT)**

   2.1 Magnitude & phase plot of the sequence $x[n] = u[n], \quad 0 \le n \le 9$ using DTFT.

   1.2 Magnitude & phase of the sequence $x[n] = a^n u[n], \quad 0 \le n \le 9$ using DTFT.

   2.3 Magnitude & phase of the sequence $x[n] = a^n u[n], \quad |a| < 1$ using DTFT.

3. **Objective3: Discrete Fourier Transform(DFT) and Inverse Discrete Fourier Transform (IDFT)**

   3.1 Using MATLAB, determine the K-point DFT U[k] of the following N-point sequence

   $$u[n] = \begin{cases} 1, & 0 \le n \le (N-1) \\ 0, & Otherwise \end{cases}$$

   Assume N=4 and K=8.

   3.2 Using MATLAB, determine the N-point IDFT x[n] of the following K-point sequence

   $$X[k] = \begin{cases} k/K, & 0 \le k \le (K-1) \\ 0, & Otherwise \end{cases}$$

   Assume N=4 and K=4.

4. **Objective4: Design of Analog IIR prototype filter -**Designing of the following prototype (3-dBcutofffrequency at Ω=1 rad/sec) filters with user defined order, maximum allowable ripple and minimum stop band attenuation. Also draw the frequency response curve and pole-zero plot.
   1.1 Prototype Butterworth Filter
   4.1 Prototype Chebyshev Type I Filter
   4.2 Prototype Chebyshev Type II Filter
   4.3 Prototype Elliptic Filter

5. **Objective5: Design of Analog IIR low pass filters–** Designing of following analog IIR low pass filters with user defined pass band and stop band frequencies, maximum allowable pass band ripple and minimum stop band attenuation.

   5.1 Butterworth Filter
   5.2 Chebyshev Type I Filter
   5.3 Chebyshev Type II Filter
   5.4 Elliptic Filter

6. **Objective6: Design of Analog IIR band pass filters–** Designing of following analog IIR band pass filters with user defined pass band and stop band frequencies, maximum allowable pass band ripple and minimum stop band attenuation.

   6.1 Butterworth Filter
   6.2 Chebyshev Type I Filter
   6.3 Chebyshev Type II Filter
   6.4 Elliptic Filter

7. **Objective7: Design of Analog IIR high pass filters–** Designing of following analog IIR high pass filters with user defined pass band and stop band frequencies, maximum allowable pass band ripple and minimum stop band attenuation.

   7.1 Butterworth Filter
   7.2 Chebyshev Type I Filter
   7.3 Chebyshev Type II Filter
   7.4 Elliptic Filter

8. **Objective8: Design of Digital IIR low pass filter –** Designing of following digital IIR low pass filters with user defined pass band and stop band frequencies, maximum allowable pass band ripple, minimum stop band attenuation and sampling frequency.

   8.1 Butterworth Filter
   8.2 Chebyshev Type I Filter
   8.3 Chebyshev Type II Filter
   8.4 Elliptic Filter

9. **Objective9: Design of Digital IIR high pass filter –** Designing of following digital IIR high pass filters with user defined pass band and stop band frequencies, maximum allowable pass band ripple, minimum stop band attenuation and sampling frequency.

   9.1 Butterworth Filter
   9.2 Chebyshev Type I Filter
   9.3 Chebyshev Type II Filter
   9.4 Elliptic Filter

10. **Objective10: Design of Digital IIR low pass filter using BLT–** Designing of following digital IIR low pass filters using bilinear transformation with user defined pass band and

stop band frequencies, maximum allowable pass band ripple, minimum stop band attenuation and sampling frequency.

10.1 Butterworth Filter
10.2 Chebyshev Type I Filter
10.3 Chebyshev Type II Filter
10.4 Elliptic Filter

11. **Objective11: Design of Digital IIR high pass filter using BLT –** Designing of following digital IIR high pass filters with user defined pass band and stop band frequencies, maximum allowable pass band ripple, minimum stop band attenuation and sampling frequency.

11.1 Butterworth Filter
11.2 Chebyshev Type I Filter
11.3 Chebyshev Type II Filter
11.4 Elliptic Filter

12. **Objective12: Design of Digital IIR high pass filter using spectral transformation–** Designing of following digital IIR high pass filters from prototype low pass filter with user defined pass band and stop band frequencies, maximum allowable pass band ripple, minimum stop band attenuation and sampling frequency.

12.1 Butterworth Filter
12.2 Chebyshev Type I Filter
12.3 Chebyshev Type II Filter
12.4 Elliptic Filter

13. **Objective 13: Design of low pass FIR filter using window method –** Designing of low pass FIR filters using the following windows:

13.1 Rectangular window
13.2 Hamming window
13.3 Hanning window
13.4 Blackman window

14. **Objective 16: Design of high pass FIR filter using window method –** Designing of high pass FIR filters using the following windows:

14.1 Rectangular window
14.2 Hamming window
14.3 Hanning window
14.4 Blackman window

EC 1664 **Credit : 1.5 (0L+0T+3P hrs/week)**

VLSI Lab.

Minimum No. of Experiments to be carried out: 12

Course Objective: To familiarize the students with the basics of VLSI Design. Students will be able to design the VLSI circuitry, layout design using EDA tools.

Pre-requisites: Digital Electronics, VLSI.

List of Experiments:

Exp. No	Title of Experiment
0.	Basic concept of stick diagram, layout, layout rule and Familiarization with any layout tools , Design rules & future scope of the Lab.
1.	Design and analysis of CMOS Inverter circuit (Schematic Diagram) with the help of EDA Tools.
2.	Design and analysis of AND gate (Schematic Diagram) with the help of EDA Tools.
3.	Design and analysis of OR gate (Schematic Diagram) with the help of EDA Tools.
4.	Design and analysis of 4:1 Multiplexer (Schematic Diagram) by using Transmission gate with the help of EDA Tools.
5.	Design and analysis of Ex-OR gate (Schematic Diagram) with the help of EDA Tools
6.	Design and analysis of Ex-OR gate (Schematic Diagram) by using Transmission gate with the help of EDA Tools.
7.	Design and analysis of Boolean function (Schematic Diagram) by Pass Transmission gate with the help of EDA Tools.
8.	Design and analysis of Dynamic CMOS (Schematic Diagram) with the help of EDA Tools.
9.	Design and analysis of Domino logic circuit (Schematic Diagram) with the help of EDA Tools.
10.	Design and analysis of NORA logic circuit (Schematic Diagram) with the help of EDA Tools.
11.	Design layout of a Inverter circuit using any equivalent layout tool. Use any standard Design rule
12.	Design layout of an universal logic gate using any equivalent layout tool. Use any standard Design rules.
13.	Validate and Design rule check of CMOS Inverter by using EDA tools.
14.	Validate and Design rule check of CMOS AND gate by using EDA tools.
15.	Familiarization with SPICE CMOS Model parameters.
16.	Using SPICE simulate MOS Inverter with different loads (Specify Cox, μ, VTO, W, L etc. of any standard MOS).
17.	Experimental analysis of transient response for CMOS Inverter in different values of βn/βp.
18.	Using SPICE simulator implement and design differential amplifier.

EC 1671

MINI PROJECT

Sl No	Subject	Objectives	Total Credits
1.	Mini Project	The students are required to undertake innovative and research oriented project under the direct supervision of a faculty member of the department. The mini project should not only to reflect their knowledge gained in the previous seven semesters but also to acquire additional knowledge and skill of their own effort. The mini projects are assigned at the end of the Vth semester and the final evaluation and grades are awarded at the end of VIth semester.	
2.	Mini Project Reviews	The progress is being evaluated in phases through interim seminars/presentations to make the department aware of his/her project.	**1**
3.	Awarded by Project Guide	The Faculty-guide assesses the work of the group(s) working under.	**1**
		Total Credits	**2**

EC1705 **Credit: 3 (L-3, T-1, P-0)**

Mobile Communication

Questions to be set ***:****Eight (Four from each unit). Each question carries 20 marks.*
Questions to be answered ***:****Any five selecting at least two from each unit.*

Course Objectives:

To introduce the concepts of wireless/mobile communication using cellular environment. To make the students know about the various modulation techniques, propagation methods, and multiple access techniques used in the mobile communication. Various Wireless network systems and standards are to be introduced.

Pre-requisites: Should have proper knowledge of Analog and Digital Communication.

UNIT – I: Generic Technologies of Mobile Communication

1. Introduction to Mobile Communication Systems: [5 Hrs.]
   Evolution of mobile communication systems, OFDMA/SC-FDMA, FDD/TDD, Overview of MIMO.

2. Cellular Concept and Mobile Radio Propagation Basic Concepts, Frequency reuse, Channel assignments, handoff, Trunking and Grade of Service, Improving coverage and system capacity. Introduction and basic properties of radio wave propagation, Outdoor and Indoor propagation models, Small scale Multipath propagation and measurements, fading. [10 Hrs.]

3. Overview of Cellular systems- AMPS, GSM, WCDMA/HSPA,CDMA2000, LTE and WiMAX.[7 Hrs.]

UNIT – II: 4G LTE/LTE-Advanced for Mobile Broadband

5. LTE radio access - an overview, Radio interface architecture- an overview.[3 Hrs.]

6. Physical transmission resources. Overall Time–Frequency Structure, Normal Subframes and Mbsfn Subframes, Carrier Aggregation, Duplex Schemes.[5 Hrs.]

7. Downlink physical-layer processing- Transport-Channel Processing, Downlink Reference Signals, Multi-Antenna Transmission, Downlink L1/L2 Control Signaling.[7 Hrs.]

8. Uplink physical-layer processing-an overview[5 Hrs.]

9. Overview of fifth generation mobile communication system [3 Hrs.]

Text Books:

1. Theodore S. Rappaport, *Wireless Communications: Principles and Practice*, 2e, Pearson, 2005.
2. William C.Y.Lee, *Mobile Cellular Telecommunication*, 2e,McGraw Hill International Edition, 1998.
3. E. Dahlman, S. Parkvall, and J. Skold, "4G LTE/LTE-Advanced for Mobile Broadband", Elsevier, 2011.

References:

1. Jochen Schiller,*Mobile Communication*, Addison-Wesley, 2nd edition,
2. MorayRumney,LTE and the Evolution to 4G Wireless Design and Measurement Challenges,Agilent Technologies Publication, 2009
3. 3GPP Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); Multiplexing and channel coding (Release 10)", **3GPP TS 36.212** v10.0.0 (2010-12) http://www.3gpp.org/ftp/Specs/html-info/36-series.htm.3GPP
4. Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); Physical layer procedures(Release 10)", **3GPP TS 36.213** v10.0.0 (2010-12).

BA 1510 (EC, IT & EE) **Credit: 3 (L-3, T-0, P-0)**

Industrial Management

Questions to be set *: Eight (Four from each unit). Each question carries 20 marks.*
Questions to be answered *: Any five selecting at least two from each unit.*

UNIT – I

Philosophy and Development of Management thought. Concept and definition of management, Functions and Roles of Management, Social Responsibilities of Management. Pioneers in Management, Taylor's Scientific Management, Contribution of Henry Fayol, and Mayo.

Process of Management: Functions of Management.
Planning: Nature and purpose of planning objectives, Different types of Plans, steps in planning.
Organizing Principles of organizing, steps in organizing, organizational structure, levels and span of management, departmentation, span of control, formal and informal organization.
Staffing: Manpower planning and recruitment.
Leading: Models and styles of leadership, managerial grid, motivation, interpersonal relations, personality, communication process, types, barriers, effective communication.
Controlling: Concept, nature and purpose, process, methods and practice of control.

Quantitative Techniques in Managerial Decisions: Concept of budget and budgetary control. Time-event network analysis; Break-even Analysis; Decision Tables.

UNIT – II

Production Management: Types of production; Concept of productivity, Types of Planning, Manufacturing Planning; Production planning, Scheduling; Work study & Method Study; Automation.

Materials Management: Practice of purchasing and materials management, quality, quality standards and inspection, sources of supply; pricing principles and practices. Inventory Management, EOQ model; ABC Analysis, Value Analysis and Value Engineering.

References:

1. H. Koontz and H. Weihrich, "Management", McGraw Hill, 1989.
2. Dobler W.D. "Purchasing & Materials Management", TMHC, New Delhi, 1984

EC 1731 **Credit: 3 (L-3, T-0, P-0)**

Program Elective II- Digital Image Processing

Questions to be set *: Eight (Four from each unit). Each question carries 20 marks.*
Questions to be answered *: Any five selecting at least two from each unit.*

Course objective:

To enrich the knowledge of the students with a sound understanding of various techniques of digital image processing. This course will present the fundamentals of image processing, will cover various transforms (e.g.,DFT,DCT and DWT), and many applications, such as enhancement, filtering, segmentation, compression (like JPEG) and image recognition.

Pre-requisites: Signals and Systems, Digital Signal Processing

UNIT – I

1. **Digital Image Fundamentals [2 Hrs.]:** Digital image representation. Elements of a digital image processing system, image model, Sampling and quantization .Basic relationships between pixels and imaging geometry.

