

**B.E. ELECTRONICS AND COMMUNICATION ENGINEERING
REGULATION 2018
CHOICE BASED CREDIT SYSTEM
I – VIII SEMESTER CURRICULUM AND SYLLABI**

SEMESTER I							
SL. No.	Course Code	Course	L/T/P	Contact hrs./wk.	C	Ext./Int.	Cat.
THEORY							
1	18MA101	Linear Algebra and Differential Calculus	3/1/0	4	4	50/50	BSC
THEORY CUM PRACTICAL							
2	18PH101	Physics for Electronics	3/0/3	6	4.5	40/60	BSC
3	18EC101	Circuit Theory	3/0/2	5	4	40/60	ESC
4	18CS111	Problem Solving using C Programming	3/0/3	6	4.5	40/60	ESC
LABORATORY COURSE							
5	18ME102	Engineering Practices	1/0/4	5	3	40/60	ESC
MANDATORY COURSE							
6	18MC101	Mandatory Course I (Induction for Three Weeks)	3 weeks				MC
TOTAL			13/1/12	26	20	500	

SEMESTER II							
SL. No.	Course Code	Course	L/T/P	Contact hrs./wk.	C	Ext./Int.	Cat.
THEORY							
1	18MA201	Integral Calculus and Complex Variables	3/1/0	4	4	50/50	BSC
2	18SB201	Engineering Biology	2/0/0	2	2	50/50	BSC
THEORY CUM PRACTICAL							
3	18CH101	Engineering Chemistry	3/0/3	6	4.5	40/60	BSC
4	18EC201	Electron Devices	3/0/3	6	4.5	40/60	ESC
5	18EN102	Technical Communication Skills	2/0/2	4	3	40/60	HSMC
LABORATORY COURSE							
6	18ME111	Engineering Graphics	2/0/2	4	3	40/60	ESC
MANDATORY COURSE							
7	18MC201	Mandatory Course II(Environmental Sciences)					MC
TOTAL			15/1/10	26	21	600	

SEMESTER III							
SL. No.	Course Code	Course	L/T/P	Contact hrs./wk.	C	Ext./Int.	Cat.
THEORY							
1	18MA302	Discrete Transforms and Fourier Analysis	3/1/0	4	4	50/50	BSC
2	18EC301	Digital Electronics	3/0/0	3	3	50/50	PCC
3	18EC302	Electronic Circuits	3/0/0	3	3	50/50	PCC
4	18EC303	Electromagnetics	4/0/0	4	4	50/50	PCC
5	18MG301	Principles of Management	3/0/0	3	3	50/50	HSMC
THEORY CUM PRACTICAL							
6	18CS311	Linux and Programming in C++	3/0/3	6	4.5	40/60	ESC
LABORATORY COURSE							
7	18EC304	Digital Electronics Lab	0/0/2	2	1	40/60	PCC
8	18EC305	Electronic Circuits Laboratory	0/0/2	2	1	40/60	PCC
MANDATORY COURSE							
9	18MC331	Mandatory Course III –Indian Constitution / Indian Traditional Knowledge					MC
TOTAL			19/1/7	27	23.5	800	

SEMESTER IV							
SL. No.	Course Code	Course	L/T/P	Contact hrs./wk.	C	Ext./Int.	Cat.
THEORY							
1	18MA403	Probability Theory and Random Processes	3/1/0	4	4	50/50	BSC
2	18EC401	Analog Integrated Circuits	3/0/0	3	3	50/50	PCC
3	18EC402	Signals and Systems	4/0/0	4	4	50/50	PCC
4	18EC403	Data Communications and Networking	3/0/0	3	3	50/50	PCC
5	18EC404	Analog and Pulse Communication	3/0/0	3	3	50/50	PCC
THEORY CUM PRACTICAL							
6	18CS411	Data Structures and Algorithms	3/0/3	6	4.5	40/60	ESC
LABORATORY COURSE							
7	18EC405	Analog Integrated Circuits Laboratory	0/0/2	2	1	40/60	PCC
8	18EC406	Analog and Pulse Communication Laboratory	0/0/2	2	1	40/60	PCC
PROJECT							
9	18EC407	Mini Project-I	-	-	1	0/100	PROJ
TOTAL			19/1/7	27	24.5	900	

SEMESTER V							
SL. No.	Course Code	Course	L/T/P	Contact hrs./wk.	C	Ext./Int.	Cat.
THEORY							
1	18EE511	Electrical Machines & Control Systems	3/0/0	3	3	50/50	ESC
2	18XXXXX	Open Elective-1	3/0/0	3	3	50/50	OEC
3	18EC501	Microcontrollers & Interfacing	3/0/0	3	3	50/50	PCC
4	18EC502	Digital Communication	3/0/0	3	3	50/50	PCC
5	18EC9XX	Professional Elective-1	3/0/0	3	3	50/50	PEC
THEORY CUM PRACTICAL							
6	18EC503	Digital Signal Processing	3/0/3	6	4.5	40/60	PCC
LABORATORY COURSE							
7	18EC504	Microcontrollers Laboratory	0/0/2	2	1	40/60	PCC
8	18EC505	Digital Communication & Networks Laboratory	0/0/2	2	1	40/60	PCC
TOTAL			18/0/7	25	21.5	800	

SEMESTER VI							
SL. No.	Course Code	Course	L/T/P	Contact hrs./wk.	C	Ext./Int.	Cat.
THEORY							
1	18EC9XX	Professional Elective-2	3/0/0	3	3	50/50	PEC
2	18XXXXX	Open Elective-2	3/0/0	3	3	50/50	OEC
3	18EC601	Antennas & Wave Propagation	3/0/0	3	3	50/50	PCC
4	18EC602	Embedded Systems and its Applications	3/0/0	3	3	50/50	PCC
5	18EC603	VLSI Circuits	3/0/0	3	3	50/50	PCC
LABORATORY COURSE							
6	18EC604	VLSI Circuits Laboratory	0/0/2	2	1	40/60	PCC
7	18EC605	Embedded Systems Laboratory	0/0/2	2	1	40/60	PCC
8	18EN601	Business Communication	1/0/2	3	2	40/60	HSMC
PROJECT							
9	18EC606	Mini Project-II	-	-	1	0/100	PROJ
TOTAL			16/0/6	22	20	900	

SEMESTER VII							
SL. No.	Course Code	Course	L/T/P	Contact hrs./wk.	C	Ext./Int.	Cat.
THEORY							
1	18EC9XX	Professional Elective-3	3/0/0	3	3	50/50	PEC
2	18EC9XX	Professional Elective-4	3/0/0	3	3	50/50	PEC
3	18EC9XX	Professional Elective-5	3/0/0	3	3	50/50	PEC
4	18XXXXX	Open Elective-3	3/0/0	3	3	50/50	OEC
5	18XXXXX	Open Elective-4	3/0/0	3	3	50/50	OEC
6	18EC701	Microwave and Optical Communication	3/0/0	3	3	50/50	PCC
LABORATORY COURSE							
7	18EC702	Microwave and Optical Communication Laboratory	0/0/2	2	1	40/60	PCC
PROJECT							
8	18EC703	Project Work Phase-I	0/0/4	4	2	0/100	PROJ
TOTAL			18/0/6	24	21	800	

SEMESTER VIII							
SL. No.	Course Code	Course	L/T/P	Contact hrs./wk.	C	Ext./Int.	Cat.
PROJECT							
1.	18EC801	Project Work Phase-II	0/0/24	24	12	40/60	PROJ
TOTAL			0/0/24	24	12	500	

SCHEME OF CREDIT DISTRIBUTION - SUMMARY

SL. No.	Stream	Credits/Semester								C	%
		I	II	III	IV	V	VI	VII	VIII		
1	Humanities (HSMC)		3	3			2			8	4.84
2	Basic Sciences(BSC)	8.5	10.5	4	4					27	16.37
3	Engineering Sciences(ESC)	11.5	7.5	4.5	4.5	3				31	18.79
4	Professional Core(PCC)			12	15	12.5	11	4		54.5	33.03
5	Professional Electives(PEC)					3	3	9		15	9.09
6	Open Electives(OEC)					3	3	6		12	7.28
7	Project Work(PROJ)				1		1	2	12	16	9.69
8	Mandatory Course (MC)										
9	Employability Skills									1.5	.90
Total		20	21	23.5	24.5	21.5	20	21	12	165	100

STRUCTURE FOR UNDERGRADUATE ENGINEERING PROGRAM

S.No.	Course Work - Subject Area	AICTE Suggested Breakdown of Credits (165)	SKCET Credits (160)
1.	Humanities and Social Sciences including Management courses	12*	8
2.	Basic Science courses	25*	27
3.	Engineering Science courses including Workshop, Drawing, Basics of Electrical / Mechanical / Computer etc.	24*	31
4.	Professional core courses	48*	54.5
5.	Professional Electives courses relevant to the chosen specialization / branch	18*	15
6.	Open Subjects- Electives from other technical and / or emerging subjects	18*	12
7.	Project Work, Seminar and / or Internship in Industry or elsewhere.	15*	16
8.	Mandatory Courses	Non Credit	Non Credit
9.	Employability Skills	1.5	1.5
Total		160*	165

**Minor Variations is allowed as per need of the respective disciplines*

HUMANITIES & SOCIAL SCIENCES INCLUDING MANAGEMENT (8 Credits)

SL. No.	Course Code	Course Title	L/T/P	Contact hrs./Wk.	C	Cat.
1.	18EN102	Technical Communication Skills	2/0/2	4	3	HSMC
2.	18MG301	Principles of Management	3/0/0	3	3	HSMC
3.	18EN601	Business Communication	1/0/2	3	2	HSMC

BASIC SCIENCE COURSES (27 Credits)

SL. No.	Course Code	Course Title	L/T/P	Contact hrs./Wk.	C	Cat.
1.	18MA101	Linear Algebra and Differential Calculus	3/1/0	4	4	BSC
2.	18CH101	Engineering Chemistry	3/0/3	6	4.5	BSC
3.	18MA201	Integral Calculus and Complex Variables	3/1/0	4	4	BSC
4.	18PH101	Physics for Electronics	3/0/3	6	4.5	BSC
5.	18SB201	Engineering Biology	2/0/0	2	2	BSC
6.	18MA302	Discrete Transforms and Fourier Analysis	3/1/0	4	4	BSC
7.	18MA403	Probability Theory and Random Processes	3/1/0	4	4	BSC

ENGINEERING SCIENCE COURSES (31 Credits)

SL. No.	Course Code	Course Title	L/T/P	Contact hrs./Wk.	C	Cat.
1.	18EC101	Circuit Theory	3/0/2	5	4	ESC
2.	18CS111	Problem Solving using C Programming	3/0/3	6	4.5	ESC
3.	18ME102	Engineering Practices	1/0/4	5	3	ESC
4.	18EC201	Electron Devices	3/0/3	6	4.5	ESC
5.	18ME111	Engineering Graphics	2/0/2	4	3	ESC
6.	18CS311	Linux and Programming in C++	3/0/3	6	4.5	ESC
7.	18CS411	Data Structures and Algorithms	3/0/3	6	4.5	ESC
8.	18EE511	Electrical Machines & Control Systems	3/0/0	3	3	ESC

PROFESSIONAL CORE COURSES (54.5 Credits)

SL. No.	Course Code	Course Title	L/T/P	Contact hrs./Wk.	C	Cat.
1.	18EC301	Digital Electronics	3/0/0	3	3	PCC
2.	18EC302	Electronic Circuits	3/0/0	3	3	PCC
3.	18EC303	Electromagnetics	4/0/0	4	4	PCC
4.	18EC304	Digital Electronics Laboratory	0/0/2	2	1	PCC
5.	18EC305	Electronic Circuits Laboratory	0/0/2	2	1	PCC
6.	18EC401	Analog Integrated Circuits	3/0/0	3	3	PCC
7.	18EC402	Signals and Systems	4/0/0	4	4	PCC
8.	18EC403	Data Communication and Networking	3/0/0	3	3	PCC
9.	18EC404	Analog and Pulse Communication	3/0/0	3	3	PCC
10.	18EC405	Analog Integrated Circuits Laboratory	0/0/2	2	1	PCC
11.	18EC406	Analog and Pulse Communication Laboratory	0/0/2	2	1	PCC

12.	18EC501	Microcontrollers & Interfacing	3/0/0	3	3	PCC
13.	18EC502	Digital Communication	3/0/0	3	3	PCC
14.	18EC503	Digital Signal Processing	3/0/3	6	4.5	PCC
15	18EC504	Microcontrollers Laboratory	0/0/2	2	1	PCC
16	18EC505	Digital Communication & Networks Laboratory	0/0/2	2	1	PCC
17	18EC601	Antennas & Wave Propagation	3/0/0	3	3	PCC
18	18EC602	Embedded Systems and its Applications	3/0/0	3	3	PCC
19	18EC603	VLSI Circuits	3/0/0	3	3	PCC
20	18EC604	VLSI Circuits Laboratory	0/0/2	2	1	PCC
21	18EC605	Embedded Systems Laboratory	0/0/2	2	1	PCC
22	18EC701	Microwave and Optical Communication	3/0/0	3	3	PCC
23	18EC702	Microwave and Optical Communication Laboratory	0/0/2	2	1	PCC

PROFESSIONAL ELECTIVE COURSES (15 Credits)

SL. No.	Course Code	Course Title	L/T/P	Contact hrs./Wk.	C	Cat.
Elective Stream I : VLSI Design						
1.	18EC901	VLSI Fabrication Technology	3/0/0	3	3	PEC
2.	18EC902	High Speed Digital Design	3/0/0	3	3	PEC
3.	18EC903	Hardware Description Languages	3/0/0	3	3	PEC
4.	18EC904	ASIC and FPGA Design	3/0/0	3	3	PEC
5.	18EC905	Testing and Verification of VLSI circuits	3/0/0	3	3	PEC
6.	18EC906	Digital Low Power VLSI Design	3/0/0	3	3	PEC
7.	18EC907	Analog CMOS Circuit Design	3/0/0	3	3	PEC
8.	18EC908	CAD for VLSI Circuits	3/0/0	3	3	PEC
9.	18EC909	Nano Electronics	3/0/0	3	3	PEC
10.	18EC910	Mixed Signal Design	3/0/0	3	3	PEC
Elective Stream II : Embedded Systems						
1	18EC911	Embedded Processors	3/0/0	3	3	PEC
2	18EC912	ARM Processor Architecture & Programming	3/0/0	3	3	PEC
3	18EC913	Sensors for Industrial Applications	3/0/0	3	3	PEC
4	18EC914	Automotive Electronics & Applications	3/0/0	3	3	PEC
5	18EC915	Embedded Linux & RTOS	3/0/0	3	3	PEC
6	18IT403	Artificial Intelligence and its Applications	3/0/0	3	3	PEC
7	18IT914	Machine Learning	3/0/0	3	3	PEC
8	18EC918	Robotics	3/0/0	3	3	PEC

9	18EC919	Medical Electronics and Instrumentation	3/0/0	3	3	PEC
10	18EC920	Internet of Things & Applications	3/0/0	3	3	PEC
Elective Stream III : Communication Engineering						
1	18EC921	Microwave Integrated Circuits	3/0/0	3	3	PEC
2	18EC922	Mobile Communication	3/0/0	3	3	PEC
3	18EC923	Satellite Communication and GPS	3/0/0	3	3	PEC
4	18EC924	Long Term Evolution Technologies	3/0/0	3	3	PEC
5	18EC925	MEMS	3/0/0	3	3	PEC
6	18EC926	Smart Antennas	3/0/0	3	3	PEC
7	18EC927	RF System Design	3/0/0	3	3	PEC
8	18EC928	Cognitive Radio Communication	3/0/0	3	3	PEC
9	18EC929	MIMO and Multicarrier Systems	3/0/0	3	3	PEC
10	18EC930	Millimeter Wave Personal Communication Systems	3/0/0	3	3	PEC
Elective Stream IV – Networks, Image and Video Processing						
1	18EC931	Wireless Sensor Networks	3/0/0	3	3	PEC
2	18EC932	Body Area Networks	3/0/0	3	3	PEC
3	18EC933	Soft Computing	3/0/0	3	3	PEC
4	18EC934	Digital Image & Video Processing	3/0/0	3	3	PEC
5	18EC935	Speech and Audio Processing	3/0/0	3	3	PEC
6	18EC936	Data Security	3/0/0	3	3	PEC
7	18EC937	Pattern Recognition Techniques	3/0/0	3	3	PEC
8	18EC938	High Speed Networks	3/0/0	3	3	PEC
9	18EC939	Advanced Wireless Networks	3/0/0	3	3	PEC
10	18EC940	Neural Networks and Deep Learning	3/0/0	3	3	PEC

OPEN ELECTIVE COURSES (12 Credits)
(Offered by Other Branches)

SL. No.	Course Code	Course Title	L/T/P	Contact hrs./Wk.	C	Cat.
1.	18CS001	Internet Marketing & E-Commerce	3/0/0	3	3	OEC
2.	18CS002	Software Product Development and Management	3/0/0	3	3	OEC
3.	18CS003	Virtual Reality	3/0/0	3	3	OEC
4.	18CS004	Network Security	3/0/0	3	3	OEC
5.	18CS005	Green Computing	3/0/0	3	3	OEC
6.	18CS006	Data Science	3/0/0	3	3	OEC
7.	18CE001	Disaster Management	3/0/0	3	3	OEC
8	18CE002	Engineering Risk and Uncertainty	3/0/0	3	3	OEC
9	18CE003	Environmental and Social Impact Assessment	3/0/0	3	3	OEC
10	18CE004	Geographical Information System	3/0/0	3	3	OEC
11	18CE005	Industrial Pollution Prevention	3/0/0	3	3	OEC
12	18CE006	Smart Materials and Smart Structures	3/0/0	3	3	OEC
13	18EE001	Power plant Engineering	3/0/0	3	3	OEC
14	18EE002	Energy Auditing, Conservation and Management	3/0/0	3	3	OEC
15	18EE003	Smart Grid	3/0/0	3	3	OEC
16	18EE004	Renewable Energy Sources	3/0/0	3	3	OEC

17	18EE005	Servo and Robot Drives	3/0/0	3	3	OEC
18	18EE006	Special Purpose Machines	3/0/0	3	3	OEC
19	18IT001	Mobile Applications Development using Android	3/0/0	3	3	OEC
20	18IT002	Introduction of Python Programming	3/0/0	3	3	OEC
21	18IT003	JAVA Programming (Fundamentals)	3/0/0	3	3	OEC
22	18IT004	Cloud Virtualization	3/0/0	3	3	OEC
23	18IT005	Database Systems	3/0/0	3	3	OEC
24	18IT006	Cyber Security	3/0/0	3	3	OEC
25	18ME001	Industrial Safety	3/0/0	3	3	OEC
26	18ME002	MEMS/NEMS	3/0/0	3	3	OEC
27	18ME003	Total Quality Management	3/0/0	3	3	OEC
28	18ME004	Product Development	3/0/0	3	3	OEC
29	18ME005	Renewable Energy	3/0/0	3	3	OEC
30	18ME006	Fuel Cell Technology	3/0/0	3	3	OEC
31	18MT001	Reliability Engineering	3/0/0	3	3	OEC
32	18MT002	Vehicle Dynamics	3/0/0	3	3	OEC
33	18MT003	Micro Machining	3/0/0	3	3	OEC
34	18MT004	Field and Service Robotics	3/0/0	3	3	OEC
35	18MT005	Automation System	3/0/0	3	3	OEC
36	18MT006	Robot Design	3/0/0	3	3	OEC

OPEN ELECTIVE COURSES
(Offered to Other Branches)

SL. No.	Course Code	Course Title	L/T/P	Contact hrs./Wk.	C	Cat.
1.	18EC001	Sensors and Actuators	3/0/0	3	3	OEC
2.	18EC002	Telemedicine	3/0/0	3	3	OEC
3.	18EC003	Artificial Intelligence and Deep learning	3/0/0	3	3	OEC
4.	18EC004	Brain Computer Interface	3/0/0	3	3	OEC
5.	18EC005	Wireless wearable Systems	3/0/0	3	3	OEC
6.	18EC006	Power Management for IOT devices	3/0/0	3	3	OEC

PROJECT WORK (16 Credits)

SL. No.	Course Code	Course Title	L/T/P	Contact hrs./Wk.	C	Cat.
1.	18EC703	Project Work (Phase I)	0/0/4	4	2	PROJ
2	18EC801	Project Work (Phase II)	0/0/24	24	12	PROJ
3	18EC407	Mini Project-I	0/0/2	2	1	PROJ
4	18EC606	Mini Project-II	0/0/2	2	1	PROJ

MANDATORY COURSES

SL. No.	Course Code	Course Title
1.	18MC101	Mandatory Course I - Induction for three weeks
2	18MC201	Mandatory Course II – Environmental Sciences
3	18MC331	Mandatory Course III –Indian Constitution / Indian Traditional Knowledge

ONE CREDIT COURSES (Additional Credits)

SL. No.	Course Code	Course Title	Credits
1.	18ECA801	Simulation Program with Integrated Circuit Emphasis	1
2.	18ECA802	PCB design	1
3.	18ECA803	PLC and SCADA	1
4.	18ECA804	CCNA/ CCSP Networking	1
5.	18ECA805	4G Core Network Operations, Administration & Maintenance	1
6.	18ECA806	IPv6 Fundamental & Deployment	1
7.	18ECA807	Advance Mobile communication Technologies	1
8.	18ECA808	Timing issues in Digital Circuits	1
9.	18ECA809	Embedded RTOS design	1
10.	18ECA810	Embedded LINUX/ C	1
11.	18ECA811	System Design	1
12.	18ECA812	Measurement System Analysis	1

SEMESTER WISE CREDIT DISTRIBUTION:-

Semester	I	II	III	IV	V	VI	VII	VIII	Total
Credits	20	21	23.5	24.5	21.5	20	21	12	165

Total Credits: 165

L: Lecture **T:** Tutorial **P:** Practical **C:** Credit **Cat.:** Category

HSMC : Humanities and Social Sciences including Management

OEC :Open Elective Courses

BSC : Basic Science Courses

PROJ : Project Work

ESC : Engineering Science Courses

PCC : Professional Core Courses

MC : Mandatory Course

PEC : Professional Elective Courses

18MA101	LINEAR ALGEBRA AND DIFFERENTIAL CALCULUS (COMMON TO ALL BRANCHES)	3/1/0/4
Nature of Course J (Problem analytical)		
Course Objectives:		
1	To develop the skill to use matrix algebra techniques that is needed by engineers for practical applications.	
2	To gain knowledge in using infinite series of approximations for solutions arising in mathematical modelling.	
3	To familiarize with functions of several variables applicable in many branches of engineering.	
4	To find the solution of ordinary differential equations as most of the engineering problems are characterized in this form.	
Course Outcomes:		
Upon completion of the course, students shall have ability to		
C101.1	Recall the concepts of matrices, ordinary and partial derivatives	[R]
C101.2	Express square matrix in the diagonal form and infinite series approximations	[U]
C101.3	Apply the knowledge of differential equation and extreme values of the given functions to solve the engineering problems	[AP]
Course Contents:		
LINEAR ALGEBRA Symmetric, Skew – symmetric and orthogonal matrices - Characteristic equation – Eigen values and eigenvectors of a real matrices and their properties (statement only) .Cayley-Hamilton theorem (statement only): Verification and application to find inverse and powers of real matrices. Orthogonal transformation of a real symmetric matrix to diagonal form – Reduction of Quadratic form to canonical form by orthogonal reduction.		
SEQUENCES AND SERIES Convergence of sequences and series – Tests of convergence of positive term series: Comparison test , D’Alembert’s ratio test- Cauchy root test -Alternating Series- Leibnitz’s test-Series of positive and negative terms-Absolute and conditional convergence.		
CALCULUS Functions of several variables: Total derivatives – Differentiation of implicit functions – Jacobians – Taylor series expansion – Maxima and Minima – Method of Lagrangian multipliers. Ordinary differential equations-Second and Higher order linear differential equations with constant coefficients –Cauchy’s and Legendre’s linear differential equations-Method of variation of parameters. Application of ODE: Differential equations connected with electric circuits and Simple Harmonic motion (Differential equations and associated conditions need to be given)		
Total Hours:		60
Text Books:		
1	G.B.Thomas and R.L.Finney, Calculus and Analytic Geometry, 13 th Edition,Pearson, Reprint,2014	
2	Kreyszig. E, “Advanced Engineering Mathematics” Tenth Edition, John Wiley and Sons (Asia) Limited, Singapore 2014.	
3	Grewal. B.S, “Higher Engineering Mathematics”, 43 rd edition, Khanna Publications, Delhi, 2014.	
Reference Books:		
1	Veerarajan. T, “Engineering Mathematics I”, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2018.	
2	Glyn James, —Advanced Modern Engineering Mathematics, Pearson Education,	

	4 th edition, 2012.			
3	N.P.Bali and Dr.ManishGoyal,"A Text book of Engineering Mathematics" 9 th edition, Laxmi publications Ltd, 2014.			
Web References:				
1	http://www.nptel.ac.in/courses/111105035			
2	http://www.nptel.ac.in/courses/122104017			
3	http://nptel.ac.in/courses/122102009			
4	http://nptel.ac.in/courses/111107063			
Online Resources:				
1	https://www.coursera.org/learn/linearalgebra2			
2	https://www.coursera.org/learn/differentiation-calculus			
3	https://www.coursera.org/learn/single-variable-calculus			
4	https://alison.com/courses/Algebra-Functions-Expressions-and-Equations			
Assessment Methods & Levels (based on Blooms' Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component	Marks	
C101.1	Remember	Classroom or Online Quiz	4	
C101 .2	Understand	Class Presentation/Power point presentation	6	
C101.1,2,3	Apply	Group Assignment & Tutorial	10	
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination[50 Marks]
	CIA1[10 Marks]	CIA2[10 Marks]	CIA3[10 Marks]	
Remember	20	20	20	20
Understand	30	30	30	30
Apply	50	50	50	50
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

18PH101	PHYSICS FOR ELECTRONICS (ECE)	3/0/3/4.5
Nature of Course : E (Theory skill based)		
Course Objectives:		
1	To learn the basic concepts of physics needed for all branches of engineering	
2	To apply the physics concepts in solving real time engineering problems.	
3	To implement and visualize theoretical aspects in the laboratory	

4	To familiarize the students to handle various instruments and equipment	
Course Outcomes:		
Upon completion of the course, students shall have ability to		
C101.1	Acquire the knowledge fundamentals of oscillation and quantum mechanics	[R]
C101.2	Understand the basics of solid state physics and understand the nature and characteristics of light.	[U]
C101.3	To understand different methods of luminescence, display devices and laser types and their applications.	[U]
C101.4	Interrelate electric and magnetic fields, and Predict the behaviour of electromagnetic waves.	[Ap]
Course Contents:		
Oscillation and Quantum mechanics		
Oscillation: Periodic motion- Simple harmonic motion-Characteristics of simple harmonic motion-Vibration of simple spring's mass system. Resonance-definition, damped harmonic oscillator – Heavy, critical and light damping, energy decay in a damped harmonic oscillator.		
Quantum mechanics: Introduction - Planck's quantum theory- Matter waves, de-Broglie wavelength, uncertainty principle – Schrödinger's wave equation – Time independent and time dependent - Physical significance of wave function - Particle in a one dimensional potential box.		
Solid State Physics and Display Devices And Lasers		
Wave nature of light – Polarization – Interference – Diffraction - Light Source - Review of Quantum Mechanical concept - Review of Solid State Physics - Review of Semiconductor Physics and Semiconductor Junction Device. Introduction to display devices- Photo Luminescence - Cathode Luminescence - Electro Luminescence –Injection Luminescence - LED, Plasma Display - Liquid Crystal Displays - Numeric Displays - Laser Emission – Absorption – Radiation - Population Inversion – Optical Feedback - Threshold condition - Laser Modes - Classes of Lasers - Mode Locking – laser applications.		
Electromagnetism		
Review of definitions of fundamental term: Permeability- Forces due to currents. Uniform and non-uniform magnetic fields. Static and time-varying magnetic fields- Electromagnetic induction. Expression for induced emf- Electric field's definition of fundamental terms - Dielectric constant, Permittivity-Dielectric displacement- Gauss theorem- Electromagnetic waves: Propagation of electromagnetic waves through isotropic media. Maxwell's equations and interpretation of Maxwell's equations.		
Lab Component		
1	Laser and optical fiber parameters	[U]
2	Wavelength measurement of mercury spectrum- Spectrometer Grating	[U]
3	Thermal conductivity of a bad conductor	[U]
4	Specific resistance- Carey fosters bridge	[U]
5	Bandgap of semiconductor	[U]
6	Magnetic field along the axis of current carrying coil- Stewart and Gee method.	[U]
7	LCR circuits.	[U]
8	Characteristics of solar cell/Photodiode	[U]
9	Time constant of RC circuits.	[U]
10	Transverse and longitudinal wave modes- Melde's experiment.	[U]

		Total Hours:	75		
Text Books:					
1	David Griffiths 'Introduction to Electrodynamics' 4th Edition, Cambridge University Press 2017.				
2	David Halliday, Robert Resnick, Jearl Walker "Fundamentals of Physics" Wileyplus.2010				
Reference Books:					
1	Bhattacharya "Semiconductor Opto Electronic Devices", Prentice Hall of India Pvt., Ltd., New Delhi, 1995.				
2	Gaur R K, Gupta S L "Engineering Physic" Dhanpat Rai Publications, 2013.				
3	The Feynman Lectures on Physics, Vol. II: The New Millennium Edition.2010				
Web References:					
1	https://ocw.mit.edu/courses/#physics				
2	http://www.feynmanlectures.caltech.edu/info/				
3	http://www.eas.uccs.edu/~mwickert/ece3110/lecture_notes/N3110_4.pdf				
4	http://teacher.pas.rochester.edu/PHY217/LectureNotes/Chapter2/LectureNotesChapter2.pdf				
5	http://www.phys.ufl.edu/~korytov/phy2049/old_notes/all_chapters.pdf				
6	https://www.tcd.ie/Physics/research/groups/magnetism/files/lectures/5006/5006-2.pdf				
7	https://www.generalplastics.com/polyurethane-foam-dielectric-materials-f...				
8	http://nptel.ac.in/courses/115101005/downloads/lectures-doc/Lecture-23.pdf				
9	http://www.if.pwr.wroc.pl/~wsalejda/fem6.pdf				
10	https://www.boundless.com/physics/.../the-hall-effect-559-10926/				
Online Resources:					
1	https://www.patana.ac.th/secondary/science/anrophysics/ntopic4/commentary.htm				
2	http://www.indiaeducation.net/				
3	https://www.jic.ac.uk/microscopy/links.html				
4	http://esiksha.com/home.asp				
5	www.fiberopticsonline.com/				
6	https://www.colorado.edu/physics/phys4510/phys4510_fa05/Chapter1.pdf				
7	https://physics.stanford.edu/people/susmita-adhikari				
Assessment Methods & Levels (based on Blooms' Taxonomy)					
Summative assessment based on Continuous and End Semester Examination					
Bloom's Level	Continuous Assessment				End Semester Examination (Theory) [40 marks]
	Theory			Practical	
	CIA-I [10 marks]	CIA-II [10 marks]	CIA-III [10 marks]		
Remember	30	20	30	20	30
Understand	60	60	60	40	60
Apply	10	20	10	30	10
Analyse	-	-	-	10	-
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

18EC101	CIRCUIT THEORY		3/0/2/4
Nature of Course		: G (Theory Analytical)	
Course Objectives:			
1	To introduce the various circuit components of an electrical network.		
2	To enable the students to understand and simplify circuits using network theorems.		
3	To impart knowledge on transient circuits		
4	To enable the students to design and develop series and parallel Resonance		
5	To demonstrate the knowledge of graph theory		
Course Outcomes:			
Upon completion of the course, students shall have ability to			
C101.1	Recalling the basic circuits laws and the basic concepts of DC & AC circuits		[R]
C101.2	Understand the basic principles of network theorems		[U]
C101.3	Understand the concepts and performance of transients, resonance and coupling		[U]
C101.4	Identify component of Graph topology, understand and apply for simplification of electrical networks.		[U]
C101.5	Apply network theorems and analyse the possibilities of deriving the equivalent circuits		[AP]
C101.6	Design RL, RC and RLC circuits and analyse the frequency response		[AN]
Course Contents:			
<p>Basic Concepts : Ohm's law - Kirchhoff's current law – Kirchhoff's voltage law– series and parallel Connected sources- resistors in series and parallel – voltage and current division– Nodal analysis – mesh analysis – source Transformation –delta wye conversion- -Thevenin and Norton theorem, Maximum power transfer, Superposition theorem, Reciprocity theorem, Compensation theorem. Millman and Tellegans Theorem. (Both AC and DC)</p> <p>Transients & Network Topology: Capacitor–Inductor–energy storage– Introduction to Laplace Transform - Transients in RL, RC, RLC series circuits using Laplace Transforms, Concept of duality, dual network, Graph's of a network, trees, chords and branches, tie set and cutset of a Graph.</p> <p>Resonance and coupled circuits: Phasor relationship for R, L and C – Impedance – admittance, series resonance – parallel resonance – their frequency response, bandwidth and quality factor – self-inductance – mutual inductance – coupling Coefficient.</p> <p>Lab Component</p>			
1	Verification of ohm's laws and kirchoff's laws		[E]
2	Verification of Thevenin's and Norton's Theorem		[E]
3	Verification of superposition Theorem		[E]
4	Verification of maximum power transfer theorem		[E]
5	Verification of reciprocity theorem		[E]
6	Verification of mesh and nodal analysis		[E]
7	Analysis of Frequency response of RL,RC and RLC circuits		[E]
8	Q factor extraction in Tank circuits		[E]
Total Hours:			75

Text Books:	
1	Sudhakar. A and Shyam Mohan. SP “Circuits and Network Analysis & Synthesis”5 th edition, Tata McGraw Hill, 2015.
2	William H.Hayt, JV Jack E.Kemmerly and Steven M. Durbin,” Engineering Circuits Analysis”, McGraw Hill India, 8 ^h edition, 2014.
3	Schaum’s Series, “Basic Circuit Analysis “,2 nd Edition, McGraw Hill India Private Ltd., 2011(Reprint)
Reference Books:	
1	Chakrabati A “Circuit Theory Analysis and Synthesis” Dhanpath Rai & Sons New Delhi 2014
2	NageswaraRao T “Electric Circuit analysis”,A R Publications 2007
Web References:	
1	http://nptel.ac.in/courses/117106101/
2	http://www.thelearningpoint.net/home/electrical-science-and-engineering/circuit-theory
3	http://www.tina.com/course/coursex
Online Resources:	
1	https://www.edx.org/course/circuits-electronics-1-basic-circuit

Assessment Methods & Levels (based on Blooms’ Taxonomy)					
Summative assessment based on Continuous and End Semester Examination					
Bloom’s Level	Continuous Assessment				End Semester Examination (Theory) [40 marks]
	Theory			Practical	
	CIA-I [10 marks]	CIA-II [10 marks]	CIA-III [10 marks]		
Remember	30	30	30	10	20
Understand	60	30	20	20	30
Apply	10	20	30	20	30
Analyse	-	20	20	20	20
Evaluate	-	-	-	30	-
Create	-	-	-	-	-

18CS111	PROBLEM SOLVING USING C PROGRAMMING (Common to Civil/Mechanical/ECE/EEE)	3/0/3/4.5
Nature of Course: K (Problem Programming)		
Course Objectives: <ol style="list-style-type: none"> 1. To understand problem solving concepts. 2. To gain knowledge about the control structures in C. 3. To write C programs using arrays, strings and pointers. 4. To learn functions, structures and unions in C. 		
Course Outcomes		
Upon completion of the course, students shall have ability to		
C111.1:	Apply problem solving techniques to solve real world problems	[AP]
C111.2:	Understand C fundamental constructs and control structures	[U]
C111.3:	Use the concept of pointers, arrays and strings in programs	[AP]
C111.4:	Develop applications using functions, structures and unions	[C]
Contents Problem Solving Techniques: Algorithm, Pseudo-code and Flowchart Problem Solving with Sequential Logic Structure - Decisions – Loops. Case Study: Raptor and Scratch Tools. C Fundamental Constructs and Control Structures: C Character Set – Identifiers and Keywords – Data Types – Constants - Variables and Arrays – Declarations - Operators and Expressions - Data input and output - Preparing and running a Complete C Program- Control Structures: Branching: if-else- Looping – while - do while – for - Nested control structures – switch – break – continue – comma - goto. Arrays, Strings, Pointers, Functions, Structures and Unions: Arrays - Defining an array - Processing an array - Multi dimensional arrays - Strings: Defining a string - Null character - initialization of strings – reading and writing a string - processing the string - Pointers: fundamentals – Pointer Declaration & Usage – Dynamic Memory Allocation. Functions: Defining a Function – Accessing a function – Function Prototype Functions - Pointer to Function - Functions Returning Pointers. - Pointers and Strings - Passing arguments to a function – Recursion. Structures and Unions: The Type Definition (typedef) – Enumerated types – Structure - Type Definition – Initialization – Accessing Structures - Structures and Functions – passing Whole Structure – Self-Referential Structure - Unions.		
List of Experiments: <ol style="list-style-type: none"> 1. Office Automation – Resume preparation , Spreadsheet processing [AP] 2. Draw Flowchart using Raptor Tool [AP] <ol style="list-style-type: none"> a. Simple Flow Chart b. Decision Making c. Looping[Pre test&Post test] 3. Create Animation / Gaming /Application using Scratch Tool [AP] 4. Program to process data types, format input and output and to evaluate an expression [AP] 5. Program using decision making statements [AP] 6. Program using looping statements [AP] 7. Program using single and two dimensional arrays [AP] 		

8.	Program with Strings	[AP]
9.	Program using Pointers.	[AP]
10.	Program using Recursion	[AP]
11.	Program using structures	[AP]
12.	Branch specific application program	[AP]

Text Books:

1. M. Sprankle, "Problem Solving and Programming Concepts", 9th Edition, Pearson Education, New Delhi, 2011.
2. Byron, S. Gottfreid, "Programming with C", McGraw Hill, Schaum's outlines, 3rd Edition, 2014.
3. YashavantKanetkar, "Understanding Pointer in C", 3rd Edition, BPB Publication, 2011.

Reference Books:

1. Herbert Schildt, "The Complete Reference C", 4th Edition, McGraw Hill, 2015
2. S.ThamaraiSelvi and R.Murugesan, "Programming in ANSI C", 6th Edition, McGraw Hill, 2012.
3. K.R.Venugopal and SudeepR.Prasad, "Mastering C", 2nd Edition, McGraw Hill, 2015

Web References:

1. <http://nptel.ac.in/courses/106105085/>
2. <http://nptel.ac.in/courses/106106127/>
3. <http://raptor.martincarlisle.com/>
4. <https://scratch.mit.edu/>

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment			Rubric Based CIA [30 Marks]	End Semester Examination [40 Marks]
	CIA1 [10 Marks]	CIA2 [10 Marks]	CIA3 [10 Marks]		
Remember	30	30	20	-	-
Understand	70	50	30	-	-
Apply	-	20	50	70	70
Analyse	-	-	-	-	-
Evaluate	-	-	-	-	-
Create	-	-	-	30	30

18ME102	ENGINEERING PRACTICES	1/0/4/3
Nature of Course: M (Practical application)		
Course Objectives:		
<ol style="list-style-type: none"> To learn the use of basic hand tools and to know the need for safety in work place and to gain hands on experience on Carpentry, Sheet metal, Plumbing, welding and Foundry. To learn about basic electrical devices, meters and electronics devices and meters and to gain knowledge about the fundamentals of various electrical and electronic gadgets, basic electronic instruments, their working and trouble shooting. 		
Course Outcomes		
C102.1	Identify and solve the basic engineering problems at home and in workplace	[Ap]
C102.2	Develop the surfaces and make simple components like tray, funnel etc.	[C]
C102.3	Make simple metal joints using welding equipment and wooden joints using carpentry tools.	[Ap]
C102.4	Prepare pipe connections and sand moulds.	[Ap]
C102.5	Understand the fundamentals of machining.	[U]
C102.6	Examine and troubleshoot electrical and electronics circuits	[A]
Course Content:		
GROUP A (CIVIL & MECHANICAL)		
Manufacturing Methods –Sheet metal operations - Welding - arc welding , gas welding , TIG & MIG welding — basic machining using lathe - metal casting - Carpentry work using power tools - Plumbing components and pipelines		
List of Experiments:		
S.No	List of Experiments	CO Mapping RBT
1	Preparation of butt joints and lap joints using arc welding and TIG / MIG welding.	C102.3 [Ap]
2	Sheet metal Forming and Bending, Model making – Trays and funnels.	C102.2 [Ap]
3	Preparation of wooden joints by sawing, planning and cutting.	C102.3 [Ap]
4	Making basic pipe connections involving the fittings like valves, taps, coupling, unions, reducers, elbows and other components used in household fittings.	C102.4 [Ap]
5	Basic machining simple turning operations.	C102.5 [U]
6	Demonstration on foundry operations like mould preparation for solid and split piece pattern.	C102.4 [Ap]
GROUP B (ELECTRICAL AND ELECTRONICS ENGINEERING)		
List of Experiments:		
Basic Circuit Elements: Resistor, inductor, capacitor. Introduction to measuring equipments: Moving iron meter, moving coil meter, Wattmeter, Energy meter, CRO, Multi-meter. Digital logic circuits, PCB design, fuse, relay, circuit breaker, wire, Earthing, fan, fluorescent lamp, iron box, mixer grinder.		
S.No	List of Experiments	CO Mapping RBT
1	Study and identification of electronic components with specification.	C102.6 [A]
2	Testing of CRO and Electronic components using Multimeter.	C102.6 [A]

3	Generation and measurement of signals using CRO.	C102.6	[A]
4	Familiarisation of digital basic gate IC's.	C102.6	[A]
5	Soldering practice-components devices and circuits- using general purpose PCB.	C102.6	[A]
6	Demonstration of meters and electrical components.	C102.6	[A]
7	Safety precautions with electrical components.	C102.6	[A]
8	Residential house wiring.	C102.6	[A]
9	Measurement of power and energy.	C102.6	[A]
10	Trouble shooting of electrical equipments.	C102.6	[A]
Total Hours			45
Reference Books:			
1. SeropeKalpakjian and Steven R. Schmid, "Manufacturing Engineering and Technology", Pearson Education, Inc. 2009 (Second Indian Reprint).			
2. Hajra Choudhury, "Elements of Workshop Technology", Vol. I & II, Media Promoters Pvt Ltd., 2014.			
3. Suyambazhagan S, 'Engineering practices' PHI Learning private limited, New Delhi,2012.			
4. D. P. Kothari and I. J. Nagrath, "Basic Electrical Engineering", Tata McGraw Hill, 2010.			
5. E. Hughes, "Electrical and Electronics Technology", Pearson, 2010.			
Web References:			
1. www.nptel.ac.in			
2. www.sme.org			
3. http://www.allaboutcircuits.com/education/			

Tentative Assessment Methods & Levels (based on Bloom's Taxonomy)		
Summative assessment based on Continuous and End Semester Examination		
Bloom's Level	Rubric based Continuous Assessment[60 marks]	End Semester Examination [40 marks]
Remember	10	10
Understand	10	10
Apply	40	40
Analyze	20	20
Evaluate	10	10
Create	10	10

18MC101	MANDATORY COURSE I	
Nature of Course : Induction Program		
Course Objectives:		
1	To have broad understanding of society and relationships	
2	To nurture the character and fulfil one's responsibility as an engineer, a citizen and a human being	

3	To incorporate meta skills and values	
Course Outcomes:		
Upon completion of the course, students shall have ability to		
C101.1	Explore academic interest and activities	[Ap]
C101.2	Work for excellence	[Ap]
C101.3	Promote bonding and give a broader view of life and character	[Ap]
Course Contents:		
<i>PHYSICAL ACTIVITY</i>		
Yoga		
<i>CREATIVE ARTS (students can select any one of their choice)</i>		
Painting, sculpture, pottery, music, dance, craft making and so on		
<i>UNIVERSAL HUMAN VALUES</i>		
Enhancing soft skills		
<i>LITERARY AND PROFICIENCY MODULES</i>		
Reading, writing, speaking – debate, role play etc. Communication and computer skills		
<i>LECTURES BY EMINENT PEOPLE</i>		
Guest lecture by subject experts		
<i>VISIT TO LOCAL AREAS</i>		
Meditation centre/orphanage/Hospital		
<i>FAMILIARIZATION TO DEPARTMENT/BRANCH INNOVATION</i>		
Lectures by Department's Head and senior faculty members		

18MA201	INTEGRAL CALCULUS AND COMPLEX VARIABLES (COMMON TO ALL BRANCHES)	3/1/0/4
Nature of Course J (Problem analytical)		
Course Objectives:		
1	To gain knowledge in improper integrals, Gamma and Beta functions which are needed in engineering applications	
2	To develop logical thinking and analytical skills in evaluating multiple integrals	
3	To acquaint with the concepts of vector calculus needed for problems in all engineering disciplines	
4	To develop an understanding of the standard techniques of complex variable theory so as to enable the student to apply them with confidence.	
Course Outcomes:		
Upon completion of the course, students shall have ability to		
C201.1	Recall basic integration formulae, scalar and vector point function concepts	[R]
C201.2	Identify the concepts of integrals in computing Beta and Gamma functions	[U]
C201.3	Apply the concepts of the integration in evaluating engineering problems related to area, volume and vector point functions.	[AP]
C201.4	Find the derivatives of the complex valued functions and to evaluate complex valued integrals.	[AP]
Course Contents:		
INTEGRAL CALCULUS		
Definite integrals - Evaluation of definite integrals using Bernoulli's formula. Beta and Gamma functions: Relation between Beta and Gamma Functions - Evaluation of Integrals using Beta and Gamma Functions. Multiple integrals : Double integration in Cartesian coordinates –Area as double integral – Change the order of integration-Triple integration in Cartesian co-ordinates –Volume as triple integral		
VECTOR CALCULUS		
Vector differential operator- Gradient of a scalar point function - Directional derivatives – Divergence and Curl of a vector point function – Irrotational and solenoidal vector fields – Simple problems– Vector integration – Green's theorem in a plane, Gauss divergence theorem and Stoke's theorem(theorem statements only)– Simple applications involving cubes and rectangular parallelopipeds.		
COMPLEX VARIABLE		
Complex differentiation: Analytic Functions - Cauchy-Riemann equations (excluding proof) – Harmonic functions- Conjugate harmonic functions – Construction of analytic functions – Conformal mapping. Transformation: $w = c+z, cz, 1/z$ and Bilinear transformation. Complex integration: Cauchy's Integral theorem (statement)- Cauchy's Integral formula - Laurent's series-Zeros and singularities – Residues – Cauchy's Residue theorem (statement). Contour integration: Evaluation of real integrals of the form $\int_0^{2\pi} f(\cos \theta, \sin \theta) d\theta$ and $\int_{-\infty}^{\infty} \frac{P(x)}{Q(x)} dx$		
Total Hours:		60
Text Books:		
1	G.B.Thomas and R.L.Finney, Calculus and Analytic Geometry, 13 th Edition, Pearson, Reprint,2014.	