2. **Image Transforms [7 Hrs.]:** DFT, DCT, DWT.

3. **Image Enhancement [5 Hrs.]:** Spatial and frequency domain methods, image enhancement by histogram modification, Image smoothing, Image sharpening, Enhancement based on image model.

4. **Image filtering and restoration [4 Hrs.]**: Inverse filter, Wiener filter, Restoration based on degradation model, algebraic approach to restoration.

UNIT – II

5. **Image segmentation [5 Hrs.]:** Detection of discontinuities, Edge linking, and boundary detection, Thresholding Region based segmentation.

6. **Image Data Compression [6 Hrs.]:** Pixel coding, Predictive techniques, Transform coding, Vector quantization, JPEG, JPEG 2000

7. **Applications [7Hrs.]:** Face Recognition, Signature Verification, Iris Recognition, Fingerprint Recognition

Text Books:

1. Rafel C. Gonzalez and Paul Wintz, *Digital Image processing*, 3e, Pearson Education, 2013.

2. Anil K. Jain, *Fundamentals of Digital Image Processing*, 2e, PHI, 2004.

3.William K. Pratt, *Digital Image Processing,* 4e, John Wiley & Sons; 2007.

References:

1. Bhabatosh Chanda andDwijesh DuttaMajumder, *Digital Image Processing and Analysis*, 2e, PHI Learning, 2011.

2. Milan Sonka, Vaclav Hlavac andRoger Boyle, *Image Processing, Analysis and Machine Vision*, 32e, Cengage Learning India Pvt Ltd, 2007.

3. S. Annadurai and R. Shanmugalakshmi, *Fundamentals of Digital Image Processing*, 1e, Pearson Education, 2007

EC 1732 **Credit: 3 (L-3, T-0, P-0)**

Program Elective II- Broadband Communication and Networking

Questions to be set *: Eight (Four from each unit). Each question carries 20 marks.*
Questions to be answered *: Any five selecting at least two from each unit.*

Course Objective:

The course is intended to give students a compact idea of modern communication technologies. The BBCN course offers a brief introduction to the broadband communication technologies, multiple access technologies and single carries Vs multi-carries technologies. The course is divided into two units. The first unit details the 3G communication network which is based on coded single carrier technology. Unit two covers the non-coded multi-carrier technologies and further describes the effect of amalgamation of coded technology with multi-carrier technology for next generation communication networks (beyond 3G).

Pre-requisites: Digital Communication and Digital Signal Processing

UNIT-I

1. **Introduction to CDMA**[5 Hrs.]
   Spread spectrum communication; Radio Access Channel Scheme, Advantages of CDMA; Power Control; Hard Handover; soft hand over; Intersystem handover; Vertical handover.

2. **Introduction to OFDM** [5Hrs.]
   Introduction; advantages of multi-carrier communication; Principle of QAM-OFDM; Modulation by DFT; Basic OFDM Modem Implementation;OFDM system Performance over Gaussian Channels; OFDM Transmission over Wideband Channels.

3. **Introduction to MC-CDMA** [5Hrs.]
   Amalgamating DS-CDMA and OFDM; Types of Multi-carrier CDMA: MC-CDMA, MC-DS-CDMA, MT-CDMA; The frequency selective Channel model; The System Model; Single user detection : maximal ratio combining, Equal Gain combining; Multi-user Detection : maximum likelihood detection.

4. **Broadband Networks** [3Hrs.]
   Introduction to Broadband Integrated Services Digital Network (B-ISDN),DSL/ADSL

UNIT-II

5. **Fading Channels and Diversity Techniques** [6 Hrs.]
   Error/Outage probability over fading channels, Diversity techniques, Multiple antennas in wireless communications

6. **Capacity and Information Rates of MIMO Channels** [6 Hrs.]
   Capacity and Information rates of noisy, AWGN and fading channels, Capacity of MIMO channels, Capacity of non-coherent MIMO channels, Constrained signaling for MIMO communications.

7. **MIMO Coding** [6 Hrs.]
   Transmit diversity with two antennas: The Alamouti scheme; Orthogonal and Quasi-orthogonalspace-time block codes, Bell Laboratories Layered Space-Time coding for MIMO

Text Books:

1. JuhaKorhonen, "Introduction to 3G Mobile Communications", Artech House,1e, Boston, London, 2003.
2. L. Hanzo, M. Munster, B. J. Choi and T. Keller, "OFDM and MC-CDMA for broadband multiuser communications, WLANS and Broadcasting", IEEE- Wiley publications, 2003.
3. BrankaVucetic and J Yuan, Space Time Coding, Wiley.
4. MohinderJankiraman, Space-Time Codes and MIMO Systems,Artech House.

Reference Books:

1. TeroOjanpera and RamjeePrasad ,"Wideband CDMA for 3rd Generation Mobile Communications", Artech House, Boston, 1e, London, 1998.
2. Riaz Esmailzadeh, Masao Nakagawa, "TDD-CDMA for Wireless Communications", Artech House, Boston, London,2e, 2003.
3. Ramjee Prasad, Nee, "OFDM for wireless Multimedia Communications", Artech House, Boston, London, 2e, 2000.

EC 1733 **Credit: 3 (L-3, T-0, P-0)**

Program Elective II- Advance Digital Signal Processing

Questions to be set *: Eight (Four from each unit). Each question carries 20 marks.*
Questions to be answered *: Any five selecting at least two from each unit.*

Course Objective:
The course is intended to give students a clear idea of signal processing methodologies in modern digital devices. The course is divided into two units. In unit I, the topics like Multirate signal processing and Hilbert Transform are elaborated. In unit II, cepstral analysis and Homomorphic deconvolution, power spectral estimation and optimal and adaptive filters are introduced.

Pre-requisites: Signals & Systems, Digital Signal Processing.

UNIT – I

1. Review [2 Hr]

Discrete-Time Signals & Systems, Sampling, DFT, Z-transform, Filter design techniques- FIR, IIR.

2. Multirate DSP [14 Hrs]

The basic sample rate Alteration device, Filters in sampler rate Alteration System, Multistage Design of Decimator & interpolator. The polyphase Decomposition, Arbitrary rate sampler rate converter, Digital filter banks, Nyquist filters, two channel quadrature mirror filter bank, L channel QMF banks, Cosine modulated L- channel filter banks, Multilevel filter bank, STFT, DCT.

3. Discrete Hilbert transforms [2 Hrs]

Real & Imaginary Part, sufficiency of the FT for causal Sequences, Sufficiency Theorems for Finite length Sequences, Relationship between Magnitude & Phase, HT Relation for complex sequences.

UNIT – II

4. Cepstrum analysis & Homomorphic Deconvolution [6 Hrs]

Definition of complex Cepstrum, Homomorphic Deconvolution, Properties of complex Logarithm, Alternative expression for complex cepstrum, The complex cepstrum of exponential sequences, Realization of the Characteristic system, Examples of Homomorphic Filtering.

5. Power Spectral Estimation [4 Hrs]

Estimation of Spectra from Finite Duration Observations of a signal, the Periodogram, Use DFT in power Spectral Estimation, Bartlett, Welch and Blackman, Tukey methods, Comparison of performance of Non-Parametric Power Spectrum Estimation Methods

6. Parametric Method Of Power Spectrum Estimation [8 Hrs]

Parametric Methods for power spectrum estimation, Relationship between Auto-Correlation and Model Parameters, AR (Auto-Regressive) Process and Linear Prediction, Yule-Walker, Burg and Unconstrained Least Squares Methods, Sequential Estimation, Moving Average(MA) and ARMA Models Minimum Variance Method, Piscaranko's Harmonic Decomposition Methods, MUSIC Method.

Text Books:

1. A.V. Oppenheim and R.W. Schaffer, "*Discrete-Time Signal Processing*", 3/e, Pearson, 2014.

2. J.G. Proakis and D. Manolakis, "*Digital Signal Processing*", 4/e, Pearson, 2007.

References:

1. S.K. Mitra, "*Digital Signal Processing-A Computer based approach*", 3/e, McGraw-Hill Education (Asia), 2006.

2. Simon Haykin, "*Adaptive Filter Theory*", 4/e, Pearson, 2012.

3.Samuel D Stearns, "Digital Signal Processing with examples in Matlab. " CRC Press.

EC 1734 **Credit: 3 (L-3, T-0, P-0)**

Program Elective II- Embedded Operating System

Questions to be set ***:*** *Eight (Four from each unit). Each question carries 20 marks.*
Questions to be answered ***:*** *Any five selecting at least two from each unit.*

Course objective: The objective of this course is to impart a solid understanding of the role of embedded operating systems and embedded systems design and development.

Pre-requisites: Embedded System, Digital Logic, Microelectronics, microprocessor, computer organization, C programming.

UNIT – I

1. **Introduction to Embedded Operating System [2** Hrs**] :**
   Definition, Examples, Application areas, categories of embedded operating system, Components, recent trends, communication interfaces and networking capability, programming languages.
2. **Architecture of Embedded Operating System [6** Hrs**] :**
   Hardware architecture-CPU, memory, clock circuitry, Software architecture-services by Operating System, Requirements for Multimedia Applications. Architecture of embedded operating systems, categories of embedded operating systems, application software, communication software.
3. **Embedded / Real-Time Operating System Concepts [10** Hrs**] :**
   Architecture of the Kernel, Process, threads, Task, task scheduler-task states, context switching, scheduling algorithms, Rate Monotonic Analysis, Task management function calls, message queues, Mutex , Interrupt service routines, event registers, pipes, signals, timers, priority inversion problem, Task communication, Task synchronization, case study.

UNIT – II

4. **Overview of Embedded / Real-Time Operating System [8** Hrs**]:**
   Commonalities of the operating systems, portable operating system interface, embedded operating system-Embedded NT, Windows XP embedded, Embedded Linux, Real-time operating systems-VxWorks, System Software, target image creation for Windows XP Embedded, porting RTOS on a Micro-controller based development board.
5. **Programming in RTLinux [4** Hrs**]:**
   Overview of RTLinux, RTLinux modules, creating RT Linux POSIX threads, core RTLinux API, Semaphore management, mutex management.
6. **Programming in Advanced Unix and Embedded C++ [6** Hrs**] :**
   Advanced hardware and firmware based Programming by using Advanced Unix**.** Concept and current industrial oriented different programming examples by using embedded C++.

Text Books:

1. Embedded system –Raj Kamal, Third edition (2017)
2. An introduction to Embedded system-Shibu K V.,TMH, Second edition (2017)
3. The 8051 microcontroller and embedded system Mazidi, Muhammad Ali, Pearson edition (2017).
4. Tanenbaum, A. S., "Operating Systems: Design and Implementation", 2nd Edition, Prentice-Hall, 1996

Reference Books:

1. Programming For Embedded Systems Cracking The Code TM ByDreamtech S/W. Team, Wiley, Pap/Cdr edition (2002).
2. Laplante P. A., "Real-Time Systems Design and Analysis", 2nd Edition, IEEE Press, 1997.
3. Krishna & Shin, "Real-Time Systems", 1st Edition, McGraw Hill, 1997

EC1735 **Credit: 3 (L-3, T-0, P-0)**

Program Elective II- Advanced Electronics devices

Questions to be set *: Eight (Four from each unit).Each question carries 20 marks.*
Questions to be answered *: Any five selecting at least two from each unit.*

Objectives: The course is designed to teach the physical principles and operational characteristics of advanced semiconductor electronic devices with emphasis on metal-oxide systems, high-electron mobility, and field-effect transistors. Topics also include quantum point contact and tunneling devices.
Pre-requisites: Electronic Devices and components.

UNIT-I

MOS Scaling theory, Issues in scaling MOS transistors: channel length modulation, mobility variation, velocity saturation, Punch through, Hot carrier effect, drain induced barrier lowering (DIBL), Gate induced drain leakage (GIDL). [10 Hrs.]

Controlling of short channel effect: Mobility booster-strained silicon technology, Gate leakage reduction-High-k dielectric, Poly depletion elimination- Metal gate. [5 Hrs.]

Advanced Junction Diodes: resonant tunneling diode (RTD). [3 Hrs.]

UNIT-II

Review: Band gap engineering: Homo- and Hetero-structure. Quantum tunnelling, Density of states: 2D, 1D, 0D structure, Quantum well, [6 Hrs.]

Metal-semiconductor field effect transistors (MESFET), Modulation doped heterostructures MODFET. High Electron Mobility Transistor(HEMT). [4 Hrs.]

Multi gate transistor: double gate transistors, FinFET, and Surround gate FET. [4 Hrs.]

Quantum electron transport through nanostructure devices: Coulomb Blockade, Single Electron transistor. [4 Hrs.]

Text Books:

1. Streetman and Banerjee, Solid State Electronic Devices, Paperback – 2015.
2. Donald Neamen and Dhrubes Biswas, Semiconductor Physics and Devices, Paperback – 1 Jul 2017.
3. S. M. Sze and K.K. Ng, Physics of Semiconductor Devices, 3ed Paperback – 2008.