2	Kreyszig. E, "Advanced Engineering Mathematics" Tenth Edition, John Wiley and Sons (Asia) Limited, Singapore 2014.
3	Grewal. B.S, "Higher Engineering Mathematics", 43 rd edition, Khanna Publications, Delhi, 2014.

Reference Books:

1	Veerarajan. T, "Engineering Mathematics II", Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2018.
2	Glyn James, —Advanced Modern Engineering Mathematics, Pearson Education, 4 th edition, 2012.
3	N.P.Bali and Dr.Manish Goyal,"A Text book of Engineering Mathematics" 9 th edition, Laxmi publications ltd, 2014.

Web References:

1	http://nptel.ac.in/video.php?subjectId=122107037
2	http://nptel.ac.in/courses/122107036/
3	http://nptel.ac.in/video.php?subjectId=117102060

Online Resources:

1	https://www.coursera.org/learn/pre-calculus
2	https://www.coursera.org/learn/linearalgebra1
3	https://alison.com/courses/Advanced-Mathematics-1
4	https://www.edx.org/course/algebra-lineal-mexicox-acf-0903-1x

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C201.1	Remember	Classroom or Online Quiz	4
C201.2	Understand	Class Presentation/Power point presentation	6
C201.1,2,3 &C201.4	Apply	Group Assignment & Tutorial	10

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment			End Semester Examination [50 marks]
	CIA-I [10 marks]	CIA-II [10 marks]	CIA-III [10 marks]	
Remember	20	20	20	20
Understand	30	30	30	30
Apply	50	50	50	50
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

18SB201	ENGINEERING BIOLOGY		2/0/0/2
Nature of Course J Theory			
Course Objectives:			
1	To grasp and apply biological engineering principles, procedures needed to solve real-world problems.		
2	To give a basic knowledge of the applications of biological systems in relevant Industries		
3	To understand the mutual dependence of modern biology and engineering		
4	To give a basic knowledge of the applications of biological systems in relevant industries		
Course Outcomes: Upon completion of the course, students shall have ability to			
C201.1	Explain the structure of human nervous system, Brain and Spinal cord		[R]
C201.2	Analyze a problem from both an engineering and biological perspective		[AN]
C201.3	Apply the concept of plant in real life situations		[AP]
C201.4	Understand the basic concepts of brain computer interface		[U]
C201.5	Understand the compatibility and functioning of artificial organs inside the living system		[U]
C201.6	Integrate the knowledge core of traditional engineering disciplines and modern biology to solve problems encountered in living systems		[AP]
Course Contents:			
<p>BASICS OF HUMAN PHYSIOLOGY AND SPEECH FUNDAMENTALS: Nervous system development - Neuron: structure – function – classification. BRAIN: structures – lobes – functional areas. BRAIN STEM: structures – functional areas. SPINAL CORD: structure – functions. Concepts of nuclei – sensory and motor Tracts .SPEECH FUNDAMENTALS: Articulatory Phonetics, Production and Classification of Speech Sounds; Acoustic Phonetics, Acoustics of speech production.</p> <p>BCI, PLANT SYSTEM AND INDUSTRIAL APPLICATION OF BIOLOGY: Fundamentals of BCI – Structure of BCI system – Classification of BCI – invasive and Partially invasive BCI .PLANT SYSTEM: basic concepts of plant growth-nutrition-photosynthesis and nitrogen fixation INDUSTRIAL APPLICATION : Transgenic plants and animals-stem cell and tissue engineering- bioreactors-biopharming-recombinant vaccines-cloning-drug discovery-bioremediation-biofertilizer- biocontrol-biofilters- biological neural network –Artificial neural network Architecture -biosensors-biopolymers-bioenergy-biomaterials-biochips .</p> <p>ARTIFICIAL ORGANS: Artificial blood, Artificial skin, Artificial Heart, Prosthetic Cardiac Valves, Artificial lung(oxygenator), Artificial Kidney (Dialyser membrane), Dental Implants</p>			
Total Hours:			30
Text Books:			
1	Matews G.G.,Neurobiology,Second Edition,Blackwell Science,UK,2000		
2	Bernhard Graitmann,Brenden Allison,GertPfurtscheller, Computer Interfaces:Revolutionizing Human-Computer Interaction, Springer 2010.		
3	Biology for Engineers, Arthur T. Johnson, CRC Press, Taylor and Francis, 2011		
Reference Books:			

1	Malcom Carpenter, —Textbook of Neuroanatomy, Mc. Graw hill Edition, 1996.
2	Biology for Engineers, Arthur T. Johnson, CRC Press, Taylor and Francis, 2011
3	W. Mark Saltzman, Tissue Engineering – Engineering principles for design of replacement organs and tissue – Oxford University Press Inc New York, 2004.

Web References:

1	https://ocw.mit.edu/courses/biological-engineering/20-010j-introduction-to-bioengineering-be-010j-spring-2006/videos/Lecture-1-bioengineering/
2	https://www.technicalsymposium.com/alllecturenotes_biomed.html
3	https://ocw.mit.edu/courses/biology/7-28-molecular-biology-spring-2005/

Online Resources:

1	https://onlinecourses.nptel.ac.in/noc16_ge03
2	https://onlinecourses.nptel.ac.in/noc17_ge04

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C201.1	Remember	Quiz	5
C201.2	Analyze	Assignment	5
C201.3 & 6	Apply	Class Presentation	5
C201.4 & 5	Understand	Group Assignment	5

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment			End Semester Examination[50 Marks]
	CIA1[10 Marks]	CIA2[10 Marks]	CIA3[10 Marks]	
Remember	20	10	10	10
Understand	80	30	40	40
Apply	-	30	30	30
Analyse	-	30	20	20
Evaluate	-	-	-	-
Create	-	-	-	-

18CH101	ENGINEERING CHEMISTRY (ECE/EEE)		3 /0 /3 /4.5
Nature of Course : E (Theory skill based)			
Course Objectives:			
1	To make the students conversant with boiler feed water, water treatment techniques.		
2	To understand the principles and applications of electrochemistry and to learn electroanalytical methods.		
3	To learn the effect of corrosion in materials and the methods for prevention of corrosion.		
4	To understand the concepts of photophysical and photochemical processes in spectroscopy		
5	To explore the synthesis and properties of important engineering plastics, energy sources and drug molecules.		
Course Outcomes:			
Upon completion of the course, students shall have ability to			
C101.1	Recall the need and requirements of boiler feed water, water treatment procedures, corrosion and its control.		[R]
C101.2	Understand the principle and working of reference electrodes and conductivity meters as an analyzer.		[U]
C101.3	Apply the knowledge of energy sources and storage devices in engineering field		[A]
C101.4	Understand the principle and working of certain analytical techniques		[U]
Course Contents:			
<p>Water chemistry and Corrosion: Water treatment-characteristics of water-hardness-types and estimation by EDTA method. Boiler feed water–requirements-disadvantages of hard water. boiler descaling process. Domestic water treatment-disinfection methods (chlorination, Ozonation, UV treatment)-demineralization process–desalination-reverse osmosis. Corrosion-types–mechanism of dry and wet corrosion-galvanic corrosion-differential aeration corrosion-protective coatings-electroplating of gold-electroless plating of nickel.</p> <p>Electrochemistry and Energy sources: Electrochemical cells-electrolytic cell-reversible and irreversible cells - Free energy and emf, cell potentials, Nernst equation and applications. Oxidation and reduction potentials-standard hydrogen electrode, saturated calomel electrode, glass electrode-pH measurement. Energy Sources-Nuclear energy-reactor-breeder reactor- Photovoltaic cells-Fuel cells. Storage Devices-Batteries- alkaline-Lead acid and nickel cadmium batteries.</p>			

Polymer chemistry, Spectroscopic techniques and Synthesis of drug molecules: Introduction-monomers and polymers-classification of polymers-Polymerization-types. Mechanism of addition polymerization (free radical mechanism). Plastics-classification-preparation, properties and uses of Nylon 6,6, Nylon 6, PVC, Bakelite and PET. Moulding methods-Compression moulding, Injection moulding and Blow moulding. Spectroscopy-Beer Lambert's law, principle, instrumentation and applications of Electronic spectroscopy (UV-visible), Vibrational and rotational spectroscopy (IR) and Flame emission spectroscopy (FES). Synthesis of a commonly used drug molecule-Asprin, p-nitroaniline from acetanilide

Field work:

Industrial visit- Water treatment plant / Sewage treatment plant / Reverse osmosis plant

Lab Component

1	Estimation of hardness of water by EDTA method	[E]
2	Estimation of alkalinity of water sample	[E]
3	Determination of chloride content in given water sample	[E]
4	Estimation of dissolved oxygen in water	[E]
5	Potentiometry- determination of redox potentials and emf's	[E]
6	Conductometric titration-mixture of acids vs NaOH	[E]
7	Determination of strength of strong acid by pH metry	[E]
8	Corrosion rate of mild steel in acid medium	[E]
9	Electroplating of nickel over copper	[E]
10	Spectrophotometry-Estimation of iron in water	[E]
11	Separation of mixture of amino acids by thin layer chromatography	[E]
12	Synthesis of Nylon 66	[E]
Total Hours:		75

Text Books:

1	Dara S.S, Umare S.S, "Engineering Chemistry", S. Chand & Company Ltd., New Delhi 2013.
2	Chemistry: Principles and Applications, by M. J. Sienko and R. A. Plane
3	Fundamentals of Molecular Spectroscopy, by C. N. Banwell
4	Physical Chemistry, by P. W. Atkins
5	Organic Chemistry: Structure and Function by K. P. C. Vollhardt and N. E. Schore, 5 th Edition http://bcs.whfreeman.com/vollhardtschore5e/default.asp
6	Engineering Chemistry (NPTEL Web-book), by B. L. Tembe, Kamaluddin and M. S.Krishnan
7	N.Krishna murthy,Vallinayagam D., "Engineering Chemistry" PHI Learning Pvt Ltd.,2014
8	R.V.Gadag, A.Nithyananda Shetty "Engineering Chemistry" 3rd edition PHI Learning Pvt Ltd.,2014

Reference Books:

1	Shikha Agarwal., "Engineering Chemistry and Applications", Cambridge University press, 2016.
2	Liliya.,Bazylak.I.,Gennady.E.,Zaikov.,Haghvi.A.K., "Polymers and Polymeric Composites" CRC Press,2014.
3	Lefrou.,Christine.,Fabry.,Pierre.,Poignet.,Jean-claude., "Electrochemistry - The Basics, with examples" 2012 ., Springer.

4	Zaki Ahmad, Digby Macdonald, "Principles of Corrosion Engineering and Corrosion Control", Elsevier Science, 2nd Edition 2012.
5	Perez, Nestor, "Electrochemistry and Corrosion Science", Springer, 2016.
6	Ghazi A.Karim. "Fuels, Energy and the Environment", CRC Press, Taylor and Francis group, 2012.
Web References:	
1	http://www.analyticalinstruments.in/home/index.html
2	www.springer.com › Home › Chemistry › Electrochemistry
3	https://www.kth.se/.../electrochem/welcome-to-the-division-of-applied-electrochemistry
4	www.edx.org/
5	https://www.ntnu.edu/studies/courses
6	www.corrosionsource.com/
Online Resources:	
1	nptel.ac.in/courses/105104102/hardness.htm
2	https://ocw.mit.edu/courses/chemistry
3	nptel.ac.in/courses/105106112/1_introduction/5_corrosion.pdf
4	https://alison.com - Spectroscopic technique, Colorimetry
5	https://ocw.mit.edu/courses/chemistry
6	nptel.ac.in/courses/113108051

Assessment Methods & Levels (based on Blooms' Taxonomy)					
Summative assessment based on Continuous and End Semester Examination					
Bloom's Level	Continuous Assessment				End Semester Examination (Theory) [40 marks]
	Theory			Practical	
	CIA-I [10 marks]	CIA-II [10 marks]	CIA-III [10 marks]		
Remember	30	30	30	10	20
Understand	60	50	40	20	50
Apply	10	20	30	40	30
Analyse	-	-	-	30	-
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

18EC201	ELECTRON DEVICES	3/0/3/4.5
Nature of Course		: C (Theory Concept)
Course Objectives:		
1	To Recall the basic Semiconductor Theory concepts.	
2	To introduce most of the basic electronic devices and discuss about their operations.	
3	To enable the student to select appropriate devices to design a circuit for a particular application.	
4	To study experimentally the characteristics of diodes, BJT, FET, thyristors, rectifiers and filters	
Course Outcomes:		
Upon completion of the course, students shall have ability to		
C201.1	Understand the basic Semiconductor Theory concepts	[U]
C201.2	Construct circuits by applying the theoretical knowledge gained in electron devices	[AP]
C201.3	Analyse the electrical characteristics of unipolar and bipolar devices with the constructed circuits	[AN]
C201.4	Observe and analyse the operation of wave shaping circuits.	[AN]
C201.5	Observe and analyse the operation of half wave rectifier, full wave rectifier with and without capacitive filters	[AN]
C201.6	Design and analyze circuits involving electronic components.	[AN]
Course Contents:		
<p>Semiconductor Theory: Energy band theory, Fermi levels; Conductors, Semiconductors and Insulators: electrical properties, band diagrams. Semiconductors: intrinsic and extrinsic, energy band diagram, P-type and N-type semiconductors, drift and diffusion carriers. – carrier concentration–continuity equation - Hall effect.</p> <p>Diodes and their Applications: Formation of P-N junction, forward and reverse biased P-N junction, V-I characteristics, Zener breakdown, Avalanche breakdown and its reverse characteristics, Tunnel diode. Rectifiers, Filters, Clipper, Clamper, Voltage Doubler, Voltage Dividers, Voltage Regulator.</p> <p>Transistors and Thyristors: BJT:Principle of transistor action–Current components–Cutoff, active and saturation region–Input and output characteristics–CE, CB, & CC Configurations – Transistor as a switch, Fundamentals of JFETs and the device characteristics – JFET parameters, MOSFET – principle of operation- Depletion and enhancement modes. Thyristors: SCR – TRIAC – DIAC - UJT operation – characteristics</p>		

Lab Component		
1	Characteristic analysis of PN Junction Diode	[E]
2	Characteristic analysis of Zener Diode	[E]
3	Characteristic analysis of BJT	[E]
4	Characteristic analysis of JFET devices	[E]
5	Negative resistance characteristics of UJT	[E]
6	Characteristic analysis of Thyristors	[E]
7	Analysis of wave shaping circuits	[E]
8	Design and analysis of Rectifiers with and without filter	[E]
Total Hours:		75

Text Books:

1	Jacob Millman, Chritos C Halkias, Satyabrata Jit, 'Electronic Devices and Circuits', 4 th edition (SIE), McGraw Hill Education India Private Ltd., 2015
2	Salivhanan, 'Electron Devices and Circuits', 4 th edition, McGraw Hill Education India Private Ltd., 2016
3	Robert Boylestad and Louis Nashelsky, 'Electron Devices and Circuit Theory', 11th edition, Pearson New International Edition, 2013

Reference Books:

1	Donald A Neaman, 'Semiconductor Physics and Devices', 4 th edition, McGraw Hill Education India Private Ltd., 2011
2	Sedra and Smith, 'Microelectronic Circuits', Oxford University Press, 5th Edition, 2005.

Web References:

1	www.allaboutcircuits.com
2	www.circuitstoday.com

Online Resources:

1	http://www.electronics-tutorials.ws
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Assessment Methods & Levels (based on Blooms' Taxonomy)

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment				End Semester Examination (Theory) [40 marks]
	Theory			Practical	
	CIA-I [10 marks]	CIA-II [10 marks]	CIA-III [10 marks]		
Remember	30	30	30	10	20
Understand	60	50	20	20	30
Apply	10	20	30	20	30
Analyse	-	-	20	30	20
Evaluate	-	-	-	20	-
Create	-	-	-	-	-

18EN102	TECHNICAL COMMUNICATION SKILLS (ECE /EEE)	2/0/2/3
Nature of Course :E(Theory Skill Based)		
Course Objectives:		
1	To enhance learners' LSRW skills.	
2	To develop communication and soft skills.	
3	To facilitate learners to acquire effective technical writing skills.	
4	To prepare learners for placement and competitive exams.	
Course Outcomes:		
Upon completion of the course, students shall have ability to		
C102.1	Recall language skills for technical communication.	[U]
C102.2	Understand and communicate effectively in personal and professional situation.	[AP]
C102.3	Apply technical writing skills to write letters, emails and prepare technical documents.	[AP]
C102.4	Apply soft skills in corporate environment.	[AP]
Course Contents:		
Listening and Speaking		
Basics of English Language - Importance of LSRW Skills - Introducing Others - Listening to Short Conversations or Monologues - Listening to Speeches / Talks - Listening and Responding - Identifying the Information Before Listening - Longer Listening Tasks - Recognise Functions Speaking - Speaking about Giving Directions / Instruction - Talk about Preferences-Agree and Disagree - Giving Opinions - Speaking Practices by Giving Examples, Reasons and Extra Information- Short Talk on Business Topics.		
Reading		
Reading Short Texts - Skimming and Scanning - Comparing Facts and Figures - Reading and Understanding Specific Information in a Text - Reading for Gist - Cloze Reading - Identifying Reasons and Consequences Through Reading Practices - Comprehension - Collocations.		
Writing and Grammar		
Writing Formal Letters (Accepting and Declining Invitations) - Writing Business Letters (Placing an Order and Complaint Letter) - Email Writing – Memo - Circular - Agenda and Minutes of the Meeting - Job Application Letter - Resume Writing - Paragraph Writing – Essay Writing-Technical Instructions and Recommendations- Jumbled Sentences - Technical Definitions - Report Phrases - Report Writing - Technical Proposal - Transcoding (Bar Chart, Flow Chart) - Note Making.		
Parts of Speech- Tenses – Subject Verb Agreement - Sentence Structures - Connectives - Modal Verbs - Question Formation - If Conditionals- Active and Passive - Impersonal Passive Voice - Vocabulary Building - Business Vocabulary - Word Formation - Prefixes and Suffixes - Synonyms, Antonyms –, Abbreviations and Acronyms – Homophones and		

Homonyms- British and American Words - Identifying Common Errors.		
Lab Components		
1	Listening Comprehension	[E]
2	Pronunciation, Intonation, Stress and Rhythm	[E]
3	Common Everyday Situations: Conversations and Dialogues.	[E]
4	Formal Presentation	[E]
5	Group Discussion	[E]
6	Interview Skills	[E]
	Total Hours:	60
Text Books:		
1	Practical English Usage. Michael Swan. OUP. 1995.	
2	Remedial English Grammar. F.T. Wood. Macmillan.2007	
3	On Writing Well. William Zinsser. Harper Resource Book. 2001	
4	Dr Sumanth S, English for Engineers, Vijay Nicole Imprints Private Limited 2015.	
Reference Books:		
1	Study Writing. Liz Hamp-Lyons and Ben Heasley. Cambridge University Press. 2006.	
2	Communication Skills. Sanjay Kumar and Pushp Lata. Oxford University Press. 2011.	
3	Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford University Press	
Web References:		
1	http://www.academiccourses.com/Courses/English/Business-English	
2	https://stepstest.in	
Online Resources:		
1	https://www.coursera.org/specializations/business-english	
2	http://www.academiccourses.com/Courses/English/Business-English	

Assessment Methods & Levels (based on Blooms' Taxonomy)					
Summative assessment based on Continuous and End Semester Examination					
Bloom's Level	Continuous Assessment				End Semester Examination (Theory) [40 marks]
	Theory			Practical	
	CIA-I [10 marks]	CIA-II [10 marks]	CIA-III [10 marks]		
Remember	20	20	20	20	20
Understand	40	40	40	40	40
Apply	40	40	40	40	40
Analyse	-	-	-	-	-
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

18ME111	ENGINEERING GRAPHICS	2/0/2/3	
Nature of Course: M (Practical application)			
Course Objectives:			
<ol style="list-style-type: none"> 1. To know the method to construct the conic curves used in Engineering Applications. 2. To develop an understanding of Isometric to Orthographic Views and vice versa. 3. To learn the basic projection of straight lines and plane surfaces. 4. To develop the imagination of solids inclined to one reference plane. 5. To know the development of surfaces used in various fields 			
Course Outcomes			
C111.1	Understand the basic concepts of Engineering Graphics.	[U]	
C111.2	Sketch isometric, orthographic projections and projection of lines and planes	[Ap]	
C111.3	Develop lateral surfaces of solids including prisms and pyramids	[Ap]	
C111.4	Construct projections of lines, planes, solids and isometric views using modelling software.	[A]	
Course Contents			
Conic curves and Special curves-Isometric to Orthographic projection-Orthographic to Isometric projection-Projection of Lines and Plane surfaces-Projection of Solids-Development of Surfaces-Introduction to Perspective projection.			
S.No	List of Experiments	CO	RBT
		Mapping	
1	Introduction to Drafting Software.	C111.1	U
2	Construction of Conic Curves (Ellipse, Parabola and Hyperbola)	C111.1	U
3	Construction of Special Curves (Cycloid and Involute)	C111.1	U
4	Isometric to Orthographic projections – Manual sketches	C111.2	Ap
5	Isometric to Orthographic projections – Software sketches	C111.4	A
6	Projection of lines - Inclined to HP, VP and Both HP & VP	C111.4	A
7	Projection of Plane surfaces (Hexagon, Pentagon and circle) – inclined to any one of the principle planes	C111.4	A
8	Projection of Solids (Prism and Pyramid) – Inclined to HP	C111.3	Ap
9	Projection of Solids (Cone and Cylinder) – Inclined to VP	C111.3	Ap
10	Development of Surfaces (Prism, Pyramid, Cone and Cylinder)	C111.4	A
11	Introduction to Perspective projection	C111.2	U
		Total Hours	45
Reference Books:			
<ol style="list-style-type: none"> 1. Bhatt N.D. and Panchal V.M., “Engineering Drawing”, Charotar Publishing House, 50th Edition, 2014. 2. K. V. Natarajan, “A Text Book of Engineering Graphics”, Dhanalakshmi Publishers, 2018. 3. Gopalakrishna K.R., “Engineering Drawing” (Vol. I&II combined), Subhas Stores, Bangalore, 2011. 4. Venugopal K. and Prabhu Raja V., “Engineering Graphics”, New Age International (P) Limited, 2013. 			