Reference Books:

1. Charles Kittel, Introduction to Solid State Physics, Wiley; Eighth edition (2012).

EC 1736 **Credit: 3 (L-3, T-0, P-0)**

Program Elective II- Information Theory and Coding

Question to be set ***:*** *Eight (Four from each unit). Each question carries 20 marks.*
Questions to be answered ***:*** *Any five, selecting at least two from each unit.*

Course Objective: The course is intended to give students a basic idea of information theory and coding. The course offers different types of source and channel coding technique, channel capacity and bounds, probability of error calculation for different channels.

Pre-requisites: Random variable and Process and , Probability, Linear Algebra

UNIT-I

Information and Sources [4 Hrs]
Definition of Information**,** Properties of Information, Physical interpretation of amount of Information**,** Zero memory information source, Entropy, Properties of Entropy**,** Markov information source**,** Adjoint Source**,** Extensions of a Markov source

Properties of Codes [3 Hrs]
Uniquely decodable codes, Instantaneous cods, Construction of Instantaneous cods, Kraft's Inequality, McMillan's Inequality

Coding Information Sources [4 Hrs]

The average length of a code, Encoding for the special sources, Shannon's First Theorems, Shannon Fano algorithm, Huffman's Codes, r-array compact cods, code efficiency and redundancy.

Channel and Mutual Information [7 Hrs]

Information Channels, probability relation in a channel, apriori and posteriori entropies, A generalization of Shannon's first theorem, Mutual information, properties of mutual information, noiseless and deterministic channels, cascaded channels, channel capacity, conditional mutual information.

UNIT-II

Reliable messages through non reliable channels [5 Hrs]
Error probability and decision rules, The Fano bound, Reliable messages and unreliable channels, An example of coding to correct errors, Hamming distance, Shannon's Second theorem for binary symmetric channel (BSC)-The First step, Random coding-Second Step.

Introduction to Error Correcting Codes [13 Hrs]

BCH Codes : Binary and Nonbinary BCH codes (Reed Solomon codes)

Convolutional codes: Convolutional encoders, and decoding convolutional codes

Turbo codes : Turbo encoders and Iterative turbo decoding

LDPC Codes : Encoding and decoding

Text Books

1. N. Abrahamson, Information Theory and coding. 2e, McGraw Hill, 1963
2. Thomos M.Cover et.al, Elements of Information Theory. 2e, Wiley Series in Telecommunication, 2004.
3. Sarah J Johnson, Iterative error correction. Cambridge University Press, 2010.

Reference Books:

1. R.G. Gallager, "Information Theory and reliable communication" , Wiely Newyork,1e, 1968
2. Richard E. Blahut, "Principles and practices of information Theory" –, Addison Wesley,1e 1987.
3. David Slapian, "Key papers in the development of information theory" , IEEE press, 1e, 1973.
4. Shu Lin et.al, Error Control coding. 2e, Pearson, 2011.

EC 1737 **Credit: 3 (L-3, T-0, P-0)**

Program Elective II – Machine learning

Questions to be set *: Eight (Four from each unit). Each question carries 20 marks.*
Questions to be answered *: Any five selecting at least two from each unit.*

Course Objective: The objective of this course is to provide a concise introduction to the fundamental concepts in machine learning and popular machine learning algorithms. The standard and most popular supervised learning algorithms including linear regression, logistic regression, support vector machines and neural networks with an introduction to Deep Learning. The basic clustering algorithms and feature reduction methods will also be discussed.

Course Outcomes : This will equip the students to apply the machine learning techniques in various domains like speech signal processing, Image and Video Processing, Communications, etc.

Pre-requisites: Probability and Random Process, Linear Algebra, and Optimization Techniques.

UNIT – I

Introduction [2 Hrs]

Basic Definition, Types of Learning: Supervised Learning, Unsupervised Learning and Reinforcement Learning, Examples of Machine Learning Applications.

Linear Regression [4 Hrs]

Linear Regression with Single Variables- Model Representation and Cost Function; Parameter Learning : Gradient Descent, Gradient Descent Intuition, Gradient Descent For Linear Regression

Linear Regression with Multiple Variables- Multiple Features, Gradient Descent for Multiple Variables, Gradient Descent in Practice: Feature Scaling and Learning Rate; Features and Polynomial Regression; Computing Parameters Analytically: Normal Equations, Normal Equations Noninvertibilty

Logistic Regression [4 Hrs]

Classification and Representation- Classification, Hypothesis Representation and Decision Boundary

Logistic Regression Model - Cost Function, Simplified Cost Function and Gradient Descent

Multiclass Classification- One-vs-all

Regularization [2 Hrs]

Solving the problem of Overfitting- The Problem of Overfitting, Cost Function, Regularized Linear Regression, Regularized Logistic Regression.

Support vector Machines [4 Hrs]

Support vector machines, Kernel functions, and Kernel SVM

Dimensionality Reduction [2 Hrs]

Principle component Analysis, Factor Analysis and Linear Discriminant Analysis.

Clustering [2 Hrs]

K-means, Gaussian mixture model, Expectation-Maximization Algorithm

UNIT II

Decision Tree and Ensemble Learning [4 Hrs]

Introduction, Univariate trees, Pruning, Rule extraction from trees, Learning rules from data, Multivariate trees

Overview of Ensemble methods, Types of Ensemble Methods: Bagging, Boosting , Stacking Random Forest

Neural Networks [10 Hrs]

Overview of neural networks, Perceptrons, Activation functions, Multilayer network, backpropagation Algorithm,

Introduction to Deep neural network- Deep learning architectures: Restricted Boltzmann machine, Deep belief network, Autoencoder, Feed forward neural network, Time delay neural network (TDNN), Recurrent Neural Network (RNN), Long short-term Memory (LSTM), Gated Recurrent unit (GRU), Convolutional neural networks (CNN), CNN Architectures (AlexNet, VGG, GoogLeNet, ResNet, etc.), Optimization Algorithms (SGD and ADAM).

Applying Machine learning in practice [2 Hrs]

Deciding What to Try Next, Evaluating a Hypothesis, Model Selection and Train/Validation/Test Sets, Diagnosing Bias vs. Variance, Regularization and Bias/Variance, Learning Curves, Deciding What to Do Next Revisited.

Machine Learning System Design [1 Hrs]

Prioritizing What to Work On, Error Analysis, Error Metrics for Skewed Classes, Trading Off Precision and Recall, Data For Machine Learning

Large Scale Machine Learning [1 Hrs]

Learning With Large Datasets, Mini-Batch Gradient Descent, Stochastic Gradient Descent Convergence, Online Learning, Map Reduce and Data Parallelism.

Text Books:

1. Ethem Alpaydın, *" Introduction to Machine Learning*", 2nd Edition, MIT Press, 2010.
2. Tom M. Mitchell, *"Machine Learning "*, McGraw-Hill Science, 1997.
3. Ian Goodfellow, Yoshua Bengio, Aaron Courville *"*Deep Learning*", MIT Press, 2017*

Reference Books:

1. Christopher M. Bishop, *"Pattern Recognition And Machine Learning"*, Springer 2006
2. Stephen Marsland, *"Machine Learning: An Algorithmic Perspective"*, 2nd Edition, CRC Press, 2015.
3. R. O. Duda, P. E. Hart, and D. G. Stork, *"Pattern classification"*. John Wiley & Sons, 2012.

Journal Papers:

[1] F. Musumeci *et al.,* "An overview on application of machine learning techniques in optical network,*"* *in IEEE Communications Surveys & Tutorials*. Dec. 2018.
URL: https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=8527529

[2] C. Zhang, P. Patras and H. Haddadi, " Deep learning in mobile and wireless networking: A survey *,"* *in IEEE Communications Surveys & Tutorials*. March. 2019.
URL: https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=8666641

[3] Deng, L., "A tutorial survey of architectures, algorithms, and applications for deep learning," *APSIPA Transactions on Signal and Information Processing*, vol. 3, e2, pp.1-29, 2014.

[4] Weibo Liu, et al., "A survey of deep neural network architectures and their applications," *Neurocomputing*, vol. 234, 2017, pp. 11-26.
URL: https://www.sciencedirect.com/science/article/pii/S0925231216315533

[5] Litjens, Geert, et al. "A survey on deep learning in medical image analysis " *Medical image analysis*, vol. 42, 2017, pp 60-88.
URL: https://www.sciencedirect.com/science/article/pii/S1361841517301135

[6] Qingchen Zhang, Laurence T. Yang, Zhikui Chen, Peng Li, "A survey on deep learning for big data," *Information Fusion*, vol. 42, 2018, pp. 146-157.
URL: shttps://www.sciencedirect.com/science/article/pii/S1566253517305328

[7] M. Mohammadi, A. Al-Fuqaha, S. Sorour and M. Guizani, "Deep learning for IoT big data and streaming analytics: A Survey, " in *IEEE Communications Surveys & Tutorials*, vol. 20, no. 4, pp. 2923-2960, 2018.

[8] V. Sze, Y. Chen, T. Yang and J. S. Emer, "Efficient processing of deep neural networks: A Tutorial and Survey," in *Proceedings of the IEEE*, vol. 105, no. 12, pp. 2295-2329, Dec. 2017.

[9] F. Richardson, D. Reynolds and N. Dehak, "Deep Neural Network Approaches to Speaker and Language Recognition," in *IEEE Signal Processing Letters*, vol. 22, no. 10, pp. 1671-1675, Oct. 2015.

EC 1738 **Credit: 3 (L-3, T-0, P-0)**

Program Elective II- Power Electronics

Questions to be set ***: Eight (Four from each unit). Each question carries 20 marks.***
Questions to be answered ***: Any five selecting at least two from each unit.***

Course Objective: To enrich the knowledge of the students with a sound understanding of basic characteristics of power electronics devices, voltage converters, Inverters, regulated power supplies, controlled rectifiers and power conditioners.

Pre-requisites: Basic idea on electrical and electronics components.

UNIT – I

1. **Power Electronic devices and circuits** [9 Hrs.] :

   SCR: Turn on and Turn off mechanisms, device ratings, safe operating area, secondary breakdown, protection and snubber circuits, gate/base, driver circuits.

   Power MOSFET: Basic operation, configuration, switching characteristics

2. **DC-DC switch mode converter topologies** [4 Hrs.] :

   Buck, Boost, Buck-Boost: Basic operation, analysis and design

3. **DC-AC switches mode inverters** [5 Hrs.] :

   Requirements of single phase and three phase systems, single phase inverter, Sinusoidal PWM inverter, three phase inverters.

UNIT – II

4. **Switched mode DC power supplies** [6 Hrs.] :

   Forward converter, Fly back converter, Half bridge and Full bridge converter power supplies.

5. Basics of Power conditioners and Uninterruptible power supplies (UPS). [2 Hrs.]

6. **Single Phase Controlled rectifiers**: Half controlled and Full controlled, Dual converters and Cyclo-converters. [10 Hrs.]

Text Books:

1. M.H. Rashid, *Power Electronics Circuits, Devices & Applications*, 3e, Pearson, 2014.
2. P. S. Bimbhra, *Power Electronics,* Khanna Publishers, 2012.

Reference Books:

1. N. Mohan, T.M. Undelane& W.P. Robbins, *Power electronic Converters, Applications & Design*,3e, John Wiley & Sons, 2002.
2. K. Hari Babu,*Power Electronics,* Revised Edition, Scitech Publications, 2009.
3. G.K. Dubey& C.R.K. Asarabada, *Power Electronic Devices*, IETE book series Vol I, TMH, 1993.

EC 1739 **Credit: 3 (L-3, T-0, P-0)**

Program Elective II- Radar Systems and Signal Processing

Questions to be set *: Eight (Four from each unit). Each question carries 20 marks.*
Questions to be answered *: Any five selecting at least two from each unit.*

Course Objective:

1. To understand matched filter.
2. Detection of Radar signals in noise.
3. Radar waveforms.
4. Pulse compression techniques.

Course Outcomes:

1. Design Radar systems specially Automotive radar in different noise environment.
2. Detection of targets in noise environment.
3. This course provides foundation for more advanced work in detection theory adaptive signal processing.

Pre-requisites: Analog and digital communication systems, DSP

UNIT – I
A: GENERALIZED RADAR Framework

1. Range equation & matched filter [5 Hrs]

Radar Block Diagram, Radar Equation, Information Available from Radar Echo, Radar Range Performance– General Radar Range Equation, Radar Detection with Noise Jamming, Beacon and Repeater Equations, Bi-static Radar.

Matched filter Receiver – Impulse Response Frequency Response Characteristic and its Derivation, Matched Filter and Correlation Function, Correlation Detection and Cross-Correlation Receiver. Efficiency of Non-Matched Filters, Matched Filter for Non-White Noise.