Web References:

1. <http://nptel.ac.in/courses/112102101/>
2. www.solidworks.com

Blooms Taxonomy based Assessment Pattern:

Tentative Assessment Methods & Levels (based on Bloom's Taxonomy)		
Summative assessment based on Continuous and End Semester Examination		
Bloom's Level	Rubric based Continuous Assessment[60 marks]	End Semester Examination [40 marks]
Remember	30	30
Understand	30	30
Apply	20	20
Analyze	20	20
Evaluate	0	0
Create	0	0

18MC201	ENVIRONMENTAL SCIENCES	2 /0 /0 /0
Nature of Course		:C (Theory Concept)
Course Objectives:		
1	To learn the integrated themes on various natural resources.	
2	To gain knowledge on the type of pollution and its control methods.	
3	To have an awareness about the current environmental issues and the social problems.	
Course Outcomes:		
Upon completion of the course, students shall have ability to		
C201.1	Recall and play an important role in transferring a healthy environment for future generation.	[R]
C201.2	Understand the importance of natural resources and conservation of biodiversity.	[U]
C201.3	Understand and analyze the impact of engineering solutions in a global and societal context.	[U]
C201.4	Apply the gained knowledge to overcome pollution problems.	[AP]
C201.5	Apply the gained knowledge in various environmental issues and sustainable development.	[AP]
Course Contents:		
Natural Resources:		
Introduction-Forest resources: Use and abuse, case study-Major activities in forest-Water resources-over utilization of water, dams-benefits and problems. Mineral resources-Use and exploitation, environmental effects of mining- case study-Food resources- World food problems, case study. Energy resources -Renewable and non-renewable energy sources Land resources- Soil erosion and desertification – Role of an individual in conservation of natural resources.		
Environmental Pollutions:		
Definition – causes, effects and control measures of: a. Air pollution-Acid rain - Green house effect-Global warming- Ozone layer depletion – case study- Bhopal gas tragedyb. Water pollution c. Soil pollution - Solid waste management-Recycling of plastics-Pyrolysis method-causes, effects and control measures of municipal solid wastes d. Noise pollution. e. Nuclear hazards-case study-Chernobyl nuclear disaster-Role of an individual in prevention of pollution.		
Social issues and the Environment:		
Sustainable development-water conservation, rain water harvesting, E-Waste Management – Environmental ethics: 12 Principles of green chemistry-Scheme of labelling of environmental friendly products (Eco mark) – Emission standards – ISO 14001 standard.		
Hours:		Total
		30
Text Books:		
1	AnubhaKaushik and C P Kaushik “Perspectives in Environmental Studies”4 th Edition, Newage International (P) Limited, Publisher Reprint 2014. New Delhi	
2	Rajagopalan, R, “Environmental Studies-From Crisis to Cure”, Oxford University Press 2015.	
Reference Books:		
1	Tyler Miller, Jr., “Environmental Science”, Brooks/Cole a part of Cengage Learning, 2014.	

2	William Cunningham and Mary Cunningham, "Environmental Science", 13 th Edition, McGraw Hill, 2015.		
3	Gilbert M. Masters, "Introduction to Environmental Engineering and Science", Third Edition, Pearson Education, 2014.		
Web References:			
1	http://nptel.ac.in/courses/104103020/20		
2	http://nptel.ac.in/courses/120108002		
3	http://nptel.ac.in/courses/122106030		
4	http://nptel.ac.in/courses/120108004/		
5	http://nptel.ac.in/courses/122102006/20		
Online Resources:			
1	https://www.edx.org/course/subject/environmental-studies		
2	www.environmentalscience.org		
Assessment Methods & Levels (based on Bloom's Taxonomy)			
Formative assessment based on Capstone Model (Max. Marks:20)			
Course Outcome	Bloom's Level	Assessment Component	Marks
C201.1	Remember	Quiz	5
C201.2	Understand	Writing Skills	5
C201.3	Understand	Class Presentation	5
C201.4	Apply	Group Assignment	5
Summative assessment based on Continuous Assessment			
Bloom's Level	Continuous Assessment		
	CIA-I [25 marks]	CIA-II [25 marks]	Term End Assessment [30 marks]
Remember	20	40	20
Understand	60	50	60
Apply	20	10	20
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-

18MA302	DICRETE TRANSFORMS AND FOURIER ANALYSIS (ECE)	3/1/0/4
Nature of Course		
J (Problem analytical)		
Pre requisites		
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Course Objectives:		
1	To acquaint the student with Fourier transform techniques which are used in variety of engineering fields	
2	To understand the different possible forms of Fourier series	
3	To study the concept of mathematical formulation of certain practical problems in terms of partial differential equations and solving for physical interpretation	
4	To apply Laplace transform technique to solve difference equations	
5	To solve difference equations using Z transform technique	
Course Outcomes:		
Upon completion of the course, students shall have ability to		
C303.1	Use Fourier transform techniques to evaluate the integrals	[R]
C303.2	Interpret Fourier series solutions to the engineering problems	[U]
C303.3	Formulate and solve the partial differential equations	[AP]
C303.4	Use Laplace transform techniques to evaluate the integrals	[AP]
C303.5	Apply the basics of Z transform techniques in Engineering problems	[AP]
Course Contents:		
<p>Continuous Time Fourier Transform and Fourier series : Conditions for existence of Fourier transform - Fourier transform pair-Properties-Transforms of simple functions.</p> <p>Continuous Time Fourier series: Dirichlet's conditions-Trigonometric Fourier Series -Odd and Even Functions- Half range sine series and cosine series-Exponential Fourier series – Properties - Harmonic analysis</p> <p>Partial Differential Equations : Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions - Lagrange's linear equations-Linear homogeneous partial differential equations of second and higher order with constant coefficients-Applications of PDE: One dimensional wave equation-One dimensional equation of heat conduction.</p> <p>Laplace Transform and Z- Transform: Laplace Transform: Convergence of Laplace transform-Transform of some standard functions –Properties-Initial and final value theorem - Inverse Laplace transform- Partial fraction method-Convolution theorem-Z- Transform: Convergence of Z transform and properties of ROC-Z-transform of Standard functions-Properties -Inverse Z- transform-Long division method, partial fraction method, Residual methods.</p>		
Total Hours:		60
Text Books:		
1	A.NagoorKani,"Signals and Systems", Tata McGraw-Hill education, 2014	
2	Kreyszig. E, "Advanced Engineering Mathematics" Tenth Edition, John Wiley and Sons (Asia) Limited, Singapore 2014	
3	Grewal. B.S, "Higher Engineering Mathematics", 43 rd edition, Khanna Publications, Delhi, 2014	

Reference Books:				
1	R.Rameshbabu and R.Anandanatarajan, "Signals and Systems", fourth edition, Scitech Publications Pvt. Ltd. 2014			
2	Veerarajan. T, "Transforms and Partial differential equations", 3 rd edition, Tata McGraw-Hill Publishing Company Ltd., reprint,2016			
3	Glyn James, —Advanced Modern Engineering Mathematics, Pearson Education, 4 th edition, 2016			
4	N.P.Bali,"A Text book of Engineering Mathematics Sem-III/IV" 13 th edition, Laxmi publications ltd, 2017			
Web References:				
1	http://nptel.ac.in/video.php?subjectId=122107037			
2	http://nptel.ac.in/courses/122107036/			
3	http://nptel.ac.in/video.php?subjectId=117102060			
Online Resources:				
1	https://www.edx.org/course/calculo-diferencial-galileox-cmath001rx			
2	https://www.edx.org/course/pre-university-calculus-delftx-calc001x-1			
3	https://www.edx.org/course/calculus-1a-differentiation-mitx-18-01-1x			
4	https://alison.com/courses/Advanced-Mathematics-1			
5	https://ocw.mit.edu/courses/.../18-335j-introduction-to-numerical-methods-fall-2010 /ocw.usu.edu › Electrical and Computer Engineering › Signals and Systems			
Assessment Methods & Levels (based on Blooms' Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component		Marks
C104.1	Remember	Classroom or Online Quiz		2
C104.2	Understand	Class Presentation/Power point presentation		4
C104.3	Apply	Group Assignment		6
C104.4& C104.5	Apply	Group activities		8
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination
	CIA1	CIA2	Term End Assessment	
Remember	20	20	20	20
Understand	30	30	30	30
Apply	50	50	50	50
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

18EC301	DIGITAL ELECTRONICS	3/0/0/3
Nature of Course	:G (Theory & Analytical)	
Pre requisites	18EC201 Electron Devices	
Course Objectives:		
1	To introduce the principles of switching algebra and various methods to minimize the logic expression	
2	To enable the students to understand the operation of various combinational logic circuits	
3	To enable the students to understand the concepts of various flip flops and their role in sequential logic circuits design	
4	To allow students to design and analyze synchronous sequential circuits	
5	To enable the students to differentiate between various types of memory and understand their roles in digital systems	
Course Outcomes:		
Upon completion of the course, students shall have ability to		
C301.1	Demonstrate knowledge on Switching algebra and their realization using logic gates	[R & U]
C301.2	Applying various methods to minimize the Boolean functions.	[U & AP]
C301.3	Understand the various circuits of combinational logic and their implementation	[AP]
C301.4	Understanding various sequential logic circuits and to apply for various design implementation.	[AP]
C301.5	Apply synchronous sequential logic for Finite state machine for reducing states.	[AP]
C301.6	Understanding the memory concepts and applying for logical function implementation.	[AP]
Course Contents:		
<p>Switching Algebra: Number systems and Conversion, Minterms, Maxterms, Complements, Implementation using universal logic gates, Minimizing functions using Karnaugh maps, Minimization using Quine McClusky method. Different logic families: Review of TTL, ECL, I²L, CMOS, NMOS, Pass transistor logic</p> <p>Combinational logic circuits: Adders and Subtractors, Multiplexer, Demultiplexers, Encoders, Decoders, Carry Look-ahead adder, Magnitude comparator, Code converters, Parity generator and Checker. Sequential logic circuits: Latches and flip flops, Realization of one flip flop using other flip flops, Asynchronous counters and Synchronous counters, Shift registers, Application of Shift registers.</p> <p>Synchronous Sequential logic: Analysis of Synchronous Sequential Circuits, Design of sequence generator and sequence detector, Finite state machine - State transition diagrams and state transition tables. Memory Elements: ROM, PROM, RAM-SRAM, DRAM, PLD's-PLA, PAL, Modelling basic combinational and sequential circuits using Verilog. Case studies: A simple computer, RTL - micro-instruction instruction decoders timing and controller circuits, data path unit</p>		
Total Hours:		45
Text Books:		
1	M. Morris Mano, Michael D.Ciletti., "Digital Design", 5 th Edition, Pearson education, 2013	

2	Donald D. Givone, "Digital principles and Design", 2004, McGraw Hill Education India Private Ltd., 29 th Reprint, 2016			
3	Samir Palnitkar, "Verilog HDL: A Guide to Digital Design and Synthesis" Prentice Hall, Second Edition, 2009			
Reference Books:				
1	J. F. Wakerly, "Digital Design - principles and practices", 4th Edition, Pearson Education, 2008.			
2	Thomas L. Floyd, Digital Fundamentals, 10th Edition, Pearson Education, New Delhi, 2011			
3	John.M Yarbrough, "Digital Logic Applications and Design", Thomson Learning, 2006.			
Web References:				
1	http://www.electrical4u.com/digital-electronics.htm			
2	http://www.technologystudent.com/elec1/dig1.htm			
3	https://thinkelectronics.org › Electronics › Basics of Digital Electronics			
4	https://www.geeksforgeeks.org/basic/digital-electronics-logic-design			
Online Resources:				
1	http://www.nesoacademy.org/electronics-engineering/digital-electronics/digital			
2	https://www.electronics-tutorials.com/basics/digital-basics.htm			
3	https://www.university.youth4work.com › ... › Lectures			
4	https://lecturenotes.in/subject/14/digital-electronics-circuit-dec			
Assessment Methods & Levels (based on Blooms' Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component	Marks	
C301.1	Remember	Quiz	3	
C301.2	Apply	Problem Solving	3	
C301.3	Understand	Group Assignment	3	
C301.4	Apply	Problem Solving	3	
C301.5	Apply	Group Assignment	3	
C301.6	Apply	Case Study	5	
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination[50 Marks]
	CIA1[10 Marks]	CIA2[10 Marks]	CIA3[10 Marks]	
Remember	20	20	10	10
Understand	40	40	40	40
Apply	40	40	30	30
Analyse	-	-	20	20
Evaluate	-	-	-	-
Create	-	-	-	-

18EC302	ELECTRONIC CIRCUITS		3/0/0/3
Nature of Course			
G (Theory analytical)			
Pre requisites			
18EC201 Electronic Devices			
Course Objectives:			
1	To introduce the concept of biasing of BJTs and MOSFETs and enable the students to understand the frequency analysis of amplifiers		
2	To enable the students to understand the concept of negative feedback in amplifiers		
3	To study about the power amplifiers and their thermal stability.		
4	To understand the analysis and design of oscillators		
5	To allow students to get familiarized with the concept of tuned amplifiers and applications		
Course Outcomes:			
Upon completion of the course, students shall have ability to			
C302.1	Understand the biasing of transistors BJT ,MOSFET & the Basic Concepts of Amplifiers BJT& MOSFET		[R]
C302.2	Analyze & Understand the frequency response of BJT & MOSFET amplifiers		[U]
C302.3	Illustrate the operation of various types of Power Amplifiers		[U]
C302.4	Apply the concepts of negative feedback and positive feedback in amplifiers		[AP]
C302.5	Design and develop a circuit based on the concepts of oscillators		[AN]
C302.6	Understand the concept of Narrow band Tuned Amplifier		[AN]
Course Contents:			
<p>Transistor biasing & Amplifiers: Biasing : Operating point, Bias Stability ,BJT-Voltage divider biasing – collector feedback biasing ,MOSFET; Bias Compensation : Amplifiers – small signal Analysis of transistor using hybrid model BJT (CE & CC), MOSFET (CS & CD), & Cascaded amplifiers(Two Stage).</p> <p>Frequency Response of an Amplifier & Power amplifiers: Frequency response of BJT (CE) & MOSFET amplifiers(CS) , low frequency response, high frequency response, Miller effect ,Short circuit current gain ,Unity Gain Bandwidth ;Power Amplifiers: class A, B, AB, C, D, E stages, short circuit protection, power transistors and thermal design considerations; & heat sink;</p> <p>Feedback amplifiers ,Signal generation & Tuned Circuits : Feedback amplifiers: Impact of negative feedback on amplifiers properties , Feedback topologies and their properties, analysis of practical feedback amplifiers, loop gain & stability; Signal Generation : Principles of Oscillators , sinusoidal oscillators: RC, LC and crystal oscillators multi-vibrators; Tuned Amplifiers : Narrowband tuned amplifier (capacitor coupled) , Overview of Double tuned amplifier and stagger tuned amplifier, BiCMOS & HCMOS.</p>			
Total Hours:			45
Text Books:			
1	Jacob Millman, Chritos C Halkias, Satyabrata Jit, 'Electronic Devices and Circuits', 4 th edition (SIE), McGraw Hill Education India Private Ltd., 2015		
2	Salivhanan, 'Electron Devices and Circuits', 4 th edition, McGraw Hill Education India Private Ltd., 2016		

3	Sedra and Smith, "Micro Electronic Circuits"; Sixth Edition, Oxford University Press, 2011			
Reference Books:				
1	Robert L. Boylestad and Louis Nashelsky, "Electronic Devices and Circuit Theory", 9 th Edition, Pearson Education / PHI, 2014.			
2	Floyd, "Electronic Devices", 9 th Edition, Pearson Education, 2011			
3	David A. Bell, Electronic Devices & Circuits, 5 th Edition, PHI, 2008			
4	Donald .A. Neamen, Electronic Circuit Analysis and Design –2 nd Edition, Tata Mc Graw Hill, 2009.			
Web References:				
1	http://www.allaboutcircuits.com/			
2	http://www.circuitstoday.com/			
3	https://circuitdigest.com/electronic-circuits/			
4	https://www.eleccircuit.com/			
Online Resources:				
1	http://www.nesoacademy.org/electronics-engineering/analog-electronics/analog			
2	https://onlinecourses.nptel.ac.in/noc18_ee11			
Assessment Methods & Levels (based on Blooms' Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Tentative Assessment Component	Marks	
C302.1	Remember	Quiz	2	
C302.2	Understand	Quiz	3	
C302.3	Analyse	Quiz	4	
C302.4	Apply	Group Assignment	4	
C302.5	Analyse	Simulation Exercise	3	
C302.6	Apply & Analyse	Simulation Exercise & Mini Project	4	
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination [50 marks]
	CIA-I [10 marks]	CIA-II [10 marks]	CIA3 [10 marks]	
Remember	30	10	10	20
Understand	50	30	40	30
Apply	20	30	30	30
Analyse	-	30	20	20
Evaluate	-	-	-	-
Create	-	-	-	-

18EC303	ELECTROMAGNETICS		3/0/0/3
Nature of Course			
		C (Descriptive & Analytical).	
Pre requisites			
		18MA302: Discrete Transform and Fourier Analysis	
Course Objectives:			
1	To review about co-ordinate systems and to enable the students to understand the concepts of electrostatics		
2	To enable the students to understand the concepts of static and vector magnetic fields		
3	To understand how electric and magnetic fields affect materials and the relation between the fields under time varying situations.		
4	To analyze the principles of propagation of uniform plane waves and radiation hazards due to electromagnetic waves		
Course Outcomes:			
Upon completion of the course, students shall have ability to			
C303.1	Recall the basics of co-ordinate systems and understand the concepts of EM field distribution under static conditions for various geometries		[R]
C303.2	Apply boundary conditions to solve for fields at interface between two different charge medium		[AP]
C303.3	Classify the basic Magneto static laws and interpret the nature of magnetic fields		[U]
C303.4	Understand the concepts of time varying electric and magnetic fields		[U]
C303.5	Apply the concepts of Maxwell's equations in propagation of uniform plane waves		[AP]
C303.6	Analyze the propagation of electromagnetic waves and radiation hazards due to electromagnetic waves		[A]
Course Contents:			
<p>ELECTROSTATICs: Introduction to Co-ordinate System, Differential Length, Area and Volume ,Introduction to line, Surface and Volume Integrals, Gradient, Divergence and Divergence theorem, Curl and Stoke's theorem, Laplacian of a Scalar. Electric Charge,Coulomb's law, Electric field, Dielectric materials Electric potential, Charge densities – Line, Surface, Volume charge densities, Electric energy Electric flux, Electric flux density, Gauss's law. Electric potential due to dipole - Capacitance Energy density in the electrostatic field. Laplace and Poisson's equations Applications for Laplace's equation - Capacitance - Parallel plate, coaxial and spherical capacitors Boundary conditions, Electric current, Current density, Point form of Ohm's law. Applications: CRT-electric deflection, Heart dipole field, Defibrillators, Pacemakers, Cross talk[theoretical concepts]</p> <p>MAGNETOSTATICS & TIME VARYING FIELD: Magnetic field, Biot-Savart's law, Ampere's law, magnetic flux, Magnetic flux density, Gauss's law, Magnetic vector potential, Lorentz force equation, Definition of Inductance and inductors, Magnetic energy and energy density Magnetic materials ,Boundary conditions. Applications: Energy stored in magnetic fields Magnetic brake, Linear motor, Time Varying Field: Induction, Faraday's law, Lenz's law, Displacement current, Limitations of Ampere's law, Maxwell's equations.</p> <p>UNIFORM PLANE WAVE: Wave, Wave equation, Wave propagation in space, Conducting media and Dielectric loss, Travelling waves and standing waves Plane waves at interfaces, Normal incidence, Phase velocity, Group velocity, Index of refraction, Power and energy relations, Polarizations - Linear, Elliptic and Circular, Oblique incidence - reflection, and</p>			

refraction for parallel and perpendicular cases, Diffraction, Radiation and nuclear health Hazards. Applications – Rectilinear optic fibres, Electromagnetic hazards and the environment. Biological effects of EMF –radiation hazards of wearable antennas .