2. Signal models [2 Hrs]

Amplitude model: Radar cross section, Statistical description,
Clutter: Noise model, Signal to Noise ratio, jamming.
Frequency models: Doppler shift
Spatial Models: Variation with angel cross range multipath

3. Sampling and quantization of pulsed radar signals [7 Hrs]

Domain criteria for sampling radar signals , sampling in the fast time dimension , Sampling in slow time ,Sampling the Doppler spectrum, spatial and angel dimension , Quantization.

Radar Waveforms: Waveform Matched filter of moving targets Ambiguity function, Pulse burst Waveforms.

Frequency Modulated pulse compression wave forms: Introduction, significance, Types:
Linear FM Pulse Compression – Block Diagram, Characteristics reduction of Side lobes, Stretch Techniques. Generation and decoding of FM Waveforms-block, schematic and characteristics of passive system, digital compression.

4. Doppler processing [3 Hrs]

Moving Target Indication: Pulse cancellers, matched filters for clutter suppression,
Blind speeds Pulse Doppler processing: DFT of moving targets, Sampling of DTFT, Fine Doppler estimation. Pulse pair processing .

Detection Fundamentals: Neynan-Pearson Detection Rule, Threshold Detection of radar signals

5. **Phase coding techniques [3 Hrs]**

Principles, Binary Phase Coding, Barker Codes, Maximal Length Sequences (MLS/LRS/PN), Block Diagram of a Phase Coded CW Radar. Linear FM and Frequency Coding Techniques: Principles, Linear FM pulses, Generation and Decoding, Distortion effects on LFM Signals, Discrete Frequencies, Waveform Analysis, Capabilities, Resolution properties of Frequency Coded Pulses

Poly Phase Codes: Frank Codes, Costas Codes, Non-Linear FM Pulse Compression, Doppler Tolerant PC Waveforms – Short Pulse, Linear Period Modulation (LPM/HFM). Side lobe Reduction for Phase Coded PC Signals.

UNIT – II

B: AUTOMOTIVE RADAR Framework

6. **Automotive Radar Reviews [4 Hrs]**

Introduction, Automotive radar classification, Basic automotive radar estimation problems: Range estimation, Velocity estimation, Direction estimation

Radar waveforms, Advanced estimation techniques: ML estimation, Super resolution techniques, MIMO radar, Target tracking problem

7. **Automotive Radar Target Tracking by Kalman Filtering [2 Hrs]**

Introduction, signal processing structure, experimental results,

8. **Automotive Radars: System-Level Considerations [2 Hrs]**

Automotive Radar Spectra, Ultra-Wideband Radar Architectures, Radar System-Level Specifications

9. **A 22–29-GHz UWB Pulse-Radar Receiver Front-End [3 Hrs]**

Receiver Architecture , Circuit Design, 22–29-GHz UWB Neutralized LNA, Quadrature Mixers and Baseband VGAs, Pulse Formation, Measurement Results

10. **Single-Chip Dual-Band 22–29-GHz/77–81-GHz [3 Hrs]**

BiCMOSTransceiver , Dual-Band Transceiver Architecture , Transceiver Implementation, Receiver, Transmitter, Dual-Band Frequency Synthesizer, Baseband Pulse Generator, Measurement Results

11. **Case Study [6 Hrs]** ARTRAC Project, Advanced Radar Tracking and Classification for Enhanced Road Safety:- THE ARTRAC SENSOR and THE ARTRAC ARCHITECTURE, Report on demonstrations of ARTRAC vehicles.

Text Books:

[1]Mark. A. Richards, “Fundamentals of Radar Signal Processing”, TMH, 2005.

[2] https://ieeexplore.ieee.org/document/7870764

[3] https://ieeexplore.ieee.org/document/6704439

[4] Vipul Jain · Payam Heydari, “Automotive Radar Sensors in Silicon Technologies”, Springer Science + Business Media New York 2013.

[5] http://artrac.tutech.eu/index.php/page/Documents-2012-04-05.html

References:

[1]Fred E. Nathanson, “Radar Design Principles: Signal Processing and the Environment”, 2nd ed., PHI, 1999.

[2]Peyton Z. Peebles Jr, “Radar Principles”, John Wiley, 2004.

[3]R. Nitzberg, “Radar Signal Processing and Adaptive Systems”, Artech House, 1999.

[4]F.E. Nathanson, “Radar Design Principles”, 1st ed., McGraw Hill, 1969.

[5]M.I. Skolnik, “Introduction to Radar Systems”, 3rd ed., TMH, 2001.

EC 1740 **Credit: 3 (L-3, T-0, P-0)**

Program Elective II- Digital Computer Architecture

Questions to be set ***:****Eight (Four from each unit). Each question carries 20 marks.*
Questions to be answered ***:****Any five selecting at least two from each unit.*

Course objective:

1) To familiarize the students with the various architecture of digital computers and its evolution.

2) To design the various units of a computer like execution unit, control unit, memory unit, and I/O unit.

3) To teach the fundamentals of parallel processing.

Pre-requisites: Digital electronics and assembly programming.

UNIT-I

1. **Basic structure of computers**: computer types, functional units, basic operational concepts, bus structure, software, performance, multiprocessors, multicomputers, historical perspective, latest CPU, GPU in use, comparison of computer CPU and mobile phone CPU. [4 Hrs.]

2. **Number representation & binary operations**: Machine instructions and programs: numbers, signed arithmetic operations, memory locations and addresses, memory operations. [3 Hrs.]

3. **Machine Instructions and Program**: Instructions and instruction sequencing, addressing modes, assembly language, basic input/output operations, stacks and queues, subroutines. [3 Hrs.]
4. **Arithmetic**: addition and subtraction of signed numbers, design of fast adders, multiplication os positive numbers, signed operand multiplication, fast multiplication, integer division, floating point numbers and operations. [6 Hrs.]

5. **System Software**: Language translators, Assembles-compilers, Interpreters, Linker loaders, text editors and formatters, Operating systems [2 Hrs.]

UNIT- II

6. **Basic processing unit**: some fundamental concepts, arithmetic logic operation, fetch, execution of complete instruction, multiple bus organization, hardwired control, microprogrammed control. [5 Hrs.]

7. **The memory system**: some basic concepts, semiconductor RAM memories, ROM, speed, size and cost, cache memories, performance considerations, virtual memories, memory management requirements, secondary storage. [5 Hrs.]

8. **I/O organization**: Accessing I/O devices, Interrupts, DMA, Buses, Interface circuits, Standard I/O interfaces. [4 Hrs.]

9. **Parallel processing**: Basic concepts, Flynn's classification and structural classification, performance considerations ,principles of pipelining structures, Array processors-Multiprocessors, Data flow computers, vector processors, general concepts RISC. [4 Hrs.]

Text Book:

1. V. Carl Ramcacher, Z. Vranesic& S. Zaky – "Computer Organisation" McGraw Hill international Edition, Computer science series 2011fifth Edition.

Reference Books:

1. J.P. Hayes- Computer architectures and Organisation – 2nd Ed. McGraw Hill, 1988.
2. KHWang& F.A. Briggs: computer Architecture & Parallel Processing, Mc. Graw Hill 1984.

EC 1741 **Credit: 3 (L-3, T-0, P-0)**

Program Elective III- Multimedia Communication System

Questions to be set ***:*** *Eight (Four from each unit). Each question carries 20 marks.*
Questions to be answered ***:*** *Any five selecting at least two from each unit.*

Course Objective:

The Enhanced Mobile Broad Band (eMBB) in the form of 3D video, Virtual reality, Augmented reality and others, is the current technology trends by exploring the use of multimedia in communication system. The course is intended to give students a clear idea of Multimedia Communication methodologies in modern digital communication system. The course is divided into two units. The Multimedia Communication course offers a brief introduction to the advanced tools like overview of source coding, source models, scalar and vector quantization theory, Audio Compression, Image Compression, and Video Compression. These are the scope of unit I. To keep pace with the current revolutionary multimedia uses in communication systems like DVB, VSAT and 5G Communication systems, Unit-II is formulated.

The students can satisfy the industry requirements of the present trends of eMBB after successful completion of the course to enjoy better employments.

Pre-requisites: Basic signals & systems, Digital Signal Processing and Digital Communication

UNIT – I

1. **Multimedia compression** [4 Hrs]: Introduction, Special features of Multimedia – Graphics and Image Data Representations -Fundamental Concepts in Video and Digital Audio –-Need for Compression – Overview of source coding, source models, channel coding, channel models.
2. **Text, Audio, Image Compression** [6 Hrs]: Compaction techniques – Huffmann coding – Arithmetic coding, Application to audio coding – MPEG audio, speech compression techniques, Transform Coding – JPEG Standard – Sub-band coding algorithms: Design of Filter banks

3. **Video Compression** [8 Hrs]: Video compression techniques and standards – MPEG Video Coding I: MPEG – 1 and 2, MPEG Video Coding II: MPEG – 4/H.264 (HD), Video Coding III: High Efficiency Video Coding (HEVC)/ H.265 (UHD)

UNIT—II

4. **Multimedia Systems in DAB and DVB[9 Hrs]:** DAB**,** DVB-T, DVB-C/C2, DVB-S/S2, VSAT systems and broadcasting of Digital Signals, Digital Television, and TV Monitor as Multimedia Terminal.

5. **Multimedia Systems in 5G Mobile [9 Hrs] :** 5G Waveforms and numerology, Basics of 5G Hybrid Beamformation, 5G Full Dimension-MIMO and Channels, mmWave 5G Communication, Multimedia used in 5G Systems.

Text Books:

1. Yun Q.Shi, Huifang Sun: Image and Video Compression for Multimedia Engineering - Fundamentals, Algorithms & Standards, CRC press, 2003.

2. Peter Symes : Digital Video Compression, McGraw Hill Pub., 2004.

3. Jonathan Rodriguez, Fundamentals oF 5G Mobile Networks, 1e, John Wiley & Sons, Ltd., 2015

4. U. Reimers. DVB: The Family of International Standards for Digital Video Broadcasting, Second Edition, Springer.2001

Reference Books:

1. Mark S. Drew, Ze-NianLi : Fundamentals of Multimedia, PHI, 1e, 2003.

2. Watkinson,J : Compression in Video and Audio, Focal press,London.1995.

3. Jan Vozer : Video Compression for Multimedia, AP Profes, NewYork, 1995.

4. Athanasios G. Kanatas, Konstantina S. Nikita, Panagiotis (Takis) Mathiopoulos, New Directions in Wireless Communications Systems: From Mobile to 5G, CRC Press, 2017.

5. GourKarmakar, Laurence S. Dooley, Mobile Multimedia Communications: Concepts, Applications, and Challenges, Information science reference, Hershey, New Work.

6. Khalid Sayood : Introduction to Data Compression, Morgan Kauffman Harcourt India, 2nd Edition, 2000.

7. David Salomon : Data Compression – The Complete Reference, Springer Verlag New York Inc., 2nd Edition, 2001.

8. Markus Rupp (Editor), Video and Multimedia Transmissions over Cellular Networks, Analysis, Modeling and Optimization in Live 3G Mobile Communications, Wiley.

EC 1742 **Credit: 3 (L-3, T-0, P-0)**

Program Elective III- Internet of Things

Questions to be set ***:*** *Eight (Four from each unit). Each question carries 20 marks.*
Questions to be answered ***:*** *Any five selecting at least two from each unit.*

Course Objective:

The course is focussed to give a vision and introduction to IoT Technology. This course will provide the knowledge of IoT Gateway, Cloud and its access. It also highlights the basic architecture of BIG DATA solution, Radio Frequency Identification system, Near-field Communication system in relevance to the IoT market perspective. The students will be able to grow the expertise in data and knowledge management methodologies after pursuing this course. The course is dedicated towards the realization of 'Connected Society' : Smart Cities and Smart World. The future Industry trends is highly inclined with the aspect of the outcomes of this course. So, after completion of this course, the students will be able to get a huge scope of jobs in this domain.

Pre-requisites: Computer Networks and Digital Signal Processing

UNIT-I

1. **IoT basics**[6 Hrs.]

   Introduction to Internet of Things, Physical Design of IOT, Logical Design of IOT, IOT Enabling Technologies, IOT Levels.IoT system components, IoT Devices, IoT Gateways, Cloud Access, Cloud Components.

2. **Big Data**[4Hrs.]

   What is Big Data (BD).Modern Corporate's need of BD Strategy. Main components of Big Data Solution. Basic Architecture of BD Solution. Introducing Hadoop.

3. **Short-Range Wireless**[8 Hrs.]

   Introduction to: Near-field communication (NFC); Radio-frequency identification (RFID)
   Thread – Network protocol based on the IEEE 802.15.4 standard, similar to ZigBee, Bluetooth low energy (BLE); Light-Fidelity (Li-Fi); Body area Networks – BAN, Z-Wave, Wireless HART, ISA 100, Interoperability in IoT.

UNIT-II

4. **5G based IoT Under Medium and Long-Range Wireless**[8 Hrs.]