Total Hours: 45

Text Books:

1	Sadiku M H, "Principles of Electromagnetics" , Oxford University Press Inc., New Delhi,2015.
2	John D Kraus and Daniel A Fleisch," Electromagnetic with applications", 5th Edition, McGraw-Hill, 2005
3	William H. Hayt, John A. Buck, "Engineering Electromagnetic", 8th Edition, McGraw-Hill, 2014.

Reference Books:

1	David K Cheng,"Fields and Wave Electromagnetics", Pearson new international edition , Pearson Education Limited 2013
2	J. Edminister, "Schaum's Outline of Electromagnetics", 4th Edition, McGraw-Hill, 2013
3	Martin K.Plonus, "Applied Electromagnetics"-McGraw Hill 1984

Web References:

1	nptel.ac.in/courses/108104087
2	http://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-630-electromagnetics-fall-2006/
3	http://nptel.ac.in/courses/117103065/
4	http://nptel.ac.in/video.php?subjectId=108106073

Online Resources:

1	Biological effects of EMF –radiation hazards of wearable antennas by Dr. Heather Song University of Colorado Springs, 2014
2	Wearable antennas for off-body radio links at VHF and UHF bands P Nepa, H Rogier - IEEE antennas and Propagation Magazine, 2015 - ieeexplore.ieee.org
3	On the evaluation of biological effects of wearable antennas on contact with dispersive medium in terms of SAR and bio-heat by using FIT technique https://ieeexplore.ieee.org/document/6521719

Assessment Methods & Levels (based on Blooms' Taxonomy)
Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C303.1	Remember	Classroom or Online Quiz	4
C303 .3,4	Understand	Class Presentation/Power point presentation	6
C303.2, 5.6	Apply, Analyze	Group Assignment & Tutorial	10

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment			End Semester Examination[50 Marks]
	CIA1[10 Marks]	CIA2[10 Marks]	CIA3[10 Marks]	
Remember	20	20	20	20
Understand	30	20	20	20
Apply	50	20	20	30
Analyse	-	40	40	30
Evaluate	-	-	-	-

18MG301	PRINCIPLES OF MANAGEMENT	3/0/0/3
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Nature of Course	: C (Theory Concept)	
Pre requisites	Nil	
Course Objectives:		
1	To enable the students to understand the principles of management and the management concepts	
2	To enable the students to understand the need for business process reengineering	
3	To enable the students to understand the concepts of organizational behaviour	
4	To enable the students to understand the human resource management	
Course Outcomes:		
Upon completion of the course, students shall have ability to		
C301.1	Explore their acquired knowledge on recalling the management skills acquired during various team activities.	[R]
C301.2	Understand the concept of principles of management.	[U]
C301.3	Apply the management concepts in an organization.	[AP]
C301.4	Analyse organizational behaviour with a case study.	[AN]
C301.5	Analyse human resource and its quality.	[AN]
Course Contents:		
<p>PRINCIPLES OF MANAGEMENT: Meaning, Definition and Significance of Management, Basic Functions of Management – Planning, Organizing, Staffing, Directing and Controlling -</p> <p>ENGINEERS AND ORGANIZATIONAL ENVIRONMENT: Social, Economic, Technological and Political and Legal - Social Responsibility of Engineers</p> <p>MANAGEMENT CONCEPTS: MBO, Theory Z, Theory X & Y, Kaizen, Six Sigma, Quality Circles, TQM and TPM BUSINESS PROCESS REENGINEERING: Need for BPR, Various phases of BPR, Quality, Production and Productivity in six sigma and TQM –Factors Influencing Productivity</p> <p>ORGANISATIONAL BEHAVIOUR:Meaning, Definition, Significance of OB, Role of Leadership, Personality and Motivation, Stress, Attitudes, Values and Perceptions,Stress at work- Resource Management - Internal and External Sources - Types of Organization.</p> <p>HUMAN RESOURCE MANAGEMENT:Meaning, Definition, Importance, Objectives and Functions, Job Analysis and Recruitment, Selection and Placement, Training and Development –Case Discussion</p>		
Total Hours:		45
Text Books:		
1	Harold Koontz, Heinz Wehrich and Ramachandra Aryasri, “Principles of Management”-Tata McGraw Hill, NewDelhi, 2014.	
2	Gary Dessler, “Human Resource Management”, Prentice Hall of India, New Delhi, 2009	
3.	Stephen P. Robbins and Mary Coulter, 'Management', Prentice Hall of India, 8th edition. 2013	
Reference Books:		

1	Mamoria, C. B., "Personnel Management", Sultan Chand and Sons, New Delhi, 2005.			
2	Charles W L Hill, Steven L McShane, 'Principles of Management', Mcgraw Hill Education, Special Indian Edition, 2007.			
3	Hellriegel, Slocum & Jackson, ' Management - A Competency Based Approach', Thomson South Western, 10th edition, 2007.			
Web References:				
1	http://www.nptel.ac.in/courses/110102016			
Online Resources:				
1	https:// www.coursera.org/learn/fundamentals-of-management			
Assessment Methods & Levels (based on Revised Bloom's Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Revised Bloom's Level	Tentative Assessment Component	Marks	
C301.1	Remember	Quiz	5	
C301.2	Understand	Writing Skills	5	
C301.3	Apply	Group Assignment	5	
C301.4 & C301.5	Analyse	Class Presentation/ Case Study	5	
Summative assessment based on Continuous and End Semester Examination				
Revised Bloom's Level	Continuous Assessment			End Semester Examination [60 marks]
	CIA-I [10 marks]	CIA-II [10 marks]	Term End Examination [10 marks]	
Remember	40	20	20	20
Understand	60	60	40	40
Apply	-	20	20	20
Analyse	-	-	20	20
Evaluate	-	-	-	-
Create	-	-	-	-

18CS311	LINUX AND PROGRAMMING IN C++	3/0/3/4.5
Nature of Course :F (Theory Programming)		
Pre requisites : 18CS111 Problem solving Using C Programming		
Course Objectives:		
1	To introduce basic Linux concepts.	
2	To explain Object Oriented Programming concepts like data abstraction and encapsulation.	
3	To analyse different kinds of constructors, inheritance and polymorphism.	
4	To understand and apply streams and file concepts.	
Course Outcomes:		
Upon completion of the course, students shall have ability to		
C311.1	Remember the basic commands of Linux.	[R]
C311.2	Understand the basic Linux Commands and file system hierarchy	[U]
C311.3	Construct and apply C++ program to solve the given problems using basic programming constructs.	[AP]
C311.4	Apply the concepts of friend function and virtual functions.	[AP]
C311.5	Apply the concepts of polymorphism.	[AP]
C311.6	Make use of I/O functionality to code basic file operations and experiment with templates.	[AP]
Course Contents:		
Introduction to Linux: Linux basic Commands- File System Hierarchy-Users, groups and permissions. Shell - Types of shell-Shell scripting.		
Principles of Object-Oriented Programming: Basic concepts and benefits of Object Oriented Programming - Programming paradigms- Comparison- Procedure Oriented Programming with Object Oriented Programming. An overview of C++: Datatypes, Selection statements, Functions, Arrays, Function overloading.Classes and objects, Default constructor, operator overloading, Friend functions- virtual functions.		
Object-Oriented Programming Concepts: Derived classes- Inheritance, Virtual Base Class, Abstract class, Polymorphism and Virtual Functions-Virtual Base class-Templates, Exception Handling-Console Input /output operation, File Handling - Error handling.		
Lab Component		
1	Linux Commands	[E]
2	Shell Programming	[E]
3	Simple Classes for understanding objects, member functions and constructors	[E]
4	Inheritance	[E]
5	Compile time polymorphism	[E]
6	Run time polymorphism	[E]

Total Hours:		75
Text Books:		
1	Christopher Negus, Christine Bresnahan, "Linux Bible", Willey Publishing Inc., 2015.	
2	Herbert Shildt , " The Complete Reference C++" , Fourth Edition, TMH, 2017.	
Reference Books:		
1	K.R.Venugopal, RajkumarBuyya, T.Ravishankar, "Mastering C++", TMH, 2017.	
2	BjarneStroustrup, "The C++ programming language" Addison Wesley, 4 th edition, 2008	
3	Richard Blum, Christine , " Linux Command Line and Shell Scripting Bible" , 2nd Edition, Wiley Publishing Inc. 2015.	
Web References:		
1	http://nptel.ac.in/courses/117106113/	
2	http://nptel.ac.in/syllabus/syllabus.php?subjectId=106106111	
Online Resources:		
1	www.edx.org/course/introduction-linux-linuxfoundationx-lfs101x-0	
2	https://www.coursera.org/learn/c-plus-plus-a	

Assessment Methods & Levels (based on Blooms' Taxonomy)

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment				End Semester Examination (Theory) [40 marks]
	Theory			Practical	
	CIA1 [10 Marks]	CIA2 [10 Marks]	Term End Assessment [10 Marks]	Rubric based CIA [40 Marks]	
Remember	-	-	-	-	-
Understand	50	20	20	20	20
Apply	50	50	50	50	50
Analyse	-	30	30	30	30
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

18EC304	Digital Electronics Lab	0/0/2/1	
Co requisites	18EC301 Digital Electronics		
Nature of Course: M (Practical application)			
Course Objectives:			
1. To design, construct and debug combinational and sequential circuits based on an abstract functional specification.			
2. To simulate basic combinational and sequential logic circuits using HDL language			
Course Outcomes			
C304.1	Ability to analyse and synthesize various techniques for implementing combinational and sequential digital circuits	[AP]	
C304.2	Analyzing and implementing the various combinational logic circuits and its truth table.	[AN]	
C304.3	Analyzing the various sequential logic circuits and its characterization.	[AN]	
C304.4	Verification of combinational logic circuits using MSI device	[AP]	
C304.5	Simulation of circuits using hardware description language and verifying its timing waveforms.	[AP]	
Course Content:			
S.No	List of Experiments	CO Mapping	BT
1	Analysis and Synthesis of Boolean Expressions using Basic Logic Gates	C304.1	[AP]
2	Analysis and Synthesis of Arithmetic Expressions using Adders/Subtractors	C304.1	[AN]
3	Analysis and Synthesis of Logic Functions using Multiplexers & Demultiplexers	C304.2	[AN]
4	Analysis and Synthesis of Logic Functions using Decoders & Encoders	C304.2	[AN]
5	Analysis and Synthesis of Boolean Relations using Digital Comparator	C304.2	[AN]
6	Analysis and Synthesis of Code Converters(Binary to Gray, BCD to Excess-3)	C304.2	[AN]
7	Analysis of Functions of BCD-TO-7-segment Decoder / Driver and Operation of 7-segment LED Display	C304.2	[AN]
8	Analysis and Synthesis of Sequential Circuits using Basic Flip – Flops	C304.3	[AN]
9	Analysis and Synthesis of Multi-bit Sequential Circuits using Shift Registers	C304.3	[AN]

10	Analysis and Synthesis of Multi-bit Sequential Circuits using Ripple counter and Synchronous Counter	C304.3	[AN]
11	Design and evaluation of 4-bit Arithmetic Logic Unit	C304.2	[C]
12	Verification using MSI Device	C304.4	[U]
13	Basic Combinational logic circuits & sequential circuits using HDL	C304.5	[C]
Total Hours			30
Reference Books:			
6. M. Morris Mano, Michael D.Ciletti., "Digital Design",4th Edition Pearson education,2011			
7. C. H. Roth Jr., Larry L. Kinney "Fundamentals of Logic Design", 7 th Edition, Cengage Learning, 2014			
8. Thomas L. Floyd, Digital Fundamentals, 10 th Edition, Pearson Education, New Delhi, 2011			
9. J.Bhasker , " A VHDL Primer", AT&T, Prentice hall,2010			
Web References:			
1. http://www.electrical4u.com/digital-electronics.htm			
2. http://www.technologystudent.com/elec1/dig1.htm			
3. http://www.allaboutcircuits.com/education/			

Assessment Methods & Levels (based on Bloom's Taxonomy)		
Summative assessment based on Continuous and End Semester Examination		
Bloom's Level	Rubric based Continuous Assessment[60 marks] (in %)	End Semester Examination [40 marks] (in %)
Remember	10	10
Understand	20	20
Apply	20	20
Analyse	20	20
Evaluate	10	10
Create	20	20

18EC305	ELECTRONIC CIRCUITS LABORATORY		0/0/2/1
Nature of Course : M (Practical application)			
Pre-requisites : 18EC201 Electron Devices & 18EC101 Circuit Theory			
Co requisites 18EC302 Electronic Circuits			
Course Objectives:			
1	To design and construct single stage, multistage amplifier circuits and to verify the voltage gain improvements & frequency response characteristics.		
2	To design and construct circuits to generate sinusoidal waveforms.		
Course Outcomes: Upon completion of the course, students shall have ability to			
C305.1	Understand and construct various types of BJT and JFET Audio Amplifiers	[AP]	
C305.2	Construct the power amplifier circuits and analyse the efficiency of power amplifiers	[AN]	
C305.3	Analyse the performance of amplifier circuits with and without negative feedback	[AN]	
C305.4	Construct the tuning circuits and understand the need of tuned circuits in communications	[AP]	
C305.5	Construct different circuits to generate sinusoidal and non-sinusoidal waveforms	[AP]	
C305.6	Analyse the performance of the various circuits using Simulation Tools & Create the PCB Layout.	[C]	
Course Contents:			
Sl.No	List of Experiments	CO Mapping	RBT
1.	D.C. characterization and finding parameters of transistors (BJT and MOSFET)	-	
2.	Design of simple Audio amplifiers (common emitter and common source)	C305.1	[AP]
3.	Design and implementation of 2- stage RC Coupled Amplifier	C305.1	[AP]
4.	Design and implementation of Class B Power Amplifier	C305.2	[AN]
5.	Design and implementation of Current Series & Shunt feedback amplifier	C305.3	[AN]
6.	Implementation of Single tuned amplifier	C305.4	[AP]
7.	Design and Implementation of radio frequency oscillator	C305.5	[AP]
8.	Design and Implementation of audio frequency oscillator (RC Phase Shift)	C305.5	[AP]
9.	Design of Astable, Monostable and Bistable multivibrators	-	
10.	Using Multisim /Orcad Pspice Tool: Simulation of Common Emitter, Common Collector & Common Source Amplifier and its input & output characteristics.	C305.6	[AP]
11.	Cascade Amplifiers using Darlington Pair of Transistors		

12.	Simulation of Wein Bridge Oscillator.		
13.	Characteristics Analysis of Single Tuned Amplifiers		
14.	PCB Layout generation of Fire Alarm Circuit using Transistor		
Total Hours:			30
Reference Books:			
1	Millman J and Halkias .C, "Integrated Electronics", Second Edition, TMH, 2012		
2	Salivhanan, 'Electron Devices and Circuits', 4 th edition, McGraw Hill Education (India) Private Ltd., 2016		
3	David A Bell, "Laboratory Manual for Electronic Devices and Circuits", 4 th edition, PHI.		
4	Paul B Zbar and Albert P Malvino, Michael A Miller, "Basic Electronics: A Text Lab Manual", 7 th edition, Tata McGraw Hill, 2009		
5	Poornachandra Rao.S and Sasikala.B, "Electronics Laboratory Primer: A Design Approach", 2 nd edition, S.Chand, 2005.		
Web References:			
1	www.allaboutcircuits.com		
2	www.circuitstoday.com		
Online Resources:			
1	http://iitb.vlab.co.in/index.php?sub=43&brch=223		
2	http://vlab.amrita.edu/?sub=3&brch=223		
Assessment Methods & Levels (based on Bloom's Taxonomy)			
Summative assessment based on Continuous and End Semester Examination			
Bloom's Level	Rubric based Continuous Assessment [60 marks] (in %)	End Semester Examination [40 marks] (in %)	
Remember	10	10	
Understand	20	20	
Apply	30	30	
Analyse	20	20	
Evaluate	10	10	
Create	10	10	

18MA403	PROBABILITY THEORY AND RANDOM PROCESSES (ECE)	3/1/0/4
Nature of Course :J (Problem analytical)		
Pre requisites Basic concepts of probability , basic integration		
Course Objectives:		
1	To study the basic probability concepts	
2	To acquire skills in handling situations involving more than one random variable	
3	To understand and have a well – founded knowledge of standard distributions which can be used to describe real life phenomena	
4	To know the probabilistic model used for characterizing a random signal and the nature of dependence relationship existing among the members of the family of the random variables	
Course Outcomes:		
Upon completion of the course, students shall have ability to		
C403.1	Recall concepts of probability and integration	[R]
C403.2	Predict the correlation and regression between the random variables	[U]
C403.3	Apply skills to handle situations involving single and multiple random variables	[AP]
C403.4	Use distribution in cluster analysis of similar binary variables.	[AP]
C403.5	Analyse various types of random processes.	[AP]
C403.6	Use the concepts of random processes in signals and systems	[AP]
Course Contents:		
<p>One dimensional Random variable and Standard distributions: Probability - Probability concepts-Addition and Multiplication law of probability – Conditional probability - Total probability theorem, Bayes theorem (statement) -Problems– One dimensional random variable - Probability mass function - Probability density function – Discrete and continuous random variables-Moment generating function-Properties -Standard distributions-Discrete distributions - Binomial – Poisson – Geometric – Continuous distributions - Uniform – Exponential - Normal distributions –MGF - Simple problems.</p> <p>Two dimensional random variables and Random Processes: Two dimensional random variables- Joint distributions - Marginal and conditional distributions – Covariance – Correlation and Regression</p> <p>Classification of Random processes- Definitions - strictly stationary processes - wide – sense stationary processes - Poisson process - Markov process - Markov Chain - Transition probabilities - Limiting distributions.</p> <p>Correlation and Spectral densities: Auto correlation - Cross correlation - Properties – Power spectral density-Cross spectral density- Properties-Relationship between cross correlation and cross spectral densities.</p>		

Total Hours:		60		
Text Books:				
1	Peebles Jr. P.Z., —Probability Random Variables and Random Signal Principles, Tata McGraw-Hill Publishers, Fourth Edition, New Delhi, 2016			
2	Palaniammal, S., —Probability and Random Processes, Prentice hall of India, New Delhi, 2014 , Reprint 2015.			
3	Gupta, S.C., & Kapoor, V.K., Fundamentals of Mathematical Statistics, Sultan Chand & sons, 2000, Reprint 2014.			
Reference Books:				
1	Ross, S., —A First Course in Probability, Ninth edition, Pearson Education, Delhi, 2014			
2	Henry Stark and John W. Woods —Probability and Random Processes with Applications to Signal Processing, Pearson Education, Fourth Edition, Delhi, 2011			
Web References:				
1	http://nptel.ac.in/courses/111104079/			
2	http://www.nptelvideos.in/2012/12/probability-random-variables.html			
3	http://freevideolectures.com/Course/3028/Econometric-Modelling/22			
4	http://freevideolectures.com/Course/2311/Digital-Communication/4			
5	http://nptel.ac.in/syllabus/111105041/			
Online Resources:				
1	https://www.coursera.org/learn/probability-intro			
2	https://ocw.mit.edu/courses/.../18-440-probability-and-random-variables-spring-2014/			
3	https://www.coursera.org/learn/wharton-introduction-spreadsheets-models/lecture/Y3bCF/3-1-random-variables-and-probability-distributions			
4	http://nptel.ac.in/upcoming_courses.php			
Assessment Methods & Levels (based on Blooms' Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component	Marks	
C143.1	Remember	Classroom or Online Quiz	2	
C143.2	Understand	Class Presentation/Power point presentation	4	
C143.3& C143.4	Apply	Group Assignment	7	
C143.5 & C143.6	Apply	Group activities	7	
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination
	CIA1	CIA2	Term End Assessment	
Remember	20	20	20	20
Understand	30	30	30	30
Apply	50	50	50	50
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

18EC401	ANALOG INTEGRATED CIRCUITS	3/0/0/3
Nature of Course	G (Theory Analytical)	
Pre requisites	18EC302 Electronic Circuits	
Course Objectives:		
1	To enable the students to learn the basic building blocks of Linear Integrated Circuits	
2	To acquaint the students about linear and non-linear applications of operational amplifiers	
3	To enable the students to understand theory and applications of analog multipliers and PLL	
4	To teach the theory and applications of ADC and DAC	
5	To impart knowledge on integrated circuits of special functions	
Course Outcomes:		
Upon completion of the course, students shall have ability to		
C401.1	Identify the building blocks and their role in Linear Integrated Circuits	[R]
C401.2	Understand the operations and characteristics and application areas of operational amplifiers	[U]
C401.3	Gain knowledge by understanding the Concept of Analog Multiplier and PLL.	[U]
C401.4	Apply the characteristic properties of operational amplifier in designing ADCs, DACs.	[AP]
C401.5	Understand and Apply the concept of Operational Amplifier in Various Voltage Regulator Design.	[AP]
C401.6	Perform simulation related to AC and DC analysis on these circuits and analyse the results	[AN]
Course Contents:		
<p>Basic information of Op-Amp, Differential amplifier and OP-AMP applications : Differential amplifier with constant current source-current mirror-characteristics of Op-Amp - Wilson Current –Mirror Circuit and Widlar Current –Mirror Circuit, OP-AMP design, inverting and non-inverting amplifiers, instrumentation amplifier, integrator and differentiator, voltage-to-current converter, current-to-voltage converter Precision rectifier, Schmitt trigger, Active filters LP,HP,BP,BR- Butterworth filter</p> <p>Analog Multiplier, Digital-to-analog converters (DAC), Analog-to-digital converters (ADC): Four quadrant multiplier, VCO, PLL and its applications, Types of DAC : Weighted resistor, R-2R ladder, Sample and Hold circuit, Types of ADC: flash, counter type, Single slope, dual slope, successive approximation - Astable and Monostable Multivibrators using 555 Timer.</p> <p>Voltage regulators: 723 General Purpose regulators, switching regulator - Audio Power Amplifier - Video amplifiers – Opto couplers - Isolation Amplifiers - Fiber optic ICs- CMOS OP-AMP-ac and dc analysis using circuit simulation software.</p>		
Total Hours:		45
Text Books:		
1	Sergio Franco, "Design with operational amplifiers and analog integrated circuits", McGraw-Hill, 4 th edition, 2016. (Reprint)	
2	D.Roy Choudhry, Shail Jain, "Linear Integrated Circuits", New Age International Pvt. Ltd.,2010 (Reprint)	