   Overview on 6LoWPAN,Low Power Wide Area Networks (LPWANS), Overview On 5G IOT, Low-power Consumption, Enhanced Coverage, Ultra-reliable Low-latency Communications Massive Number of Devices, Application Scenarios of LPWANs :

LoRaWAN, Sigfox, NB- IoT, TSN, EtherCAT, MODBUS, The NB-IOT deployment scenarios. Recent NB-IoTdeveices.

5. **IoT Networking Protocols [4Hrs]**
   MQTT, CoAP, AMQP, XMPP

6. **Towards 'connected Society' : Smart Cities and Smart World**[6 Hrs.]
   Smart Home, Connected Vehicle, Smart Agriculture, Smart Healthcare, Smart Grid.

Text Books:

1. Pethuru Raj and Anupama C. Raman, *The Internet of Things: Enabling Technologies, Platforms, and Use Cases*, 1/e, CRC Press, Taylor & Francis Group, 2017.
2. Vijay Madisetti, ArshdeepBahga, *Internet of Things A Hands-On- Approach*,2014, ISBN:978 0996025515
3. Hongjian Sun, Chao Wang, Bashar I. Ahmad*, From Internet of Things to Smart Cities: Enabling Technologies*, CRC Press, Taylor & Francis Group, 2018.

Reference Books:

1. Adrian McEwen, *Designing the Internet of Things*, Wiley Publishers, 2013, ISBN: 978-1-118-43062-0

2. Daniel Kellmereit, *The Silent Intelligence: The Internet of Things*. 2013, ISBN 0989973700

3. NB-IoT : Enabling New Business Opportunities- Building A Better Connected World, Huawei http://bookgedebook.tk/downloads/nb-iot-enabling-new-business-opportunities-huawei.pdf
4. Mishra S., Bhutia S.D., Akhtar N., Dhar S., "*Cloud-Based Multilayer Telemedicine Architecture: A Case Study*" in: Advances in Communication, Devices and Networking. Lecture Notes in Electrical Engineering, vol 537. Springer, Singapore, Bera R., Sarkar S., Singh O., Saikia H. (eds) (2019)

EC 1743 **Credit: 3 (L-3, T-0, P-0)**

Program Elective III- Satellite and Optical Communication Systems

Questions to be set *: Eight (Four from each unit). Each question carries 20 marks.*
Questions to be answered *: Any five selecting at least two from each unit.*

Course Objectives: To understand the basic principles/concepts and apply them for the analysis, design and development of systems including measurement.
Pre-requisites: Students should have previous knowledge of microwave engineering and optoelectronics.

UNIT I

1. Satellite Communication:

Introduction to satellite communication systems, Orbital Mechanics & Launchers, Spacecraft subsystems, AOCS, TT&C, Space Craft antennas, Equipment reliability, and Multiple access: TDMA, FDMA, CDMA, Estimation of Channel Requirements, SPADE, Immarsat System, Demand access in INTEL, sat TDMA Subsystem, Earth Station technology, Design of antennas, Tracking, Equipments for earth station, Direct Video Broadcasting, DTH technology.

UNIT II

2. Optical Communication:

Optical sources- LED and laser diode- Principles of operation, concepts of line width, phase noise, switching and modulation characteristics. Optical detectors- pn detector, pin detector, avalanche photodiode- Principles of operation, concepts of responsivity, sensitivity and quantum efficiency, noise in detection, typical receiver configurations (high impedance and trans-impedance receivers.)

Coherent systems- Homodyne and heterodyne systems, coherent systems using PSK, FSK, ASK and DPSK modulations, related noise effects, performance degradation induced by laser phase and intensity noise, degradation induced by nonlinear effects in fiber propagation.

Optical amplifiers- semiconductor amplifier, rare earth doped fiber amplifier (with special reference to erbium doped fibers), Raman amplifier, Brillouin amplifier- principles of operation, amplifier noise, signal to noise ratio, gain, gain bandwidth, gain and noise dependencies, inter modulation effects, saturation induced crosstalk, wavelength range of operation.

Text Books:

1. Leonid Kazovsky, Sergio Benedetto and Alan Willner: "Optical Fiber Communication Systems", Artech House, 1996.
2. John Senior: "Optical Fiber Communications", Second Edition, PHI, 1992.
3. SilvelloBeti, Giancarlo De Marchis and Eugenio Iannone: "Coherent Optical Communications Systems', John Wiley, 1995.
4. G.P.Agarwal: "Nonlinear fiber Optics", Second edition, Academic Press, 2000.
5. Pratt, Bostian : "Satellite Communications" Johnwiley& Sons- 2002.

References:

1. Gred Keiser: Optical Fiber Communications (3rd Ed.), McGraw Hill, 2000.
2. John Gowar: Optical Communication Systems (2nd Ed.), Prentice Hall, 1993.

EC 1744 **Credit: 3 (L-3, T-0, P-0)**

Program Elective III- Speech Processing

Questions to be set ***:****Eight (Four from each unit). Each question carries 20 marks.*
Questions to be answered ***:****Any five selecting at least two from each unit.*

Course Objective: To enrich the knowledge of the students with a sound understanding of various techniques of speech processing. It begins with the human speech production mechanism and then goes on to the fundamental parameters of speech such as pitch frequency, formants, spectral features like log spectrum, 3-D spectrogram, cepstral features, MFCC, linear prediction coefficients, transform-domain parameters, etc. It deals with applications like speech coding, speech enhancement, speaker and language recognition, speech recognition, text to speech synthesis, and the overview of state of the art techniques like DNN for speech processing.

Pre-requisites: Signal and System, Digital Signal Processing, Probability and Random Process.

UNIT- I

1. **Introduction to Speech Processing** [8 Hrs.]

   Human Speech production mechanism and its digital model, Place and Manner of Articulation, Windowing, Pre-emphasis filter, STFT, Spectrogram. Auditory perception: psycho acoustics

2. **Feature Extraction** [10 Hrs.]

   Prosodic features:-Energy contour, Pitch contour, and Syllable duration, Voiced /Unvoiced detection using Energy and Zero crossing Rate, AMDF and Pitch.

   Acoustic features:- LPC- Basic Principles of linear predictive analysis, Auto correlation method, Solution of LPC equations using Durbin's Recursive algorithm, Cepstral analysis of Speech, MFCC, Shifted Delta Cepstral.

UNIT – II

3. **Statistical Modeling Techniques** [8 Hrs.]

   K-means clustering and Vector quantization, Gaussian mixture Modeling, Hidden Markov modeling, Dynamic time warping, GMM mean supervector, Joint factor analysis (JFA), i-vector.

4. **Channel Compensation Techniques [2 Hrs]:** Joint factor analysis (JFA), Linear Discriminant Analysis (LDA), Within-class covariance normalization (WCCN), Nuisance Attribute Projection (NAP)

5. **Classifiers [3 Hrs]**: Cosine distance scoring, Support vector machine, Gaussian PLDA, Generative Gaussian model, Logistic regression, Deep Neural network (DNN)
6. **Application of speech processing** [6 Hrs.]

   Speech Coding (LPC Vocoder, CELP), Speech Enhancement, Speaker and Language recognition, Automatic Speech Recognition, Text to Speech Synthesis

Text Books:

2. Thomas F, Quatieri, Discrete-Time Speech Signal Processing, Prentice Hall Pearson Education,2004.
3. Douglas O'Shaughnessy, Speech communication: human and machine, Addison-Wesley Pub.Co.,1987
4. L.R. Rabiner and B. H. Juang, Fundamentals of Speech Recognition, Prentice Hall,1993.

Reference Books:

1. Ben Gold and Nelson Morgan, Speech and Audio Signal Processing, John Wiley and Sons Inc., Singapore, 2004
2. L.R.Rabiner and R.W.Schaffer – Digital Processing of Speech signals – Prentice Hall - 1979
3. J.R. Deller, J.H.L. Hansen and J.G. Proakis, Discrete Time Processing of Speech Signals, John Wiley, IEEE Press, 1999.

EC 1745 ***Credit:*** 3 (L-3, T-0, P-0)

Program Elective III- Detection and Estimation Techniques

Questions to be set *: Eight (Four from each unit). Each question carries 20 marks.*
Questions to be answered *: Any five selecting at least two from each unit.*

Course Objective: In this course both hypothesis testing and estimation theory are covered. The course starts with a review of probability distribution, multivariate Gaussians and Central limit theorem. Unit I covers the detection techniques like simple and composite hypotheses test, Bayes, Minimax and Neyman-Pearson formulations, detection of deterministic signals. In unit II detection of random signals, Bayesian and Non Bayesian estimation of parameters are discussed.

Pre-requisites: Probability Theory.

UNIT – I

1. Review of probability theory [4 Hrs.]

Basics of Random variable and Random Process, Expectation, Covariance, pdf of multivariate Gaussian distribution, Central limit theorem.

2. Statistical Decision theory [8 Hrs.]

Binary Hypothesis test: Bayesian, Minimax, Neyman-Pearson, Composite Hypothesis test, Likelihood ratio test, Kullback-Leibler divergence.

3. **Detection of Deterministic Signals** [6 Hrs.]

Matched filter detector and its performance; generalized matched filter; detection of sinusoid with unknown amplitude, phase, frequency and arrival time, linear model.

UNIT – II

4. **Detection of Random Signals** [6 Hrs.]

Estimator-correlator, linear model, general Gaussian detection, detection of Gaussian random signal with unknown parameters, weak signal detection.

5. Bayesian Estimation (Estimation of random parameters) [6 Hrs.]

Least Square Estimation (LSE), Minimum Mean Square Error (MMSE) Estimation, Linear MMSE, Minimum Mean Absolute Error (MMAE) Estimation, Maximum A Posteriori (MAP) Estimation.

6. Non-Bayesian Estimation (Estimation of unknown parameters) [6 Hrs.]

Sufficient statistics, Bias, Cramaer-Rao Lower Bound (CRLB), Maximum likelihood (ML)

Text Books:

1. Steven M. Kay, "*Fundamentals of Statistical Signal Processing, Volume I: Estimation Theory*", 1e, Prentice Hall, 1993.

2. Steven M. Kay, "*Fundamentals of Statistical Signal Processing, Volume II: Detection Theory*", 1e, Prentice Hall, 1998.

3. H. Vincent Poor, "*An Introduction to Signal Detection and Estimation*", 2e, Springer, 1998

Reference Books:

1. Harry L. Van Trees, "*Detection Estimation and Modulation Teory, Part I : Detection Estimation and Filtering Theory* ", 2e, Wiley, 2013.

2. Mourad Barkat, "*Signal Detection and Estimation*", 2e, Artech House, 2005.

EC 1746 **Credit: 3 (L-3, T-0, P-0)**

Program Elective III- Photonic Devices and Circuits

Questions to be set *: Eight (Four from each unit).Each question carries 20 marks.*
Questions to be answered *: Any five selecting at least two from each unit.*

Course Objectives:

Photonics deals with light generation, amplification, guiding, manipulation and detection for harvesting information. This course provides an introduction to the fundamental principles governing the operation and design of coherent light sources and detection tools. Photonic devices lie at the heart of the communications revolution, and have become a large and important part of the electronic engineering field.

Pre-requisites: Basic Electronics, Semiconductor Physics, Electronic Devices and Circuits, Analog Electronics.

UNIT-I

1. Introduction. [4 Hrs.]

Energy bands in solids, Electronic properties of semi conductors - effect of pressure and temperature on band gap, Semiconductors, carrier concentrations, Work function, Excess carrier in semiconductors, density of carriers in intrinsic and extrinsic semiconductors. Consequence of heavy doping, conduction processes in semiconductors, electron-hole pair formation and recombination. PN junction, carrier recombination and diffusion, injection efficiency, heterojunction, internal quantum efficiency, double heterojunction, quantum well, quantum dot and super lattices

2. Modulation of Light [6 Hrs.]

Optical proprieties of semiconductors-Excitation absorption, donor-acceptor and impurity band absorption, long wavelength absorption, Birefringence, Optical activity, Electro-optic effect, Materials exhibiting electro-optic effect, Kerr modulators, Magneto-optic devices – Faraday effect.

3. Semiconductor optoelectronics [8 Hrs.]

Semiconductor lasers and light-emitting diodes: LED: Radiative transition, Emission spectra, Luminous efficiency, Band-to-band optical transitions. LASERs: introduction, Threshold conditions, Laser losses; Lineshape function, Doppler broadening, Collision broadening, Natural broadening, Population inversion and pumping threshold conditions, Laser modes, Mode locking, Q-switching.

UNIT-II

4. Display Devices [8 Hrs.]

Luminescence – Photoluminescence, Cathodoluminescence, Electroluminescence; Injection luminescence and light emitting diode – Radiative recombination processes: Interband transitions, Impurity center recombination, Exciton recombination; LED materials, LED construction, Plasma displays, Liquid crystal displays, Numeric displays, Optoelectronics modulation and switching devices-Analog and Digital modulation. EO, AO and MO modulators, SEED.