Reference Books:					
1	S.Salivahanan, V S Kanchana Bhaaskaran, Linear Integrated Circuits, McGraw-Hill, 2 nd edition,2015				
2	WilliamD.Stanely, 'Operational Amplifiers with Linear Integrated Circuits'. Pearson Education, 2004				
Web References:					
1	http://www.electronics-tutorials.ws				
2	http://www.allaboutcircuits.com				
Online Resources:					
1	http://www.nesoacademy.org/electronics-engineering/analog-electronics/analog				
Assessment Methods & Levels (based on Blooms' Taxonomy)					
Formative assessment based on Capstone Model (Max. Marks:20)					
Course Outcome	Bloom's Level	Assessment Component			Marks
C401.1	Remember	Quiz			5
C401.2	Understand	Class Presentation			3
C401.3	Understand	Group Assignment			3
C401.4	Apply	Problem solving			3
C401.5	Apply	Problem solving			3
C401.6	Analyse	Simulation Exercise			3
Bloom's Level	Continuous Assessment			End Semester Examination[50 Marks]	
	CIA1[10 Marks]	CIA2[10 Marks]	CIA3[10 Marks]		
Remember	20	20	10	10	
Understand	60	40	40	40	
Apply	20	40	30	30	
Analyse	-	-	20	20	
Evaluate	-	-	-	-	
Create	-	-	-	-	

18EC402	SIGNALS AND SYSTEMS	4/0/0/4
Nature of Course		
	G (Theory Analytical)	
Pre requisites		
	18MA302- DICRETE TRANSFORMS AND FOURIER ANALYSIS	
Course Objectives:		
1	Understanding the fundamental characteristics of signals and systems.	
2	Understanding signals and systems in terms of both the time and transform domains.	
3	Developing Expertise in time domain and frequency domain approaches to the analysis of Continuous and Discrete systems	
4	Development of the mathematical skills to solve problems involving convolution and filtering	
Course Outcomes:		
Upon completion of the course, students shall have ability to		
C402.1	Acquire the knowledge of signal and its classifications, operations on signals and classifications of systems based on its properties	[R]
C402.2	Analyze the spectral characteristics of continuous-time periodic and a periodic signals using Fourier analysis.	[AN]
C402.3	Evaluate the response of LTI system using convolution integral and LSI system using convolution.	[AN]
C402.4	Analyze system properties based on impulse response and Fourier analysis.	[AN]
C402.5	Apply the Laplace transform and Z- transform for the analysis of continuous-time and discrete-time signals and systems.	[AP]
C402.6	Understand the fundamental characteristic of Biomedical signals	[U]
Course Contents:		
<p>SIGNALS AND SYSTEMS: Signals (discrete / continuous) – Basic signals - Classification of signals – Operations on signals – Systems - Classification of systems - System properties: linearity, causality, stability, continuous-time Linear Time Invariant (LTI) system and its properties , discrete-time Linear Shift Invariant (LSI) systems and its properties , System representation using differential equations</p> <p>ANALYSIS OF CT SYSTEM: Continuous Time Fourier transform - Properties - Laplace transform – Region of convergence – Properties - Inverse Laplace transform - Relationship between Laplace and Fourier transform- system representation using differential equations - System Analysis using Laplace transform and Fourier transform – Analysis of electrical networks using Laplace Transform - impulse response and step response - frequency response – convolution integral</p> <p>ANALYSIS OF DT SYSTEM and INTRODUCTION TO BIOMEDICAL SIGNALS</p> <p>Fourier series representation of discrete-time signals- Sampling: sampling theorem – aliasing - signal reconstruction: ideal interpolator, zero-order hold, first-order hold - Discrete Time Fourier Transform (DTFT) and its properties - system representation using difference equations -Relationship between Z-transform and DTFT. System Analysis using Z-transform and DTFT - poles and zeros – stability – impulse response and step response - frequency response – magnitude and phase response - convolution sum- Realization structures: Direct</p>		

form I, II, Cascade and Parallel.

Introduction to Biomedical Signals –Origin of Bio potential- Bio potential signals - The electrocardiogram (ECG) -The electroencephalogram (EEG) - The electromyogram (EMG)- The phonocardiogram (PCG) - The electrooculogram (EOG)

Total Hours: **60**

Text Books:

1	Mahmood Nahvi, "Signals and systems", McGraw Hill Education, 1/E, 2015.
2	Allan V. Oppenheim et al," Signals and Systems", Prentice Hall of India, 2/E, 2015. Ramakrishna Rao P, "Signals and Systems", McGraw Hill Education, New Delhi, 2/E, 2013.
3	Leslie Cromwell, "Biomedical Instrumentation And Measurement ", Prentice Hall of India, New Delhi, 2011

Reference Books:

1	J. Roberts, "Fundamentals of Signals and Systems", Tata McGraw Hill, 2007.
2	B. P. Lathi, "Signal Processing and Linear Systems", Oxford University Press, 1998.
3	R.F. Ziemer, W.H. Tranter and D.R. Fannin, "Signals and Systems – Continuous and Discrete", Prentice Hall, 4/E, 1998.

Web References:

1	http://www.nptelvideos.in/2012/12/signals-and-system.html
2	http://freevideolectures.com/Course/3177/Signals-and-Systems

Online Resources:

1	https://www.edx.org/course/signals-systems-part-1-iitbombayx-ee210-1x-2
2	https://www.edx.org/course/signals-systems-part-2-iitbombayx-ee210-2x-2

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C402.1	Remember	Quiz	5
C402.2, C402.4 & C402.5	Analyze	Assignment	10
C402.3 & C402.6	Analyze	Simulation	5

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment			End Semester Examination[50 Marks]
	CIA1[10 Marks]	CIA2[10 Marks]	CIA3[10 Marks]	
Remember	20	10	10	10
Understand	40	10	40	40
Apply	40	40	30	30
Analyse	-	40	20	20
Evaluate	-	-	-	-
Create	-	-	-	-

18EC403	DATA COMMUNICATIONS AND NETWORKING		3/0/0/3
Nature of Course			
	M Theory		
Co- requisites			
	18EC404:Analog and Pulse communication		
Course Objectives:			
1	To introduce the concept and technologies used in modern data communication and computer networking		
2	To introduce the students the functions of different layers.		
3	To introduce the various addressing mechanisms employed in computer networking		
4	To understand the types and functions of transmission control protocols.		
5	To allow students to get familiarized with the concepts behind the different types of networking applications.		
Course Outcomes:			
Upon completion of the course, students shall have ability to			
C403.1	To understand the concept of data communication and networking models		[R]
C403.2	To study the functions of OSI layered architecture and its protocols		[U]
C403.3	To explore the different routing and IP addressing modes in computer networks.		[U]
C403.4	To understand the concepts related to congestion and QoS.		[AP]
C403.5	To understand the concepts related to Congestion Control, web and network security		[AN]
Course Contents:			
<p>DATA COMMUNICATIONS: Components – Direction of Data flow – networks – Components– types of Connections – Topologies –Protocols and Standards - ISO / OSI model – Transmission Media – Coaxial Cable – Fiber Optics – Line Coding – Modems – RS232 Interfacing sequences. TCP/IP protocol suite. Flow Control and Error control - stop and wait – go back-N ARQ – selective repeat ARQ- sliding window – HDLC - LAN - Ethernet IEEE 802.3 – IEEE 802.4 - IEEE 802.5 - IEEE 802.11 – FDDI - SONET – Bridges.</p> <p>NETWORK, TRANSPORT AND APPLICATION LAYER: Internet works – Packet Switching and Datagram approach – IP addressing methods – IPV4 - Next generation IP: IPV6, Subnetting – Routing – Distance Vector Routing – Link State Routing – Routers - multicast routing: DVMRP- MOSPF. Transport Layer Services – Multiplexing and Demultiplexing – User Datagram Protocol (UDP) – Principles of Reliable Data Transfer – Transmission Control Protocol (TCP).Congestion Control- Quality of services (QOS) – Integrated Services – Differentiated Services- WWW- HTTP- SMTP-FTP- Telnet- Domain name space- Sockets.</p> <p>CRYPTOGRAPHY- Symmetric Key Cryptography - Asymmetric Key Cryptography- Network security: confidentiality: cipers, Digital signature, Authentication, Key management.</p>			
Total Hours:			45
Text Books:			
1	Behrouz A. Foruzan, “Data communication and Networking”, 5th Edition Tata McGraw-Hill, 2013.		
2	William Stallings, “Data and Computer Communication”, Sixth Edition, Pearson Education, 2013.		
3	Larry-L-Peterson& Bruce S David, “Computer-Networks-a-Systems-Approach”-		

	,Morgan Kaufmann Publishers, Fourth Edition, 2007			
Reference Books:				
1	E. Andrew S. Tannenbaum, “Computer Networks”, PHI, Fifth Edition, 2011..			
2	CJames .F. Kurose & W. Rouse, “Computer Networking: A Top down Approach Featuring”, Pearson Education, 3/e, Pearson Education.			
3	M.N.Bandyopadhyay,” Optical communication Networks”, PHI, 2014.			
Online Resources:				
1	https://nptel.ac.in/courses/106105082/			
2	https://onlinecourses.nptel.ac.in/noc18_cs38/preview			
3	https://www.coursera.org/learn/data-communication-network-services			
4	https://www.edx.org/course/computer-networks-internet-kironx-fhlcnx			
Web References:				
1	https://cosmolearning.org/courses/data-communication-542/video-lectures/			
2	https://www.tutorialspoint.com/data_communication_computer_network/			
3	https://freevideolectures.com/subject/networking/			
Assessment Methods & Levels (based on Blooms' Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Tentative Assessment Component	Marks (20)	
C403.1	Remember	Quiz	4	
C403.2, C403.3	Understand	Quiz	8	
C403.4	Apply	Group Assignment	4	
C403.5	Analyse	Simulation Exercise	4	
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination[50 Marks]
	CIA1[10 Marks]	CIA2[10 Marks]	CIA3[10 Marks]	
Remember	20	10	10	10
Understand	40	10	40	40
Apply	40	40	30	30
Analyse	-	40	20	20
Evaluate	-	-	-	-
Create	-	-	-	-

18EC404	18EC404 ANALOG AND PULSE COMMUNICATION	3/0/0/3
Nature of Course		
	G (Theory analytical)	
Pre requisites		
	18MA302 Discrete Transforms and Fourier Analysis	
Course Objectives:		
1	To introduce the concepts of analog communication systems.	
2	To equip students with various issues related to analog communication such as modulation, demodulation, transmitters and receivers.	
3	To discuss different types of digital pulse modulation techniques.	
4	To introduce the fundamental concepts of sampling and time division multiplexing.	
5	To describe the effect of noise in analog and pulse modulation systems.	
Course Outcomes:		
Upon completion of the course, students shall have ability to		
C404.1	Gain knowledge of the components of analog communication systems.	R
C404.2	Analysis and design of various modulation and demodulation techniques.	AN
C404.3	Interpret with differentiate types of transmitters and receivers used for particular application.	U
C404.4	Evaluate the performance of analog communications in the presence of noise.	E
C404.5	Identify and familiarize with basic techniques for generating and demodulating pulse code modulated signals	AP
C404.6	To develop an insight into TDM.	U
Course Contents:		
Amplitude modulation		
Elements of an electrical communication system, concept of modulation and demodulation, baseband and passband signals and their representations , Need for modulation, amplitude modulation (AM) - double sideband (DSB), double sideband suppressed carrier (DSBSC), single sideband suppressed carrier (SSBSC) and vestigial sideband (VSB) modulation; AM transmitter and receiver, Receiver Characteristics, Representation of narrowband noise ; receiver model, signal to noise ratio (SNR), noise figure, noise temperature, noise in DSB-SC, SSB, AM.		
Angle modulation		
Angle modulation - phase modulation (PM) & frequency modulation (FM); narrowband and wideband FM, FM transmitters, FM receivers, pre-emphasis and de-emphasis, Amplitude limiters , Noise in Angle Modulation System, Noise Triangle in Angle Modulation System, Noise in Pre-emphasis and de-emphasis.		
Pulse modulation		
Sampling process, sampling theorem for band limited signals, pulse amplitude modulation (PAM), pulse width modulation (PWM), pulse position modulation (PPM), pulse code modulation (PCM), line coding , differential pulse code modulation, delta modulation and adaptive delta modulation, noise consideration in PAM and PCM systems. Basics of time division multiplexing, Introduction to PDH and SDH.		

		Total Hours:	45	
Text Books:				
1	George Kennedy and Bernard Davis," Electronic Communication systems", 6th Edition, TMH, 2017			
2	Wayne Tomasi, "Electronic Communications Systems - Fundamentals Through advanced", 6th Edition Pearson Education, , 2015			
3	Simon Haykins and Michael Moher,"Communication Systems", 5th Edition, John Wiley and sons, 2015.			
Reference Books:				
1	H. Taub and D. L. Schilling, Principles of Communication Systems, 4 th edition , McGraw Hill, 2017.			
2	J. G. Proakis and M. Salehi, Communication system engineering, 2/e, Pearson Education Asia, 2002.			
3	R. E. Ziemer, W. H. Tranter, Principles of Communications: Systems, Modulation, and Noise, 5/e, John Wiley & Sons, 2001.			
Web References:				
1	https://moodle.najah.edu/mod/resource/view.php?id=48306			
2	http://nptel.ac.in/courses/117105143			
3	http://nptel.ac.in/courses/117102059			
Online Resources:				
1	https://lecturenotes.in/subject/580/analog-communication-systems-acs			
2	https://www.wisdomjobs.com/.../analog-communication.../analog-communication-pulse			
3	www.gatestudy.com/wp-content/uploads/2015/09/Pulse-Modulation-Techniques.pdf			
Assessment Methods & Levels (based on Blooms' Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component	Marks	
C404.1	Remember	Quiz	3	
C404.2	Analyze	Problem solving	4	
C404.3	Understand	Class Presentation	4	
C404.4	Evaluate	Problem solving	3	
C404.5	Apply	Group Assignment	3	
C404.6	Understand	Technical presentation	3	
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination[50 Marks]
	CIA1[6 Marks]	CIA2[6 Marks]	CIA3[8 Marks]	
Remember	20	10	10	10
Understand	40	40	40	30
Apply	-	-	40	20
Analyse	30	40	-	30
Evaluate	10	10	10	10
Create	-	-	-	-

18CS411	DATA STRUCTURES AND ALGORITHMS	3/0/3/4.5
Nature of Course		
	K (Problem Programming)	
Pre requisites		
	18CS311 - Linux and Programming in C++	
Course Objectives:		
1	To study the systematic way of solving problems, various methods of organizing large amount of data.	
2	Capable of designing and analysing implementation of data structures and algorithms for different kinds of problems	
3	To understand the Algorithms and Data structures used for solving a problem are much more important than knowing the exact code for it in some programming language.	
4	To provide an insight into the intrinsic nature of the problem as well as possible solution techniques, independent of programming language, programming paradigms, computer hardware or any other implementation technique.	
Course Outcomes:		
Upon completion of the course, students shall have ability to		
C411.1	Choose appropriate data structure and algorithms, understand the ADT and use it to design algorithm for a specific problem.	[A]
C411.2	Apply the different Queue techniques for the real time applications	[AP]
C411.3	Understand the necessary mathematical abstraction to solve real world problems.	[U]
C411.4	Comprehend and select algorithm design approach in a problem specific domain	[AP]
C411.5	Understand and apply the concepts of Trees and graphs in different scenarios	[AP]
Course Contents:		
<p>Linear Data Structures and Algorithms: Importance of algorithms and data structures- Stages of algorithm development for solving a problem: Describing the problem, Identifying a suitable technique, Design of an Algorithm, Proof of Correctness of the Algorithm - Recursive and non-recursive algorithm. Linear Data structure: Arrays, List: singly and doubly linked list, Stack: Stack ADT using array and linked list, Applications: checking balancing parenthesis, infix to postfix conversion, Evaluating postfix expression, Queues: Queue ADT using array and linked list, circular queue.</p> <p>Algorithm Analysis of Sorting and Searching: Introduction to algorithm analysis, Time and space complexity, Basic efficiency classes- Brute force: bubble sort, selection sort and linear search- Decrease and conquer: insertion sort and interpolation search- divide and conquer: Merge sort, quick sort and binary search.</p> <p>Non-Linear Data Structures: Trees: Basic terminologies, Tree Traversal: inorder, preorder and postorder- Binary Search Tree- AVL trees, Red Black trees, splay trees- Heaps- Hashing. Graph: Basic terminologies-Back Tracking: DFS and BFS - Greedy Algorithm: Topological sorting, Dijkstra's Algorithms and Minimum Spanning Trees.</p> <p>Advanced Data Structures: Bi-connected components, Cut vertices, Matching, Network flow, Data Mining, Data Fusion, Web Data structures, Real Time application.</p>		
Total Hours:		45
Lab Component:		

1	Array, Loops
2	Linked List
3	Stacks
4	Queues
5	Brute force technique
6	Decrease and conquer
7	Divide and conquer
8	Greedy Technique
9	Binary Search Tree ADT
10	Backtracking : BFS and DFS
11	Minimum Spanning Tree
12	Dijkstra's Shortest path algorithm
Total Hrs :30	

Text Books:

1	Mark Allen Weiss, Data Structures and Algorithm Analysis in C++, 4 th edition, Pearson Education, 2014.
2	AnanyLevitin, Introduction to the Design and Analysis of Algorithms, 3 rd Edition, Pearson, 2012
3	Thomas H. Cormen, C.E. Leiserson, R L.Rivest and C. Stein, Introduction to Algorithms , Paper Back 2010, Third edition, MIT Press, 2010(Reprint)

Reference Books:

1	Thomas H. Cormen, C.E. Leiserson, R L.Rivest and C. Stein, Introduction to Algorithms , Paper Back 2010, Third edition, MIT Press, 2010(Reprint)
2	SanjoyDasgupta, C.Papadimitriou and U.Vazirani , Algorithms , Tata McGraw-Hill, 2006.
3	V. Aho, J.E. Hopcroft and J. D. Ullman, Data Structures and Algorithms, Pearson India, 1st Edition, 2002.
4	V. Aho, J.E. Hopcroft and J. D. Ullman, Design and Analysis of Computer Algorithms, Pearson, 1st edition, 2011.
5	Sara Baase , Allen Van Gelder, Computer Algorithms, Introduction to Design and Analysis, 3rd edition, Wesley Longman Publishing, 2000.
6	Mark Allen Weiss, Data Structures and Algorithm Analysis in C, 2nd edition, Pearson Education, 2007

Web References:

1	http://web.stanford.edu/class/cs97si/
2	http://nptel.ac.in/courses//106103069/
3	http://web.stanford.edu/class/cs97si/

Online Resources:

1	https://www.coursera.org/learn/data-structures
2	https://www.coursera.org/specializations/data-structures- algorithms
3	http://nptel.ac.in/courses//data-structures

Assessment Methods & Levels (based on Blooms' Taxonomy)

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment				End Semester Examination (Theory) [40 marks]
	Theory		Practical		
	CIA1 [6 marks]	CIA2 [6 marks]	Term Assessment [8 marks]	End Assessment [40 Marks]	
Remember	-	-	-	-	-

Understand	50	20	20	20	20
Apply	50	50	50	50	50
Analyse	-	30	30	30	30
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

18EC405	ANALOG INTEGRATED CIRCUITS LABORATORY	0/0/2/1	
Nature of Course			
M (Practical application)			
Co requisites			
18EC401: Analog Integrated Circuits			
Course Objectives:			
1	To design, construct and verify variety of circuits using various linear and non-linear ICs.		
Course Outcomes:			
Upon completion of the course, students shall have ability to			
C405.1	Apply the operational amplifiers properties and developing real-time applications like multivibrator and Schmitt Trigger.	[AP]	
C405.2	Evaluate the characteristic performance of Integrator, Differentiator and Instrumentation Amplifier.	[E]	
C405.3	Hook-up the circuit using Operational amplifiers to generate Waveform and Design of Active filters.	[C]	
C405.4	Apply the 555 timer properties and develop Multivibrator circuits	[AP]	
C405.5	Perform Simulation of ADC , DAC and construct an application	[AN]	
C405.5	Perform Simulation of various Multivibrators and construct an application	[AN]	
Course Contents:			
List of Experiments			
S.No	List of Experiments	CO Mapping	RBT
15	Measurement of Op-Amp parameters	-	
16	Applications of Op-Amp (Adder, Subtractor, adder-subtractor, average amplifier)	C405.1	[U]
17	Design of Astable, Monostable multivibrators and Schmitt Trigger	C405.1	[AP]
18	Integrator and Differentiator using Op-Amp	C405.2	[E]
19	Instrumentation Amplifier using Op-Amp	C405.2	[E]
20	Waveform generation using Op-Amp (Triangular, Sawtooth)	C405.3	[C]
21	Design of Active filters (LPF, HPF)	C405.3	[C]
22	Applications of 555 timer (Astable, Monostable multivibrator).	C405.4	[AP]
23	Study of PLL using 565, study of capture range, lock range, VCO	-	
24	Using Tina/ Orcad Pspice Simulation of Analog to Digital Converter and construct a simple application	C405.5	[AN]
25	Simulation of Digital to Analog Converter and construct a simple application	C405.5	[AN]
26	Simulation of Multivibrator. and construct a simple application	C405.6	[AN]
Total Hours:			30
Reference Books:			

1	Sergio Franco, "Design with operational amplifiers and analog integrated circuits", McGraw-Hill, Fourth edition, 2008.
2	D.Roy Choudhry, Shail Jain, "Linear Integrated Circuits", New Age International Pvt. Ltd.,2010
3	S.Salivahanan, V S KanchanaBhaaskaran, Linear Integrated Circuits, McGraw-Hill, 2 nd edition,2015
4	WilliamD.Stanely, 'Operational Amplifiers with Linear Integrated Circuits'. Pearson Education, 2004
Web References:	
1	http://nptel.ac.in/courses/117107094/
2	http://www.technologystudent.com/elec1/elecex.htm
Online Resources:	
1	http://iitb.vlab.co.in/?sub=43&brch=225
2	http://vlab.amrita.edu/?sub=1&brch=282

Assessment Methods & Levels (based on Bloom's Taxonomy)		
Summative assessment based on Continuous and End Semester Examination		
Bloom's Level	Rubric based Continuous Assessment[60 marks] (in %)	End Semester Examination [40 marks] (in %)
Remember	10	10
Understand	20	20
Apply	20	20
Analyse	20	20
Evaluate	10	10
Create	20	20

18EC406	ANALOG AND PULSE COMMUNICATION LABORATORY	0/0/2/1	
Co requisites	18EC404: Analog and Pulse Communication		
Nature of Course: M (Practical application)			
Course Objectives:			
3. To learn about the performance of continuous and pulse modulation and demodulation circuits and to gain experience on the design of intermediate frequency.			
4. To learn about the sampling process and to study the use of simulation tools for the communication circuits.			
Course Outcomes			
C406.1	Design, construct and analyse the performance of various continuous modulation and demodulation circuits.	[AN]	
C406.2	Design and Analyse the circuit for intermediate frequency.	[AN]	
C406.3	Build and verify the circuits for different pulse modulation techniques.	[AN]	
C406.4	Construct the circuits for Pre-emphasis and De-emphasis.	[Ap]	
C406.5	Construct and test the working of sampling process.	[U]	
C406.6	Analyze the performance of the modulation and sampling using Simulation Tools	[AN]	
Course Content:			
S.No	List of Experiments	CO Mapping	RBT
1	Design an amplitude modulation system with envelope detection and study its (a) signal handling and (b) frequency response characteristics.	C406.1	[AN]
2	Design a DSBSC modulation system with coherent demodulation and study its (a) signal handling and (b) frequency response characteristics when carrier is suppressed.	C406.1	[AN]
3	Design an AGC stage at 455 kHz centre frequency for voice communication and study the effect of AGC on amplifier performance.	C406.1	[AN]
4	Design and test a mixer stage for translating AM signal to IF frequency stage.	C406.2	[AN]
5	Design Frequency modulation.	C406.1	[AN]
6	Design PAM, PPM and PWM.	C406.3	[AN]
7	Design Pre-emphasis and De-emphasis circuits.	C406.4	[Ap]
8	Design, test and analysis of Sampling Process.	C406.5	[U]
9	Simulation of AM, FM, Sampling Process	C406.6	[AN]
Total Hours			30
Reference Books:			
10. George Kennedy and Bernard Davis, "Electronic Communication systems", 4th Edition, TMH, 2008			
11. Wayne Tomasi, "Electronic Communications Systems – Fundamentals Through advanced", 5th Edition Pearson Education, 2012			
12. Simon Haykins and Michael Moher, "Communication Systems", 5th Edition, John Wiley and sons, 2015.			
13. H. Taub and D. L. Schilling, Principles of Communication Systems, 3rd Reprint, McGraw Hill, 2006.			