5. Photodetectors [5 Hrs.]

Photodetectors- Thermal detectors, photoconductors, Junction photodiodes, APD, phototransistor, Modulated barrier PD, Schottky Barrier PD. MSM PD. Detectors for long wavelength operation, microcavity PD, Reverse saturation current in photodetector, Solar cells- I-V characteristics and spectral response,Ideal conversion efficiency, Fill factor, Equivalent circuit, Voc, Isc and Load resistance, Materials and design considerations of solar cells.

6. Applications of Photonic devices [5 Hrs.]

Light extraction from LEDs, Semiconductor lasers, Laser applications, Holography and its applications, Photon devices – Photoemissive devices, photodiodes, Photomultipliers, Optical Backbone communication system

Text Books:

1. Pallab Bhattacharaya, *Semiconductor Optoeletronic Devices*, PHI., 1997
2. Wilson & Hawkes, *Optoelectronics: An introduction*, Prentice Hall India, 1998
3. Smith, F.G. & King, T.A., *Optics and Photonics: An introduction*, John Wiley, 2007

Reference Books:

1. A.Yariv, *Optical Electronics*, Oxford University Press., 2007
2. J. M. Liu, *Photonic Devices*, Cambridge University Press., 2009
3. K.Iizuka, *Elements of Photonics*: *Vol. I and II*, John Wiley., 2002
4. Jasprit Singh, *Semiconductor Optoelectronics: Physics & Technology*, Tata Mc Graw Hill., 1995

EC 1747 ***Credit: 3 (L-3, T-0, P-0)***

Program Elective III- Adaptive Signal Processing

Questions to be set ***: Eight (Four from each unit). Each question carries 20 marks.***
Questions to be answered ***: Any five selecting at least two from each unit.***

Course Objective: To enrich the knowledge of the students with a sound understanding of various techniques of adaptive signal processing. This course will present the basic principles of adaptation; will cover various adaptive signal processing algorithms (e.g., LMS, RLS), linear optimal filters (like Wiener) and many applications, such as adaptive noise cancellation, channel equalization and to the Cognitive radio.

Pre-requisites: Signal and System, Digital Signal Processing, Probability and Random Process.

UNIT – I

1. Introduction to Adaptive Filters [4 Hrs.]

Adaptive filter structures, issues and examples.
Applications of adaptive filters (Channel equalization, Noise Cancellation, Echo Cancellation, beam forming, etc.)

2. Stationary Processes and Models [8 Hrs.]

Review of random variables and Random Process, Expectation, Mean Ergodic theorem, Correlation matrix of a stationary discrete time stochastic process and its properties, Stochastic models, Asymptotic stationarity of an autoregressive process, Yule-Walker Equations, Power spectral density and its properties.

3. Wiener Filters [6 Hrs]

Problem statement, Principle of Orthogonality, Minimum mean square error, Wiener Hopf equations, Error Performance Surface, Example.

UNIT – II

4. Linear Prediction [5 Hrs]

Forward Linear Prediction, Backward Linear Prediction, Levinson- Durbin Algorithm, Cholesky Factorization, Predictive modeling of Speech.

5. **Linear Adaptive Filtering [9 Hrs]**

Review of Eigen value and Eigen vectors, Singular value decomposition, Pseudoinverse.

Steepest-Descent Algorithm, Least Mean Square (LMS) algorithm, Normalized LMS Algorithm, Recursive Least squares (RLS) algorithm and their examples.

6. **Kalman Filter** [**6 Hrs**]-Problem statement, The Innovations process, Filtering

Text Books:

1. Simon Haykin, *Adaptive Filter Theory*,4e, Pearson Education, 2008.

2. Ekram Hossain and Vijay Bhargava, *Cognitive Wireless Communication Networks*, Springer, 2007.

Reference Books:

1. Bernad Widrow, Adaptive Signal Processing , 1e, Pearson Education, 2007.

2. Dimitris G. Manolakis, Vinay K. Ingleand Stephen M. Kogon, *Statistical & Adaptive Signal Processing*, Artech House Signal Processing Library, 2005.

3. Tulay Adali and Simon Haykin, *Adaptive Signal Processing: Next Generation Solutions*, Wiley-IEEE Press, March 2010.

EC 1748 **Credit: 3 (L-3, T-0, P-0)**

Program Elective III- Wireless Sensor Network

Questions to be set ***: Eight (Four from each unit). Each question carries 20 marks.***
Questions to be answered ***: Any five selecting at least two from each unit.***

Course Objective: To understand and explore wireless sensor networks and its applications for human kind.
Pre-requisites: Students should have previous knowledge of transducers, communication engineering and computer networks.

UNIT-I

Module-I: Introduction to Sensor Networks, unique constraints and challenges, Advantage of Sensor Networks, general Applications of Sensor Networks. [4 Hrs.]

Module-II: Comparison of Mobile Adhoc Networks (MANETs), Vehicular Adhoc Networks (VANET) and Wireless Sensor Networks (WSN), Enabling technologies for Wireless Sensor Networks. [4Hrs.]

Module-III: Sensor Node Hardware and Network Architecture, Single-node architecture, Hardware components and design constraints, Operating systems and execution environments, introduction to TinyOS and nesC, Network architecture, Optimization goals and figures of merit, Design principles for WSNs, Service interfaces of WSNs, Gateway concepts.
[10 Hrs.]

UNIT-II

Module-IV: Deployment and Configuration, Localization and positioning, Coverage and connectivity, Single-hop and multihop localization, self-configuring localization systems, sensor management, Handover in WSN. [6Hrs.]

Module-V: Network Protocols, Issues in designing MAC protocol for WSNs, IEEE 802.15.4 standard and Zig Bee, Dissemination protocol for large sensor network, Routing protocols for WSN. [6Hrs.]

Module-VI: Role of WSN in IoT, WSN for Habitat Monitoring, Environment Monitoring, Mine safety and monitoring, smart agriculture, Industrial WSN, Green WSN. [6Hrs.]

Text Books :

1. Holger Kerl, Andreas Willig, *Protocols and Architectures for Wireless Sensor Network*, John Wiley and Sons, 2005, ISBN: 978-0-470-09511-9

2. Raghavendra, Cauligi S, Sivalingam, Krishna M., ZantiTaieb, *Wireless Sensor Network*, Springer,1e, 2004, ISBN: 978-4020-7883-5.

3. Waltenegus Dargie, Christian Poellabauer, *Fundamentals of Wireless Sensor Networks: Theory and Practice*, Willey, 2010, ISBN 978-0-470-99765-9.

Reference Books:

1. Ibrahiem M. M. El Emary, S. Ramakrishnan, *Wireless Sensor Networks: From Theory to Applications*, CRC Press, 2016, ISBN 9781138198821

2.Kazem, Sohraby, Daniel Minoli, TaiebZanti, *Wireless Sensor Network: Technology, Protocols and Application*, John Wiley and Sons,1e, 2007 ,ISBN: 978-0-471-74300-2.

EC 1749 **Credit: 3 (L-3, T-0, P-0)**

Program Elective III- Software Defined Network

Questions to be set ***: Eight (Four from each unit). Each question carries 20 marks.***
Questions to be answered ***: Any five selecting at least two from each unit.***

Course Objective: A paradigm shift in the use cases of 'mobile broadband' to 'connected smart society' in the form of IoT and Smart Cities enabling technologies is noticed by the society. Three enabling technologies using the LTE and 5G mobile are i)eMBB ii)MTC and iii)URLLC. The more flexibilities in both the Network as well as Physical layers are being introduced in the heterogeneous network (HetNet) in the name of Cloud RAN, SON and SDN. The Mobile Service Providers all over the world including India are engaged in this technological evolution by implementing all the above.

The course is intended to give students a clear idea of the above technologies. The Unit I will discuss the generic technology overview of individual technology whereas, in Unit II, the individual technologies are combined together to have the idea of total system. Thus the integrated system is aiming for the final enriched experience of the user in high speed GIGABIT internet access using a combined 4G /5G mobile.

Pre-requisites: Digital Communication, Computer Networks.

UNIT – I

1. Cloud RAN

Cloud RAN (C-RAN) Basics, Architecture Components, System Structures, Advantages of C-RAN, Virtualization in C-RAN, Network Functional Virtualization in C-RAN, Challenges of C-RAN.

2. **Software Defined Network**

History and Evolution of Software Defined Networking (SDN), Overview of Control Plane and Data Plane, Active Networking, Open Flow protocol, Concept of Network Virtualization, implementation using SDN.

UNIT – II

3. Adaptive SON and Smart LPN for 5G Heterogeneous Networks:

Introduction to Self-organization network, Need of Self-organization, Cognitive Radio and Compressed Sensing, Compressed Sensing Background, Compressed Sensing of Analog Signal, Parallele Segmented Compressed Sensing Structure (PSCS), Joint Signal Reconstruction, Simulation Example.

Channel Modelling:
Software Designed Cloud Data Center Simulation –Goals and Requirements, Framework Design---Cloud Sim Core Logic, Abstracting Physical and virtual Topology, Network Modules, Calculating packet Transmission Time, Abstracting User Requests, GUI Modules,

Validation with Mininet Setup, Testbed Configuration.Introduction to Smart Low power node.

4. Intelligent SDN and NFV for 5G HetNet Dynamics:

Envision of 5G Mobile Networks, Overview of Heterogeneous Networks
5G Mobile Design Principles, Key Technological Components, Spectrum Consideration, Intelligent SDN Architecture for 5G HetNets, New T Mobile 5G advantage, Radio Resource and Interference Management for Heterogeneous Networks, Capacity and Coverage Enhancement in Heterogeneous Networks , Advanced Heterogeneous Networks.
Necessary Standard Extensions for Enabling 5G:
Preliminaries of Network Function Virtualization (NVF), Software Defined radio(SDR), Software Defined Network (SDN) and an integrated 4G/5G Network architecture, Current Standardization Progress on NVF, SDR, SDN. Requirements of 4G/5G NVF, SDR, SDN, Existing Standard and necessary Extension for NVF, SDR, SDN Enabled Network, Necessary Standard Extension for 4G/5G Network.

5. Case Study of a HETNET

Text Books

1. Thomas D. Nadeau, Ken Gray,*SDN: Software Defined Networks, An Authoritative Review of Network Programmability Technologies*, Thomas D Nadeau, Ken Gray, O'Reilly Media, August 2013, ISBN: 978-1-4493-4230-2, ISBN 10:1-4493-4230-2.

2. Software Defined Networks: A Comprehensive Approach By Paul Goransson, Chuck Black.

3. SDN: Software Defined Networks: An Authoritative Review of Network Programmability Technologies, Book by Ken Gray and Tom Nadeau.

4. HrishikeshVenkatarman and Ramona Trestian, *5G Radio Access Networks: Centralized RAN, Cloud-RAN, and Virtualization of Small Cells*, CRC Press, 2017.

5. Bo Rong (et.al.) *5G Heterogeneous Networks Self-organizing and Optimization*, Springer, 2016.

Reference Books

1. Fei Hu, Network Innovation through OpenFlow and SDN: Principles and Design, CRC Press, ISBN-10: 1466572094, 2014.

2. Paul Goransson and Chuck Black, Morgan Kaufmann,*Software Defined Networks: A Comprehensive Approach*, June 2014, Print Book ISBN: 9780124166752, eBook ISBN : 9780124166844

3. Tony Q. S. Quek(et.al.), *Cloud Radio Access Networks: Principles, Technologies, and Applications*, 1e, Cambridge University Press, 2017.

EC 1750 **Credit:** 3 (L-3, T-0, P-0)

Program Elective III- Data Science for Engineers

Questions to be set *: Eight (Four from each unit). Each question carries 20 marks.*
Questions to be answered *: Any five selecting at least two from each unit.*

Course Objective:

1. To Provide Insights about the Roles of a Data Scientist and enable to analyze the Big Data.
2.ToUnderstand the principles of Data Science for the data analysis and learn cutting edge tools andtechniques for data analysis.
3.Figure Out Machine Learning Algorithms.
4.Learn business decision making and Data Visualization

Pre-requisites: Fundamentals of linear algebra, basic programming skills.

UNIT – I

1. Review of Linear Algebra [5 Hrs]

Linear algebra for data science, solving linear equations, Distance, Hyper planes and half spaces, Eigen values and Eigen vectors.

2. An Introduction to Data Science [6 Hrs]

Definition, working, benefits and uses of Data Science, Data science vs BI, The data science process, Role of a Data Scientist

3. **Statistical Data Analysis &Inference** [7 Hrs.]

Populations and samples, Statistical modeling, probability distributions, fittings a model, Statistical methods for evaluation, Exploratory Data Analysis, Hypotheses testing, Getting started with R programming.

UNIT – II

4. **Learning Algorithms [8 Hrs]**

k-nearest neighbor, Simple and multiple Linear Regression, Logistic Regression, Support vector machine, Model-Based Clustering, Clustering High-Dimensional data, Naïve Bayes, Data Wrangling.

Data.**5. Data Visualization [5 Hrs]**

Data Visualization basics, techniques, types, applications, tools, Data Journalism, Interactive dashboards

6. Business problems and data science solutions [5 Hrs]

Data Science and Business Strategy: Thinking Data Analytically, Redux, Competitive Advantage with Data Science, Data Science Case Studies, Case Study: Global Innovation Network and Analysis

Text Books:

1. Rachel Schutt and Cathy O'Neil, *Doing Data Science*, 1/e, O'Reilly Media, 2013
2. Joel Grus ,*Data Science from Scratch*, 2/e, O'Reilly Media, 2015
3. Foster Provost and Tom Fawcett, O'Reilly,*Data Science for Business*,1/e, O'Reilly Media, 2013

Reference Books:

1. Gilbert Strang , *Introduction to Linear Algebra*, 5/e, Wellesley-Cambridge Press and SIAM, 2016
2. Douglas Montgomery, *Applied Statistics and Probability for Engineers*, 3/e, John Wiley & Sons, Inc., 2003

EC 1721 **Credit: 3 (L-3, T-0, P-0)**

Open Elective I - Industrial IoT and Industry 4.0

Questions to be set *: Eight (Four from each unit).Each question carries 20 marks.*
Questions to be answered *: Any five selecting at least two from each unit.*

Course Objective:

The course is focussed to give a vision and introduction to Industrial IoT Technology. This course will provide the knowledge of Pathways, Gateways and IoT Nodes, Cloud and its access. It also highlights the basic architecture of BIG DATA solution, 5G based Cellular , Satellite and Fiber Communication system in relevance to the IoT market perspective. The students will be able to grow the expertise in data and knowledge management methodologies after pursuing this course. The course is dedicated towards the realization of 'Connected Society' Smart Factories, Smart Health Care, Retail and Logistics, Oil and Gas Industry, Smart Cities, Smart Grid. The future Industry trends is highly inclined with the aspect of the outcomes of this course. So, after completion of this course, the students will be able to get a huge scope of jobs in this domain.

Pre-requisites: Communication Technology and Systems **,** Computer Networks and Digital Signal Processing.

UNIT I

1. Industrial IoT

Introduction to Industrial IoT [5 Hrs]:Introduction, Evolution of Industrial IoT, Key Opportunities and Benefits, Industrial Internet System, Smart Business Models, Cyber Physical Systems, IIoT Reference Architecture.[1-CH1]

2. Introducing Industry 4.0

Defining Industry 4.0, Why Industry 4.0 and Why Now?, Technology drivers for industry 4, [4], The Value Chain, Lean Production Systems, Benefits to Business, Industry 4.0 Design Principles, Building Blocks of Industry 4.0, Industry 4.0 Reference Architecture, SCADA in IIoT. [1. CH13]

3. Advances in Robotics in the Era of Industry 4.0 :

Recent Technological Components of Robots, Industrial Robotic Applications, Internet of Robotic Things, Cloud Robotics, Sets Up Smart Manufacturing Line, iRobot Factory-cognitive manufacturing, Cloud computing in IIoT[2- CH 11, 3]

4. Communication Protocols and Networks:

Wireless Communication Systems: Review of IEEE 802.15.4, Bluetooth Low Energy, ZigBee and ZigBee IP, Z wave,RFID, NFC, 5G-NR, mmWave Communication.
IioTNetworking: -Industrial Ethernet- MODBUS-TCP, EtherCat, Etherner/IP, Profinet, TSN, Fieldbus- MODBUS-RTU, Profibus, CC-Link, InterBus, DeviceNet.
IIoT Network Protocols: LPWAN, LoRaWAN, SIGFOX
Pathways and Gateways for connection of IoT Industrial End Nodes to Cloud:-IOT end Nodes, IoT Gateways, Connection through: i) Fiber and ADSL ii) Cellular Base Station iii) Satellite.Realization of IOT gateways through PATHWAVE based integrated software.

UNIT II

5. Data Analyticsin Industry 4.0

Big data in Industry 4.0,IIoT Data characteristics, challenges, IIoT Analytics- machine learning, Deep learning, Batch Processing, complex event processing (CEP), Processing and Analytics, supervisory control and management, MIDAS (M2M Platform),Big data driven smart manufacturing.

6.Security in IIoT: Security Threats and Vulnerability, Industrial Challenges, Evolution of Cyber attacks, Cyber attack Solution, Strategic principles in cyber security, Security Measures. [2. CH 16]

7: Augmented Reality, Virtual Reality and Additive Manufracturing in the Age of Industry 4.0:

Role of AI in Industry 4.0, Introduction to AR and VR, AR Hardware and Software, Industrial Application of AR, Additive Manufacturing Technologies, Advantages and Disadvantages, Impact of AM Technologies in society. [2-CH13,14]

8: Industrial IoT Use Cases:

Smart Factories, smart agriculture, Smart Health Care, Retail and Logistics, Oil and Gas

Industry, Smart Cities, Smart Grid. [1, CH 14,2], 5G Industrial IoT Use-Cases using Live OTA

5G NR Network

Text Books:

1. Alp Ustundag, EmreCevikcan, Industry 4.0: Managing the Digital Industrial Transformation, Springer Series in Advance Manufracturing, Switzerland, 2018.
2. Alasdin Gilchrist, Industry 4.0: The Industrial Internet of Things, Apress, Bnagken, DOI 10.1007/978-1-4842-2047-4, Thailand, 2016.

References:

1.http://literature.cdn.keysight.com/litweb/pdf/5992-3305EN.pdf

2.http://literature.cdn.keysight.com/litweb/pdf/5992-3469EN.pdf

3.https://www.keysight.com/in/en/cmp/pathwave.html

4.https://www.thefastmode.com/technology-solutions/14484-nokia-qualcomm-power-up-5g-industrial-iot-use-cases-using-live-ota-5g-nr-network

5.https://www.keysight.com/main/facet.jspx?&cc=IN&lc=eng&k=pathwave&pSearch=tnmSearch&hasLuckySearch=true

6. IDC Technologies Industrial Automation © 2012 The IDC Engineers &Ventus Publishing ApS ISBN 978-87-403-0004-8

EC 1722 ***Credit: 3 (L-3, T-0, P-0)***

Open Elective I - Automation and Robotics

Questions to be set *: Eight (Four from each unit).Each question carries 20 marks.*
Questions to be answered *: Any five selecting at least two from each unit.*

Course Objective: To serve as a course in acquiring knowledge in Robotics. After the completion of the course, students should be able to design and analyze automatic robot system. Also they will gather sufficient knowledge to understand the direction of the research activities going on in the field of robot automation.

Pre-requisites: Digital Circuits & Logic Design, Microprocessor, Microcontroller, C++ programming and Computer Organization & Architecture.

UNIT – I

1. Robotics: Classification of Robots, Degree of freedom, Kinematics; Multidisciplinary approach: Motors-DC motors, Stepper Motors, Servo Motors. [4 Hrs.]

2. Robot controls-Point to point control, Continuous path control, Intelligent robot, Control system for robot joint, Control actions, Feedback devices, Encoder, Resolver, Adaptive control, Trajectory planning, Pick and place operations, Continuous path motion, Interpolated motion, Straight-line motion.[5 Hrs.]

3. Introduction to robotic sensors, Range detectors, assembly aid devices, force and torque sensors, machine vision, ranging, laser, acoustic, magnetic, fiber optic and tactile sensors. [5 Hrs.]

4. Case Studies: Home security system, playing robot, Unmanned vehicles, Smart card application.[4 Hrs.]

UNIT – II

5. Introduction: Definition, automation principles and strategies, scope of automation, socio-economic consideration, low cost automation, basic elements of advanced functions. Automated Navigation guidance by vision system. [3 Hrs.]

6. Introduction to Artificial Intelligence and intelligent agents, categorization of AI. Rules for some AI problems: water jug problem, missionaries-cannibals problem etc. Solving problems by searching: state space formulation, depth first and breadth first search, iterative deepening Artificial neural networks. [8 Hrs.]

7. Introduction to machine learning: well posed learning problem, designing a learning system: training experience, target function, final design. Issues in machine learning Concept, Learning and General to specific ordering: concept learning task, concept learning as search, version spaces and candidate elimination, inductive bias. [7 Hrs.]

Text Books:

1. Mikell P Groover, Nicholas G Odrey, Mitchel Weiss, Roger N Nagel, Ashish Dutta, *Industrial Robotics, Technology programming and Applications*, McGraw Hill, 2nd Edition 2012.
2. Fu. K. S., Gonzalez. R. C. & Lee C.S.G., *Robotics control, sensing, vision and intelligence*, 1e, McGraw Hill Book co, 2008.
3. Peter Flach, *Machine Learning: The Art and Science of Algorithms That Make Sense Of Data*, 1e, Cambridge University Press, 2015.
4. Russell, *Artificial Intelligence : A Modern Approach*, 3e, Pearson Education India, 2015.

Reference Books:

1. David A. Forsyth, Jean Ponce, *Computer Vision: A Modern Approach*, Prentice Hall, 2003
2. S.R. Deb, *Robotics Technology and flexible automation*, 2e, Tata McGraw-Hill Education, 2009.

EC 1723 ***Credit:*** *3 (L-3, T-0, P-0)*

Open Elective I – MEMS & NEMS

Questions to be set *: Eight (Four from each unit).Each question carries 20 marks.*
Questions to be answered *: Any five selecting at least two from each unit.*

Course Objective: The objective of this course is to impart a solid understanding of the role of micro and nano systems and its design and development.

Pre-requisites: Basic knowledge in Microprocessor ,Micro electronics, VLSI and embedded system.

Scope: Capable to design MEMS & NEMS product and implement in various industrial applications.

UNIT-1

1.**Introduction to micro-systems** Overview of microelectronics manufacture and Microsystems technology. Definition - MEMS materials. Laws of scaling. The multi disciplinary nature of MEMS. Materials for MEMS manufacturing, Applications of MEMS in various industries.

2. **MEMS manufacturing technologies** : Bulk Micro manufacturing, surface micro machining, LIGA, SLIGA, High aspect ratio (HAR) silicon micromachining, Micro system packaging materials, surface bonding, wire bonding, sealing.

3**. MEMS Devices** Working principle of Microsystems, micro-actuation techniques, micro sensors, Definition, Constructional description, Classification, Working principle, and applications of MEMS Accelerometers and MEMS gyroscopes, RF MEMS, Optical MEMS

4. **MEMS devices for biomedical applications** MEMS Pressure Sensors, MEMS Hearing-Aid Transducer , Micro fluidics for diagnostics, Micro fluidics for drug delivery, Micro machined needles, Microsurgical tools. Modern trends in MEMS.

UNIT-II

5**.Introduction to Nano-systems** Overview of microelectronics manufacture and Microsystems technology. Definition - NEMS materials. scaling, short channel effects - channel engineering - source/drain engineering - high k dielectric - copper interconnects - strain engineering, SOI MOSFET, multigate transistors – single gate – double gate – triple gate – surround gate, quantum effects – volume inversion – mobility – threshold voltage –

inter subband scattering, multigate technology – mobility – gate stack.

6. **Silicon nanowire MOSFETs –** Evaluvation of I-V characteristics – The I-V characteristics for nondegenerate carrier statistics – The I-V characteristics for degenerate carrier statistics – Carbon nanotube – Band structure of carbon nanotube – Band structure of graphene – Physical structure of nanotube – Band structure of nanotube – Carbon nanotube FETs – Carbon nanotube MOSFETs – Schottky barrier carbon nanotube FETs – Electronic conduction in molecules – General model for ballistic nano transistors – MOSFETs with 0D, 1D, and 2D channels – Molecular transistors – Single electron charging – Single electron transistor.

7. **Radiation effects in SOI MOSFETs**, total ionizing dose effects – single-gate SOI – multi-gate devices, single event effect, scaling effects.

8. **Digital circuits** – impact of Nano device performance on digital circuits – leakage performance trade off – multi VT devices and circuits – SRAM design, analog circuit design – transconductance - intrinsic gain – flicker noise – self heating –band gap voltage reference – operational amplifier – comparator designs, mixed signal – successive approximation DAC, RF circuits. Modern trends in NEMS.

Text Books:

1. Tai-Ran Hsu, *MEMS and Microsystems Design and Manufacture*, Tata McGraw-Hill Publishing Company Ltd, 2002.
2. Chang Liu, *Foundation of MEMS,* Pearson Education,2006.
3. Rai Choudhury P., *MEMS and MOEMS Technology and Applications*, PHI Learning Private Limited, 2009.
4. Marc F Madou, *Fundamentals of Micro Fabrication*, CRC Press, 2nd Edition, 2002.
5. J P Colinge, "FINFETs and other multi-gate transistors", Springer – Series on integrated circuits and systems, 2008.
6. Mark Lundstrom, Jing Guo, "Nanoscale Transistors: Device Physics, Modeling and Simulation", Springer, 2006

Reference Books:

1. Francis E.H. Tay and Choong .W.O, Micro fluidics and Bio MEMS application, IEEE Press New York, 1997.
2. Trimmer William S., Ed., *Micromechanics and MEMS,* IEEE Press New York, 1997.