Web References:

1. www.nptel.ac.in
2. <http://www.allaboutcircuits.com/education/>

Assessment Methods & Levels (based on Bloom's Taxonomy)		
Summative assessment based on Continuous and End Semester Examination		
Bloom's Level	Rubric based Continuous Assessment [60 marks] (in %)	End Semester Examination [40 marks] (in %)
Remember	10	10
Understand	20	20
Apply	20	20
Analyse	20	20
Evaluate	10	10
Create	20	20

18EC501	MICROCONTROLLER AND INTERFACING	3/0/0/3
Nature of Course	:G (Theory & Analytical)	
Pre requisites	18EC301 Digital Electronics	
Course Objectives:		
1	To introduce the basic concept of 8051 microcontroller	
2	To enable the students to understand the MSP Microcontroller and its operation..	
3	To enable the student to relate various interfacing devices with microcontrollers.	
4	To introduce the basic concept of ARM microcontroller and its operations	
5	To allow students to design and analyze various external circuitry with microcontroller	
6	To enable the students to differentiate between various types of microcontroller family and its specifications.	
Course Outcomes:		
Upon completion of the course, students shall have ability to		
C501.1	Understand the internal blocks of 8051 microcontroller	[U]
C501.2	Develop assembly language programs for various 8051 applications.	[AP]
C501.3	Interface peripheral devices with 8051 microcontroller	[AN]
C501.4	Understand the internal blocks of MSP 430 series microcontroller	[U]
C501.5	Relate the various timer modes and interrupts of MSP430 controller	[AN]
C501.6	Compare the ARM 7 and ARM 9 TDMI architecture and interfacing with external circuit.	[E]
Course Contents:		
<p>Introduction : Introduction to microprocessors, address bus, Data bus and Control bus, Tri state bus, clock generation, Connecting microprocessor to I/O devices, data transfer schemes, Architectural advancements of microprocessors, Evolution of microprocessors. 8085&8086 Architecture, 8085 Instruction set, 8085&8086 Addressing modes.</p> <p>8 BIT Microcontroller: Introduction to 8051 micro-controller, Architecture, Special Function Registers, Instruction set, Addressing modes, Interrupts, Power down operation, Memory organization, Programming 8051, Micro controller based system designs. Memory Interfacing and I/O interfacing - Parallel communication interface – Serial communication interface – Timer – <u>Keyboard</u> /display controller – Interrupt controller – DMA controller.</p> <p>MSP430 Microcontroller: Architecture of MSP430 Microcontrollers: Central Processing Unit and Registers, Basic Clock Module and operation: Digital controlled Oscillator and Registers Digital Input -Output: Input, Output Registers, Function Select Register, Port Interrupts, Pull Up /Down Registers Timers: Timer Block diagram and Operation, Timer Modes, Output Unit, Timer Interrupts, Low Power Down Modes, Watchdog Timer and operation.</p> <p>ARM Processor- The ARM architecture, ARM Bus architecture, ARM7 TDMI, ARM 9 TDMI, ARM Instruction Set, Memory Mapping, The Thumb Instruction Set, Interfacing of sensors, transducers, actuators, A/D and D/A Converters with ARM.</p>		
Total Hours:		45
Text Books:		

1	Muhammad Ali Mazidi, "The 8051 Microcontroller and Embedded systems", Prentice Hall India, New Delhi, 2013
2	Kenneth J Ayala, "The 8051 Microcontroller – Architecture, Programming and Applications", Penram International Publications, Mumbai, India, 2005
3	MSP430 Microcontrollers Basics, John H Devis, 1stEdition, Newnes Publisher.2008
4.	ARM on-chip architecture, Pearson Edition,second edition 2009.

Reference Books:

1	The PIC Microcontroller and Embedded systems – Using Assembly and C for PIC18," Muhammad Ali Mazidi, Rolin D. McKinlay, and Danny Causey, Prentice Hall, 2013
2	Programmable Microcontrollers with Applications: MSP430 LaunchPad with CCS and Grace By CemUnsalan, 2st Edition,2012
3	Microprocessor Architecture, Programming and Applications with the 8085 Ramesh Gaonkar

Web References:

1	https://exploreembedded.com
2	https://www.elprocus.com/peripherals-interfacing-to-the-microcontroller-8051-in-electronics/
3	http://www.ti.com/microcontrollers/msp430-ultra-low-power-mcus/overview.html
4	https://developer.arm.com/products/architecture/cpu-architecture

Online Resources:

1	https://freevideolectures.com/course/3018/microprocessors-and-microcontrollers/22
2	www.infocobuild.com/education/audio-video-courses/electronics/.../lecture-05.html
3	https://training.ti.com/msp430-workshop-series
4	www.ee.ic.ac.uk/pcheung/teaching/ee2_computing/ARMbasics4

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C501.1	Understand	Quiz	3
C501.2	Apply	Problem Solving	3
C501.3	Analyze	Problem Solving	3
C501.4	Understand	Group Assignment	3
C501.5	Analyze	Group Assignment	3
C501.6	Evaluate	Case Study	5

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment			End Semester Examination[50 Marks]
	CIA1[10 Marks]	CIA2[10 Marks]	CIA3[10 Marks]	
Remember	-	-	-	-
Understand	40	40	40	40
Apply	30	40	-	20
Analyze	30	20	30	20

Evaluate	-	-	30	20
Create	-	-	-	-

18EC502	DIGITAL COMMUNICATION	3/0/0/3
Nature of Course	G (Theory & Analytical)	
Pre requisites	18EC402 Signals and Systems 18EC404 Analog and Pulse Communication	
Course Objectives:		
1	To discuss the signal waveform representation and optimum filter.	
2	To enable the students to understand the importance of wave shaping techniques.	
3	To deliberate different types of passband transmission systems.	
4	To study channel capacity and diversity concepts.	

5	To enable the students to differentiate between error control coding and understand their roles in digital systems	
Course Outcomes:		
Upon completion of the course, students shall have ability to		
C502.1	Analyze the performance of matched filter and correlator.	AN
C502.2	Apply wave shaping techniques to minimize ISI.	AP
C502.3	Analyze modulation techniques with respect to generation, bandwidth and probability of error.	AN
C502.4	Study the channel capacity and diversity concepts.	U
C502.5	Know the concepts of Error control coding used in Digital Communication.	U
C502.6	Differentiate and apply Error control coding in Communication.	AP
Course Contents:		
<p>Baseband Transmission: Geometric representation of signal waveforms, Matched filter; Nyquist rate and wave shaping techniques; ISI and adaptive equalization, Maximum-likelihood sequence detector (MLSD), Correlative level Coding, Duobinary Signalling, Line coding.</p> <p>Passband transmission: Coherent and non-coherent detection of signals in noise - Probability of error analysis of digital modulation techniques, BPSK, BFSK, DPSK Mary modulation schemes: QPSK, MSK; QAM, (Signal representation, Generation and Detection, Probability of error analysis). Digital transmission through Band-Limited channel - Design of BL signals with zero ISI; Design of BL signals for controlled ISI- Maximum-likelihood sequence detector (MLSD),</p> <p>Channel capacity and Error control coding: Introduction to Shannon Hartley theorem, Discrete memoryless channel and Binary symmetric channel, Diversity concepts - Introduction to maximal-Ratio combining, Coherent equal gain combining, Linear Block Codes, Cyclic Codes, Convolutional Codes.</p>		
Total Hours:		45
Text Books:		
1	S. Haykin, Micheal Moher, Communication Systems, 5 th Ed., John Wiley & Sons, 2009.	
2	S. Haykin, Digital Communication Systems, John Wiley & Sons, 2013	
3	H. Taub and D. L. Schilling, Principles of Communication Systems, 4 th edition , McGraw Hill, 2017.	
Reference Books:		
1	J. G. Proakis, Digital Communications, McGraw-Hill, 5 th Ed., 2014.	
2	A. B. Carlson, Communication Systems: An Introduction to Signals and Noise in Electrical Communication, 4 th Ed., McGraw-Hill, 2010.	
3	Bernard Sklar, Fredric J. Harris, Digital Communications: Fundamentals and Applications, Pearson Education, 3rd edition, 2018.	
Web References:		
1	https://nptel.ac.in/courses/108102096/	
2	https://nptel.ac.in/courses/Webcourse-contents/IIT%20Kharagpur/.../New_index1.html	
3	https://ocw.mit.edu/.../lecture-videos/lecture-5-error-correction-syndrome-decoding/	
Online Resources:		
1	www.eie.polyu.edu.hk/~em/dtss05pdf/00d%20Matched%20filter.pdf	
2	people.ee.duke.edu/~mbrooke/.../Material/eyes%20and%20NRZ%20and%20ISI.pdf	
3	www.eie.polyu.edu.hk/~em/adc01pdf/L10_PSK.pdf	

4	www.dtic.mil/dtic/tr/fulltext/u2/a156195.pdf			
Assessment Methods & Levels (based on Blooms' Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component	Marks	
C502.1	AN	Technical presentation	3	
C502.2	AP	Group Assignment	3	
C502.3	AN	Problem Solving	3	
C502.4	U	Quiz	3	
C502.5	U	Seminar	3	
C502.6	AP	Problem Solving	5	
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination [50 Marks]
	CIA1 [10 Marks]	CIA2 [10 Marks]	CIA3[10 Marks]	
Remember	10	10	10	10
Understand	30	40	40	30
Apply	30	-	50	30
Analyse	30	50	-	30
Evaluate	-	-	-	-
Create	-	-	-	-

18EC503	DIGITAL SIGNAL PROCESSING	3/0/3/4.5
Nature of Course	G (Theory Analytical)	
Pre requisites	18EC402 SIGNALS AND SYSTEMS	
	Course Objectives:	
1	To familiarize the students to understand DFT ,FFT techniques and its applications in filter design	
2	To allow students to design and analyze digital filters	
3	To enable the students to understand the quantization process and it related errors	
4	To enable the students to understand the concept of multi rate signal processing and its applications	
5	To enable students to design, simulate and evaluate various types of filters	
	Course Outcomes: Upon completion of the course, students shall have ability to	

C503.1	Explore their acquired knowledge on recalling the applications of transformation techniques	[R]
C503.2	Understand the concept of transformation techniques used for DT system analysis and its various properties	[U]
C503.3	Apply the transformation techniques in filter design	[AP]
C503.4	Analyze the spectral characteristics of Digital filter using windowing techniques.	[AN]
C503.5	Understand the concepts of quantization effects and behavioural changes in filter response.	[U]
C503.6	Evaluate the properties of various types of filters through design and simulation using software.	[E]

Course Contents:

Discrete Fourier Transform : computation of DFT-Properties - circular convolution- Fast Fourier Transforms (FFT) algorithms - Decimation in Time algorithm – Decimation in Frequency algorithms – DFTs in linear filtering – overlap add/save methods

Design and Implementation of Digital Filter: Finite Impulse Response (FIR) filters – Linear phase FIR filters – Design of FIR filters using windowing technique – Rectangular , Hamming and **Hanning windows** – Frequency Sampling technique – IIR digital filter design from analog filter using impulse invariance technique and bilinear transformations –**Structures of IIR and FIR filter.**

Finite word length Effects and Applications of DSP: Quantization process – co-efficient quantization error – Input quantization error – Product quantization error - Limit Cycle Oscillations (LCO) – Multirate DSP – Decimation – Interpolation -sampling rate conversion by rational factor I/D. Applications – Channel vocoders – **Subband coding of speech signal**-Quadrature mirror filters.

Lab Component

Analysis and simulation using MATLAB

1	Generation of Signals	[E]
2	Stability analysis of a system	[E]
3	Computation of N-Point DFT through circular convolution and matrix multiplication method	[E]
4	Computation of N-Point DFT using DIT and DIF algorithm	[E]
5	Design of FIR filter using windowing technique	[E]
6	Design of IIR filter using Impulse invariant and Bilinear transformation technique	[E]

Using TMS32C50/6713

7	Implementation of N-Point DFT	[E]
8	Implementation of FIR filter	[E]

Total Hours: 75

Text Books:

1	John G. Proakis & Dimitris G. Manolakis, Digital Signal Processing, Pearson, 4 th edition, 2014.
2	Sanjit K. Mitra, Digital Signal Processing: A Computer-Based Approach, The McGraw-Hill Companies, 4th Edition 2013
3	Alan V Oppenheim; Ronald W Schafer, Digital Signal Processing , Pearson India,1 st edition, 2015

Reference Books:

1	B. P. Lathi, “ Principles of Signal Processing and Linear Systems”, Oxford University Press, 2014.
2	Emmanuel C..Ifeachor, & Barrie.W.Jervis, “Digital Signal Processing”, Second edition, Pearson Education / Prentice Hall, 2012.

Web References:

1	https://www.tutorialspoint.com//digital signal processing/index.htm
2	http://www.nptel.ac.in/courses/108105055

Online Resources:

1	https://www.edx.org/course/discrete-time-signal-processing-mitx-6-341x-1				
2	https://ocw.mit.edu/resources/res-6-008-digital-signal-processing				
3	www.coursera.org/learn/dsp				
Summative assessment based on Continuous and End Semester Examination					
Bloom's Level	Continuous Assessment [60 Marks]				End Semester Examination [40 Marks]
	CIA1	CIA2	Model	Practical	
	[6Marks]	[6 Marks]	[8 Marks]	Rubric based CIA [40 Marks]	
Remember	20	10	10	-	10
Understand	40	10	20	20	20
Apply	40	40	30	30	30
Analyse	-	40	40	30	40
Evaluate	-	-	-	20	-
Create	-	-	-	-	-

18EE511	ELECTRICAL MACHINES & CONTROL SYSTEMS		3/0/0/3
Nature of Course :C (Theory analytical)			
Pre requisites :18EC101 Circuit Theory			
Course Objectives:			
1	To impart knowledge on constructional features and working principles of DC machines		
2	To impart knowledge on constructional features and working principles of transformers and AC motors		
3	To understand time domain and frequency domain analysis of control systems required for stability analysis		
4	To impart basic knowledge of components of control system		
5	To obtain the basic knowledge of digital control systems		
Course Outcomes:			
Upon completion of the course, students shall have ability to			
C511.1	Understand the working principle of DC machines and its types.		[U]
C511.2	Understand the principle of operation of transformers and AC motors		[U]
C511.3	To determine the modelling of control system by applying in time domain analysis		[AP]
C511.4	To analyze the frequency response of a systems to infer its stability		[AN]
C511.5	Understand the concept of P,PI PID Controllers and components of control systems		[U]
Course Contents:			
Dc Machines- DC Generator & DC motor, Construction, principle of operation, types, speed control: Ward Leonard method , Characteristics – Transformer- construction, principle of operation, Classification, Auto transformer – Alternator- AC motors –Induction and synchronous motors, principle of operation, starters and speed control			
Control systems - System concept, open loop and closed loop systems, differential equations and transfer functions, Modelling of Electric systems, signal flow graph, Mason's			

gain formula, **Time domain analysis** - Test signals – time response of first order and second order systems, time domain Specifications , concepts of generalized error co-efficient and steady state errors

Frequency Domain Analysis- correlation between time and frequency response – stability analysis using Bode plots, concepts of stability – Routh-Hurwitz stability - **P, PI and PID** controllers **Control System components**- Stepper motors – AC servo motor – DC servo motor – **Application of Digital Control systems.**

Total Hours: **45**

Text Books:

1	Nagrath & Gopal, Control System Engineering, , New Age International Edition, Fifth Edition, 2011.
2	P. S. Bimbhra, "Electrical Machinery", Khanna Publishers, 2011.
3	A. E. Fitzgerald and C. Kingsley, "Electric Machinery", McGraw Hill Education, 2013.

Reference Books:

1	Benjamin.C.Kuo, Automatic Control Systems, 7th Edition – Prentice Hall of India, 2009
2	M.Gopal, Control Systems, Tata McGraw-Hill, 2012.
3	Richard Poley, 'Control Theory Fundamentals', 2 nd Edition, Createspace, 2014.

Web References:

1	http://nptel.ac.in/courses/108101037/
2	http://nptel.ac.in/courses/108102043/

Online Resources:

1	http://www.electronics-tutorials.ws/systems/closed-loop-system.html
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Assessment Methods & Levels (based on Bloom's Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Tentative Assessment Component	Marks
C511.1	Understand	Quiz	4
C511.2	Understand	Quiz	4
C511.3	Apply	Problem solving	4
C511.4	Analyze	Group Assignment	4
C511.5	Understand	Class presentation	4

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment			End Semester Examination [50 marks]
	CIA-I [10 marks]	CIA-II [10 marks]	CIA-III [10 marks]	
Remember	20	20	20	20
Understand	80	20	40	40
Apply	-	20	20	20
Analyze	-	20	20	20
Evaluate	-	-	-	-
Create	-	-	-	-

18EC504	MICROCONTROLLERS LABORATORY	0/0/2/1	
Nature of Course	M (Practical application)		
Co requisites	18EC501 :Microcontrollers & Interfacing		
Course Objectives:			
1	To write and execute the programming for various application using Microcontrollers.		
Course Outcomes:			
Upon completion of the course, students shall have ability to			
C504.1	Understand the addressing modes of 8051	[U]	
C504.2	Apply the interfacing procedures of 8051 with peripheral devices using 8051	[AP]	
C504.3	Evaluate the command word format for interfacing with peripherals	[E]	
C504.4	Analyze the usage of Embedded C codes in microcontroller	[AN]	
C504.5	Synthesis and dumb the codes using IAR embedded work bench	[AP]	
C504.6	Study of Keil Microvision	[U]	
Course Contents:			
8051 basic programming-using different addressing modes-subroutines- interfacing of 8051 with-ADC & DAC-stepper motor-8255-8279-MSP430-Led blinking-seven segment display-RTOS-ARM-LED blinking-seven segment display-UART interfacing			
List of Experiments			
S.No	List of Experiments	CO Mapping	RBT
	Programming using 8051 microcontroller		
27.	Arithmetic Instructions - Addition/subtraction, multiplication and division, (16 bits Arithmetic operations – bit addressable).	C504.1	[AP]
28.	Data Transfer - Block move, Exchange, Sorting, Finding largest element in an array	C504.1	[AP]
29.	Boolean & Logical Instructions (Bit manipulations).	C504.1	[AP]
30.	Programs using Conditional CALL & RETURN.	C504.1	[AP]
31.	Code conversion: BCD – ASCII; ASCII – Decimal; Decimal - ASCII;HEX - Decimal and Decimal - HEX.	C504.1	[AP]
	INTERFACING with 8051 microcontroller		

32.	Generate different waveforms Sine, Square, Triangular, Ramp , using DAC interface	C504.2	[AP]
33.	Stepper motor control interface to 8051 microcontroller.	C504.2	[AP]
34.	Programmable peripheral interface to 8051 microcontroller.	C504.3	[E]
35.	keyboard and seven segment display interface with 8051 microcontroller.	C504.3	[E]
36.	ADC and DAC using 8051 microcontroller.	C504.3	[E]
Programming using MSP430			
37.	LED blinking	C504.3	[AN]
38.	Seven segment display interfacing	C504.5	[AP]
39.	Hex keypad interfacing	C504.3	[AN]
40.	Interfacing motor with MSP430.	C504.5	[AP]
41.	Study of RTOS for MSP 430.	C504.5	[AP]
Programming using ARM			
16	LED blinking	C504.6	[AN]
17	Seven segment display interfacing	C504.6	[AN]
18.	UART interfacing	C504.6	[AN]
Total Hours:			30
Reference Books:			
1	Muhammad Ali Mazidi, "The 8051 Microcontroller and Embedded systems", Prentice Hall India, New Delhi, 2006		
2	Kenneth J Ayala, "The 8051 Microcontroller – Architecture, Programming and Applications", Penram International Publications, Mumbai, India, 1996		
3	MSP430 Microcontrollers Basics, John H Devis, 1stEdition, Newnes Publisher.		
4	ARM on-chip architecture, Pearson Edition,second edition 2009.		
Web References:			
1	https://exploreembedded.com		
2	https://www.elprocus.com/peripherals-interfacing-to-the-microcontroller-8051-in-electronics/		
Online Resources:			
1	processors.wiki.ti.com/index.php/MSP430_LaunchPad_Tutorials		
2	https://www.electronicshub.org › ARM		

Assessment Methods & Levels (based on Bloom's Taxonomy)		
Summative assessment based on Continuous and End Semester Examination		
Bloom's Level	Rubric based Continuous Assessment [60 marks] (in %)	End Semester Examination [40 marks] (in %)
Remember	10	10
Understand	20	20
Apply	30	30
Analyse	20	20
Evaluate	10	10
Create	10	10

18EC505	Digital Communication and Networks Lab	0/0/2/1
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Co-requisites	18EC502 Digital Communication		
Pre-requisites	18EC403 Data Communication and networks		
Nature of Course: M (Practical application)			
Course Objectives:			
5. To learn about the performance of digital modulation circuits and to experience the use of simulation tools for the communication circuits.			
6. To analyze error performance of a digital communication system in presence of noise and other interferences.			
7. To understand the working principle of different communication protocols and to analyze the flow control mechanism and routing algorithms.			
Course Outcomes:			
C505.1	Construct and test the working of line coding techniques.	[U]	
C505.2	Construct and analyze the performance of modulation circuits.	[AN]	
C505.3	Analyze the modulation performance and error performance using Simulation Tools	[AN]	
C505.4	Analyze the performance of various communication protocols.	[AN]	
C505.5	Execute flow control and error control mechanism	[AP]	
C505.6	Compare routing algorithms.	[AN]	
Course Content:			
S.No	List of Experiments	CO Mapping	RBT
1	Line Coding Techniques	C505.1	[U]
2	Generation of ASK		
3	Generation of BFSK, BPSK	C505.2	[AN]
4	Generation and Spectral analysis of PN sequence	C505.2	[AN]
5	Simulation of BFSK, BPSK	C505.3	[AN]
6	Simulation of QPSK	C505.3	[AN]
7	Simulation of ISI	C505.3	[AN]
8	Simulation of DS-SS PSK and spectral analysis	C505.3	[AN]
9	Perform and simulate the experiment on CSMA, CSMA/CD and CSMA/CA protocols with LAN trainer kit with Bus Topology and Star Topology and compare the results	C505.4	[AN]
10	Study the performance of Token Bus and Token Ring Protocols using simulation	C505.4	[AN]
11	Implementation of Data Link Layer flow control mechanism – Stop and Wait, Sliding Window protocol	C505.5	[AP]
12	Implementation of Data Link Layer error detection mechanism- CRC	C505.5	[AP]
13	Implementation of Distance Vector and Link State Routing algorithm	C505.6	[AN]
		Total Hours	30

Reference Books:

14. S. Haykin, Digital Communication Systems, John Wiley & Sons, 2013
15. A. B. Carlson, Communication Systems: An Introduction to Signals and Noise in Electrical Communication, 4th Ed., McGraw-Hill, 2010.
16. Behrouz Forouzan and Firouz Mosharraf, Computer Networks: A Topdown approach, SIE, McGraw-Hill, 2012.
17. William Stallings, Data and Computer Communication, 8th edition, Pearson Education, 2007.