3. Maluf, Nadim, “An introduction to Micro electro mechanical Systems Engineering”, AR Tech house, Boston 2000.
4. Julian W.Gardner, Vijay K.Varadan, Osama O. Awadel Karim, *Micro sensors MEMS and Smart Devices*, John Wiby& sons Ltd., 2001.
5. Mohamed Gadel Hak, *MEMS Handbook*, CRC Press, 2002.
6. Sabrie Solomon, *Sensors Handbook*, Mc Graw Hill, 1998.
7. M S Lundstorm, "Fundamentals of Carrier Transport", 2nd Ed., Cambridge University Press, Cambridge UK, 2000

EC 1724 **Credit:** 3 (L-3, T-0, P-0)

Open Elective I - Nano Electronics

Questions to be set *: Eight (Four from each unit).Each question carries 20 marks.*
Questions to be answered *: Any five selecting at least two from each unit.*

Objectives: The course is designed to teach the physical principles and operational characteristics of semiconductor devices with emphasis on metal-oxide systems and its effect at nanometer range device structure.
Pre-requisites: Semiconductor physics.

UNIT- I

Overview: Nano devices, Nano materials, Nano characterization technique. [2 Hrs.]

Definition of Technology node, Basic CMOS Process flow. [2 Hrs.]

MOS Scaling theory, Issues in scaling MOS transistors : Short channel effects.[4 Hrs.]

MOS capacitor, Role of interface quality and related process techniques, Gate oxide thickness scaling trend, SiO_2 vs High-k gate dielectrics. Integration issues of high-k dielectric . Interface states, bulk charge, band offset, stability. [6 Hrs.]

Germanium Nano MOSFETs : strain , quantization , Advantages of Germanium over Silicon , PMOS versus NMOS. [4 Hrs.]

UNIT- II

Synthesis of Nanomaterials : CVD, Nucleation and Growth, ALD, Epitaxy, MBE. [4 Hrs.]

Thickness measurement techniques: Contact - step height, Optical - reflectance and ellipsometry. AFM. [4 Hrs.]

Characterization techniques for nanomaterials: FTIR, XRD, AFM, SEM, TEM, EDAX etc. Applications and interpretation of results. [6 Hrs.]

Emerging nanomaterials : Nanotubes, nanorods and other nano structures, LB technique, Soft lithography etc. Microwave assisted synthesis, Self assembly etc. [4 Hrs.]

Text Books:

1. V. V. Mitin, Introduction to nanoelectronics: Science, Nanotechnology, Engineering, and Applications, 1e, Cambridge University Press, 2007.
2. G.W. Hanson, *Fundamental of nanoelectronics*, 1e, Pearson Education, 2009.

Reference Books:

1. Suprio datta, Lessons From Nanoelectronics: *A New Perspective On Transport*: Volume 1, World Scientific Publishing Company (23 August 2012).
2. Razali Ismail, Mohammad Taghi Ahmadi, Sohail Anwar, *Advanced Nanoelectronics (Nano and Energy)*, CRC Press; 1 edition (21 December 2012).

EC 1762 **Credit: 1.5 (0L+0T+3P hrs/week)**

Advanced Communication Lab.

Minimum No. of Experiments to be carried out: 12. [Minimum experiments to be done from group1, 2, 3 and 4 are 3, 2, 2 and 3, respectively.]

Course Objective: To familiarize the students with the characteristic of the wireless channel, equalizer system, OFDM, MIMO concept. Students will be able to implement some of the standard communication system and able to do performance analysis of the system.

Pre-requisites: Analog and Digital Communication.

List of Experiments:

Group-1

1. Study of BER Vs. SNR curves and constellation diagram for QPSK, QAM modulation.
2. Design LMS and RLS based adaptive equalizer and study its BER Vs. SNR performance.
3. Design ZF, MMSE and ML receiver and study its BER Vs. SNR performance.
4. Write a programme for CRC encoder followed by its detection at the receiver side.
5. Design convolution encoder and Viterbi decoder and study its BER Vs. SNR performance.
6. Write a programme for plotting the probability distribution function for the Rician, Rayleigh and Nakagami-m Channel. And its impact on the transmitted signal.
7. Design of OFDM based communication system and study its BER Vs. SNR performance.
8. Study of BER Vs. SNR curves for MIMO communication system.

Group-2

9. Study the performance of WiFi System.
10. Study the performance of WiMax System.
11. Study the performance of LTE System.
12. Study the performance of 5G communication System.

Group-3

13. Analog and Digital communication link using optical fiber.
14. Study of Propagation loss, Bending loss and Measurement of Numerical Aperture in OFC.

Group-4

15. Hardware realization of the basic communication system using LabVIEW.
16. Realization of correlation processing in SFF SDR platform.
17. Hardware realization of DTH system.
18. Satellite searching by aligning DTH system and its analysis.

EC 1763 **Credit : 1.5 (0L+0T+3P hrs/week)**

Microwave Lab.

Minimum No. of Experiments to be carried out: 12.

Course Objective: The experiments under this curriculum "**Microwave Laboratory**" are designed for seventh semester students, to present the basic principles, characteristics, and applications of commonly used microwave devices and antennas who have a prior knowledge of electromagnetics, solid state devices and antennas which is covered in their curriculum in previous semesters. This subject explains the techniques for designing microwave circuits which have been increasingly adopted in such diverse applications as radio astronomy, long distance communications, space navigation, radar systems, medical equipment, and missile electronic systems. As a result of the accelerating rate of growth of microwave technology in research and the vital industry, students who are preparing themselves to contribute in this field will get a profound background to understand the theoretical and experimental design and analysis of microwave devices and circuits. Moreover this subject also serves as a backbone to understand some of their vital subjects like satellite communication, mobile communication e.t.c in upcoming semester.

Pre-requisites:

- Basics of co-ordinate systems, vector algebra and calculus are required.
- Should have proper knowledge of Electromagnetic waves
- Profound knowledge of antennas.

List of Experiments:

Cycle 1

1. To study the characteristics of the Reflex Klystron Tube and to determine its electronic tuning range.
2. To determine the frequency and the wavelength in a rectangular waveguide on TE_{10} mode.
3. To measure the performance of E plane Tee, H plane Tee and Magic Tee.
4. To observe the behavioral characteristics of directional coupler.
5. To study V-I characteristics of GUNN diode.
6. To plot the radiation pattern of Folded Dipole Yagi-Uda antennas
7. To study Radiation pattern of Horn antenna.
8. To plot the Radiation Pattern of simple Dipole Yagi-Uda antennas.

Cycle 2

9. To verify the experimental characteristics of phase shifter and circulator with Theoretical study.
10. To design a Band Reject/Band Pass microstrip filter on Software Platform.
11. To design a microstrip patch antenna on Software Platform and visualize its performance parameters.
12. To fabricate an antenna with PCB designing techniques.
13. To measure the return loss, VSWR of an antenna using Vector Network analyser.
14. To measure the return loss and insertion loss of a Band pass filter using Vector Network Analyser.
15. To develop a complete bench set up for microwave experiments.
16. To develop a satellite link as an application of microwave communication.

EC 1781

INDUSTRIAL TRAINING II

Sl No	Subject	Objectives	Total Credits
1	Industrial Training/ Industrial Visit I	The students are required either to undergo minimum of 4 weeks training in industries or to attend summer training course on courses beyond the scope of normal curriculum organized by the Department by calling experts from outside.	1
		Total Credits	**1**

EC1875 **Duration of Project: 16 weeks**

MAJOR PROJECT

The students are required to undertake innovative and research oriented project, not only to reflect their knowledge gained in the previous seven semesters but also to acquire additional knowledge and skill of their own effort. During their major project, the students are required to submit progress of their work in phases to make the department aware of his/her project. At the end of 16 weeks, students have to report to the internal guides/faculty member for final refinement and documentation. It is mandatory to follow software/hardware methodologies in carrying out the project work. The project is evaluated through internal presentation before the panel of faculty members followed by the evaluation by external examiner appointed by the university.

EC 1307 ***Credit: 3 (L-3, T-0, P-0)***

Applied Electronics

Question to be set ***:*** *Eight (Four from each unit). Each question carries 20 marks.*
Questions to be answered ***:*** *Any five selecting at least two from each unit.*

Course Objective **:** To be familiar with the basic building blocks of electronic circuits like diodes, transistors, etc.

Pre-requisites **:** Semiconductor Physics.

UNIT – I

PN Junction Diodes [7]
Introduction to p-n junction diodes-Characteristics, Applications (Rectifiers, Clipper, Clamper). Special Purpose Diodes – Zener diodes, LED, Photo diodes, Opto Coupler, Solar Cell.

BJT (Bipolar Junction Transistors) [6]
Introduction to Transistors-Configuration, Characteristics, Biasing. BJT as an amplifier: Graphical analysis (DC and AC loadline in CE mode only).

FET (Field Effect Transistors) [5]
JFET – Biased JFET, I_D vs. V_{DS} and I_D vs. V_{GS} Curves, JEFT approximations, Depletion mode-MOSFET, Enhancement mode-MOSFET and their characteristics.

UNIT-II

Regulated Power Supply [3]
Linear Mode Regulator using Zener diode and Transistor, Switching Mode Regulators.

OP-AMPS [12]
Non inverting voltage feedback, Open loop and closed loop voltage gains, Input and output impedances, Benefits of negative feedback, Linear Applications:- Differential and Instrumentation Amplifiers, Active filters: - 1^{st} order High pass, Low pass, Band pass, Band reject (Butter-worth filters), Automatic gain control, Summing Amplifiers, Subtractor, Non-Linear Applications:- Half wave rectifiers, Peak Detector, Sample-and-Hold circuit, Comparators, Schmitt Triggers, D-to-A and A-to-D Converter.

555 Timer [3]
Block diagram, Monostable operation, Astable operation, Voltage Controlled Oscillator, PLL.

Text Books:

1. Robert L. Boylestad, Louis Nashelsky, *Electronic devices and circuit theory*, Pearson Education, 11th Edition, 2013.
2. Ramakant Gayakwad, *Opamps & Linear Integrated Circuits*, PHI, 4th Edition, 2004.
3. V S Kanchana Bhaaskaran , Salivahanan, *Linear Integrated Circuits*, Tata Mcgraw Hill Education Private Limited 2nd Edition, 2008.
4. N.N. Bhargava(Late), D.C. Kulshreshtha, Solan S.C. Gupta, Basic Electronics and Linear Circuits, McGraw Hill Education; 2nd Edition, Paperback-1 Jul 2017.

Reference Books:

1. Donald Schilling, Charles Belove, *Electronic Circuits: Discrete and Integrated*, McGraw Hill Education (India) Private Limited; 3rd Edition, 2002.
2. S Salivahanan, N. Suresh Kumar, *Electronic Devices and Circuit*, McGraw Hill Education (India) Private Limited; 3rd Edition, 2012.
3. D. Chattopadhyay, P.C. Rakshit, *Foundations of Electronics*, New Age International Publishers Ltd., 2nd Edition, 2015.
4. Choudhury D. Roy, Shail B. Jain, *Linear Integrated Circuits*, New Age International Publishers Ltd., 4th Edition, 2010.
5. Jacob Millman, Christos Halkias, Chetan Parikh, *Integrated Electronics*, McGraw Hill Education, 2nd Edition, Paperback, 2009.
6. David A. Bell, *Electronic Devices and Circuits*, Oxford Publications, 5th Edition, 2008.
7. Albert Malvino, David Bates, *Electronic Principles*, McGraw Hill Education (India) Private Limited; 7th Edition, 2006.

EC 1364 **Credit: 1.5 (0L+0T+3P hrs/week)**

Applied Electronics Lab.

Minimum No. of Experiments to be carried out: 12.

Objectives: To be familiar with the applications of basic building blocks of electronic circuits, like diodes, transistors, etc.

Pre-requisites: Basic Electronics

List of experiments

1. Diode characteristics: Silicon, Germanium, Zener Diode, determination of static and dynamic resistances.
2. FET characteristics and determination of FET parameters. (μ, r_p, g_m).
3. Frequency response RC coupled amplifier.
4. Design of Voltage series regulator using Zener diode and a transistor and to measure regulation.
5. Design OPAMP circuits to work as: - (i) Inverting & Non-Inverting Adder and (ii) Subtractor.
6. Design OPAMP circuits to work as: - (i) Voltage Follower and (ii) Positive Clamper.
7. Design OPAMP circuits to work as: -(i) Half wave rectifier and (ii) Peak Detector.
8. Design of OPAMP Schmitt trigger for given UTP and LTP and use it to convert sine wave to square wave.
9. Design of OPAMP basedComparator.
10. Design of OPAMPbased Active Filters: - High Pass & Low Pass.
11. Design a 4-bit R–2R ladder DAC using OPAMP.
12. Design of multivibrator using IC 555: - (i) Astable and (ii) Monostable
13. Application of IC 555 as a Voltage Controlled Oscillator (VCO).