Web References:

1. shop.a1-cbiss.com/digital_communication_lab_manual_2010.pdf
2. www.ece.ucf.edu/files/labs/EEL4515_LabManual.pdf
3. www.cse.hcmut.edu.vn/~ptvu/net1/

Assessment Methods & Levels (based on Bloom's Taxonomy)**Summative assessment based on Continuous and End Semester Examination**

Bloom's Level	Rubric based Continuous Assessment [60 marks] (in %)	End Semester Examination [40 marks] (in %)
Remember	10	10
Understand	20	20
Apply	30	30
Analyse	20	20
Evaluate	10	10
Create	10	10

18EC601	ANTENNAS AND WAVE PROPAGATION		3/0/0/3
Nature of Course			
		J (Problem analytical)	
Pre requisites			
		18EC303 Electromagnetics	
Course Objectives:			
1	To gain knowledge in radiation field and its basic characteristics		
2	To know the basics of antenna array and its applications.		
3	To acquire knowledge on different types of antennas and its applications		
4	To gain knowledge in different wave propagation phenomenon		
5	To gain knowledge in fading and diversity techniques		
Course Outcomes:			
Upon completion of the course, students shall have ability to			
C601.1	Recall basic electromagnetic theory concepts.		[R]
C601.2	Draw antenna radiation pattern and measure different antenna parameters.		[U]
C601.3	Design antenna array pattern and determine its basic parameters		[AP]
C601.4	Performance analysis of special antennas		[AN]
C601.5	Apply wave propagation techniques in different applications		[AP]
C601.6	Select and apply diversity techniques for antenna design based on fading methods		[AP]
Course Contents:			
<p>Fundamental Concepts and Antenna Arrays:: Physical concept of radiation, retarded potentials, Hertzian dipole; Antenna parameters: Radiation pattern, gain, directivity, effective aperture, reciprocity principle; Radiation from half wave dipole antenna, Array of point sources, end fire and broadside arrays, pattern multiplication, synthesis of binomial array.</p> <p>Special Antennas: Log-periodic and Yagi-Uda antenna, rhombic antenna, Helical antenna-Huygens' principle, slot antenna, Radiation from rectangular patches, feeding techniques, horn antenna, parabolic reflector antennas, Smart antenna: Historical development of smart antennas, Fixed weight beamforming basics, Adaptive beamforming.</p> <p>Wave Propagation-Fading and Diversity Techniques: Ground wave, surface wave, and space wave propagation; Tropospheric and duct propagation; structure of ionosphere and ionospheric propagation, Multipath fading and ray bending, Rayleigh and Rician fading, Space diversity, Polarization diversity, Frequency diversity, Time diversity.</p>			
Total Hours:			45
Text Books:			
1	K D Prasad, "Antenna and Wave Propagation", Third Edition(Reprint), Satya Prakashan, 2017.		
2	Edward C. Jordan and Keith G. Balmain, "Electromagnetic Waves and Radiating Systems", 2nd Ed., Prentice-Hall of India.2015.		
	Frank B Gross, "Smart Antennas with MATLAB", Second Edition, Tata		

3	McGraw-Hill Publications 2015.			
Reference Books:				
1	Constantine A. Balanis, "Antenna Theory and Design", Third Edition, John Wiley & Sons. 2015.			
2	Theodore S Rappaport, "Wireless Communication:Principles and Practice,Second Edition,Prentice Hall of India,2002.			
3	John D.Kraus Ronald J Marhefka, and Ahmad S Khan "Antennas and Wave Propagation", Fifth Edition, Tata McGraw-Hill Publications, 2017.			
Web References:				
1	http://nptel.ac.in/courses/108101092/			
2	http://nptel.ac.in/courses/117107035/			
3	https://nptel.ac.in/courses/117104099/			
4	https://nptel.ac.in/courses/117105136/			
Online Resources:				
1	http://www.antenna-theory.com			
2	https://www.tutorialspoint.com/antenna_theory			
3	http://www.amanogawa.com/archive/antennaA.html			
4.	www.jackwinters.com/cwc.ppt			
Assessment Methods & Levels (based on Revised Bloom's Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Revised Bloom's Level	Tentative Assessment Component	Marks	
C601.1	Remember	Quiz	3	
C601.2	Understand	Class Presentation	3	
C601.3	Apply	Problem Solving	3	
C601.4	Analyse	Group Assignment	4	
C6015,	Apply	Problem Solving	3	
C601.6	Apply	Group Assignment	4	
Summative assessment based on Continuous and End Semester Examination				
Revised Bloom's Level	Continuous Assessment			End Semester Examination [50 Marks]
	CIA1 [10 Marks]	CIA2 [10 Marks]	CIA3 [10 Marks]	
Remember	20	20	20	20
Understand	30	30	30	30
Apply	50	30	50	50
Analyse	-	20	-	-
Evaluate	-	-	-	-
Create	-	-	-	-
18EC602	Embedded Systems and its Applications			3/0/0/3
Nature of Course :G (Theory)				
Pre requisites 18EC501 Microcontrollers & Interfacing				
Course Objectives:				
1	Learn the architecture and process of embedded system			
2	Be familiar with the embedded computing platform design and analysis			
3	Be familiar with the embedded computing platform design and analysis			
4	Learn the system design techniques and networks for embedded systems			

5	Experience the real time consumer electronic systems	
Course Outcomes:		
Upon completion of the course, students shall have ability to		
C601.1	Get an insight into the overall landscape and characteristics of Embedded systems	[U]
C601.2	Understand the requirements, specification and basic compilation techniques.	[U]
C601.3	Evaluating the program and validation through testing	[E]
C601.4	Gain the knowledge of real time operating systems	[AN]
C601.5	Understand and apply the real time characteristics such as scheduling algorithms for the real time scenario	[AP]
C601.6	Understand and apply the real time characteristics such as scheduling algorithms for the real time scenario	[AP]
Course Contents:		
<p>Introduction and architecture of Embedded systems: Characteristics-Challenges of Embedded Systems –design process –Choice of Microcontroller –building an embedded systems - The CPU Bus-Memory devices and systems–Designing with computing platforms – consumer electronics architecture Categories of embedded systems, overview of embedded architecture, specialties of embedded systems, recent trends in embedded systems. Hardware architecture, software architecture, application software, communication software, process of generating executable image, development/ testing tools.</p> <p>Embedded system design process and system design techniques: platform-level performance analysis - Components for embedded programs- Models of programs- Assembly, linking and loading – compilation techniques- Program level performance analysis – Software performance optimization – Program level energy and power analysis and optimization – Analysis and optimization of program size- Requirements, specifications, architecture design, designing hardware and software components, system integration, models of programs, Basic compilation techniques. Design methodologies, requirement analysis, specifications, quality assurance. Program validation and testing, clear box testing, black box testing, evaluation function tests, performance testing. Distributed embedded systems – MPSoCs and shared memory multiprocessors.</p> <p>Real time operating system concepts, characteristics and case studies: Introduction – Multiple tasks and multiple processes Interprocess communication mechanisms – Evaluating operating system performance- power optimization strategies for processes – Example Real time operating systems-POSIX-Windows CE Architecture of the kernel, tasks and task scheduler, task states, context switching, scheduling algorithms, rate monotonic analysis, task management function calls, interrupt service routine, semaphore, mutex, mailboxes, message queues, event registers, pipes, signals timers, memory management priority inversion problems, Clock driven approach, Round robin approach, priority driven approach, dynamic vs static systems, Effective release time and deadlines. Off-line vs on-line scheduling, overview of RTOS, off the shelf operating systems, embedded OS, real time operating systems, handheld OS. Case studies of program modelling and programming with RTOS, Automatic chocolate vending machine, Orchestra playing robots, adaptive cruise control in a car, smart card</p>		
Total Hours:		45
Text Books:		
1	Dr KVKK Prasad,” Embedded/Real time systems: Concepts, design and programming”,25 th Edition, Embedded/Real time systems: Concepts, design and programming Pearson education, Dreamtech press,2014	
2	Marilyn Wolf, “Computers as Components - Principles of Embedded Computing System Design”, Third Edition “Morgan Kaufmann Publisher (An imprint from Elsevier), 2012	

3	Rajkamal, "Embedded Systems: Architecture, Programming and Design", TMH Publications, Third Edition, 2014			
Reference Books:				
1	Qing Li, "Real time concepts for Embedded systems,CMP Books 2003			
2	Jane W S Liu, "Real time systems", Prentice Hall,2000			
3	Jonathan W.Valvano, "Embedded Microcomputer Systems Real Time Interfacing", Third Edition Cengage Learning, 2012.			
Web References:				
1	https://www.tutorialspoint.com/embedded_systems/es_overview.htm			
2	https://www.electronics-notes.com/articles/digital-embedded-processing/embeddedsystems/basics-primer.php			
3	https://www.mathworks.com/solutions/embedded-systems.html			
4	https://spectrum.ieee.org/computing/embedded-systems			
Online Resources:				
1	https://www.edx.org/course/embedded-systems-shape-the-world-microcontroller-inputoutput			
2	https://onlinecourses.nptel.ac.in/noc18_cs54			
3	https://www.coursera.org/learn/introduction-embedded-systems			
4	https://www.coursera.org/learn/embedded-operating-system			
Assessment Methods & Levels (based on Blooms' Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component	Marks	
C601.1	Understand	Quiz	3	
C601.2	Understand	Group Assignment	3	
C601.3	Evaluate	Group Assignment	3	
C601.4	Analyze	Problem solving	3	
C601.5	Apply	Simulation Exercise	3	
C601.6	Apply	Design	5	
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination[50 Marks]
	CIA1[10 Marks]	CIA2[10 Marks]	CIA3[10 Marks]	
Remember	-	-	-	10
Understand	80	20	-	40
Apply	-	-	50	30
Analyse	20	20	40	20
Evaluate	-	60	10	-
Create	-	-	-	-

18EC603	VLSI Circuits	3/0/0/3
Nature of Course :G (Theory & Analytical)		
Pre requisites 18EC301- Digital Electronics		
Course Objectives:		
1	Introduce the basics of Integrated Circuits and fabrication process.	
2	Familiarize the basics of CMOS transistors and its characteristics	
3	Gain knowledge on CMOS logic structures	
4	Impart knowledge on various combinational and sequential logic design.	
5	Introduce concepts on semiconductor memories.	
Course Outcomes:		
Upon completion of the course, students shall have ability to		
C603.1	Understand the basics of VLSI circuits and its impact in Industry.	[R]
C603.2	Analyzing the various CMOS fabrication techniques and applying for layout.	[AP]
C603.3	Analyze the MOS transistor equations for presence of parasitic components.	[AN]
C603.4	Design of various CMOS logic structures for analyzing at transistor level.	[AN]
C603.5	Construction of Combinational and Sequential logic design based on timing analysis	[AP]
C603.6	Analyzing the various semiconductor memories	[AN]
Course Contents:		
<p>Issues and Challenges in Digital IC Design: General overview of Design hierarchy, Layers of abstraction, Integration density and Moore's law, VLSI design flow, MOS Transistor: Review of NMOS, PMOS, CMOS Transistor, Second Order effects, CMOS Logic: Basic gates, Complex Gates, MOSFET fabrication: Basic steps of fabrication, NMOS Fabrication, CMOS P-well and N-well process, Silicon on Insulator, Stick Diagram, Layout Diagram, Layout Design rules</p> <p>Circuit Characterization: MOS Device Equations, CMOS Inverter (DC Characteristics), Estimation of Resistance and Capacitance, Switching characteristics, Power dissipation, CMOS Logic structures: Pseudo-nMOS, Dynamic CMOS, Clocked CMOS, Domino Logic, Domino and NORA designs Combinational Logic Design: Static CMOS ,Ratioed Circuits, Pass Transistor, Transmission gate, Cascade Voltage Switch Logic Dynamic Logic Circuits, Dynamic Logic Design Considerations, Noise considerations in dynamic design,</p> <p>Sequential Circuits Design: Classification ,Parameters, Static Latches and Register, Race Condition, Dynamic Latches and Registers, Two Phase vs. Single Phase clock designs, Pulse Based Registers, Semiconductor memories: Non-volatile and volatile memory devices, SRAM, DRAM Cell Design, Flash memories, Differential Sense Amplifiers, Single Ended Sense Amplifier</p>		
Total Hours:		45
Text Books:		
1	A.Pucknell, Kamran Eshraghian, "BASIC VLSI Design", Third Edition, Prentice Hall of India, 2007.	
2	N.Weste, K.Eshraghian, "Principles of CMOS VLSI Design", Second Edition, Addison Wesley, 2016	
3	J.M. Rabaey, A. Chandrakasan and B. Nikolic, Digital Integrated Circuits- A Design Perspective, 2/e, Prentice Hall of India, 2016	

Reference Books:				
1	J. P. Uyemura, Introduction to VLSI Circuits and Systems, John Wiley & Sons (Asia), 2015.			
2	W. Wolf, Modern VLSI Design - System on Chip design, 3/e, Pearson Education, 2015.			
3	D. A. Hodges, H. G. Jackson, R. Saleh, Analysis and Design of Digital Integrated Circuits in Deep submicron Technology, 3/e, McGraw Hill, 2005.			
Web References:				
1	https://www.tutorialspoint.com/vlsi_design/			
2	https://electronicsforu.com/resources/learn-electronics/vlsi-developments-ic-fabrication			
3	http://www.vlsi-expert.com/p/vlsi-basic.html			
4	https://www.engineersgarage.com/articles/vlsi-design-future			
Online Resources:				
1	https://www.youtube.com/watch?v=9SnR3M3CIm4			
2	https://www.techopedia.com/definition/714/very-large-scale-integration-vlsi			
3	www.techulator.com › Resources › Electronics › Circuits & Componets			
4	www.almamapper.com/library/notes/vlsi-electronics/			
Assessment Methods & Levels (based on Blooms' Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component	Marks	
C603.1	Remember	Quiz	3	
C603.2	Apply	Group Assignment	3	
C603.3	Analyse	Group Assignment	3	
C603.4	Analyse	Problem solving	3	
C603.5	Apply	Simulation Exercise	3	
C603.6	Analyse	Design	5	
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination [50 Marks]
	CIA1 [10 Marks]	CIA2 [10 Marks]	CIA3 [10 Marks]	
Remember	20	20	10	10
Understand	60	40	40	40
Apply	20	40	30	30
Analyse	-	-	20	20
Evaluate	-	-	-	-
Create	-	-	-	-

18EC604	VLSI Circuits Laboratory	0/0/2/1
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Co requisites	18EC603 VLSI Circuits		
Nature of Course: M (Practical application)			
Course Objectives:			
1. To design, construct and debug MOSFET circuits.			
2. To simulate basic combinational and sequential logic circuits using HDL language			
3. Implementing logical circuits using FPGA.			
Course Outcomes			
C604.1	Understand and construct various types of MOSFET circuits and analyzing its behaviour	[AN]	
C604.2	Construct universal gates using backend tool and analyze power and timing parameter.	[AN]	
C604.3	Construct and simulate various Combinational logic circuits using HDL	[AN]	
C604.4	Construct and simulate various sequential logic circuits using HDL	[AN]	
C604.5	Implementing a logical circuit by interfacing with FPGA	[AP]	
Course Content:			
S.No	List of Experiments	CO Mapping	BT
SPICE Simulation using Tanner & Cadence			
1	DC Characteristics of NMOSFET	C604.1	[AN]
	DC Characteristics of PMOSFET	C604.1	[AN]
2	DC Characteristics of CMOS	C604.1	[AN]
3	Switching Characteristics of CMOS Inverter	C604.2	[AN]
4	Characterization of CMOS Ring Oscillator	C604.1	[AN]
5	Transient analysis of CMOS NAND,NOR and simple multiplexers	C604.2	[AN]
Logic Simulation & Synthesis using HDL			
7	Simulation and Synthesis of basic logic gates	C604.3	[AN]
8	Simulation and Synthesis of MSI combinational circuits	C604.3	[AN]
9	Simulation and Synthesis of MSI sequential circuits	C604.4	[AN]
10	Mini Project - FPGA based system design	C604.5	[AN]
11	Implementation of Combinational Circuits using FPGA	C604.5	[AP]
Total Hours			30
Reference Books:			
1	Muhammed H Rashid, SPICE for circuits and Electronics using PSPICE, Pearson Education,1994.		
2	Gordon Roberts, Adel Sedra, SPICE, The Oxford Series in Electrical and Computer Engineering, 2 nd edition,1996		
3	J.Bhasker ,” A VHDL Primer”, AT&T, Prentice hall,2010		
4	Stephen Brown, Zvonko Vranesic, Fundamentals of Digital Logic with VHDL Design, McGrawHill India Ltd., 2006		
Web References:			
1. www.vlsi-expert.com/p/vlsi-basic.html			

2.electronicsforu.com › Resources › Learning Corner
3.http://www.allaboutcircuits.com/education/

Assessment Methods & Levels (based on Bloom's Taxonomy)		
Summative assessment based on Continuous and End Semester Examination		
Bloom's Level	Rubric based Continuous Assessment [60 marks] (in %)	End Semester Examination [40 marks] (in %)
Remember	10	10
Understand	20	20
Apply	30	30
Analyse	40	40
Evaluate	-	-
Create	-	-

18EC605	Embedded Systems Laboratory	0/0/2/1
Nature of Course: M (Practical application)		
Course Objectives: To write a program for simple applications and analysis the output		
Course Outcomes		
C605.1	Learn the working of 89C51 family and ARM processor and memory interface	[U]
C605.2	Write programs for interfacing display devices	[AP]
C605.3	Write programs to interface memory and I/Os with processor	[AP]

C605.4	Write programs to interface real time clock and matrix keyboard	[AN]	
C605.5	Write programs to do multidisciplinary projects	[AP]	
Course Content:			
S.No	List of Experiments	CO Mapping	BT
1	Study of Keil Compiler using 89C51XX and ARM	C605.1	[U]
2	Interfacing LED and LCD	C605.2	[AP]
3	Interfacing Stepper motor and DC motor	C605.3	[AP]
4	Interfacing real time clock and matrix hex board	C605.4	[AN]
5	Interfacing 7 segment display	C605.3	[AN]
6	Interfacing EEG and temperature sensor	C605.5	[AP]
Total Hours			30
Reference Books:			
1	Y.Zhu., Embedded Systems with ARM Cortex-M Microcontrollers in Assembly Language and C: Third Edition, E-Man Press LLC,2017		
2	Jonathan W.Valvano, "Embedded Microcomputer Systems Real Time Interfacing", Third Edition Cengage Learning, 2012.		
3	Michael J. Pont, "Embedded C", Pearson Education, 2nd Edition, 2008		
Web References:			
1. https://blog.edx.org/embedded-systems-a-hands-on-lab-based-course			
2. http://www.vlab.co.in/participating-institute-iit-kharagpur			
3. https://github.com/virtual-labs/fpga-and-embedded-systems-lab-coep			
4. https://www.arm.com			

Assessment Methods & Levels (based on Bloom's Taxonomy)		
Summative assessment based on Continuous and End Semester Examination		
Bloom's Level	Rubric based Continuous Assessment [60 marks] (in %)	End Semester Examination [40 marks] (in %)
Remember	-	-
Understand	40	40
Apply	30	30
Analyse	30	30
Evaluate	-	-
Create	-	-

18EC70	MICROWAVE AND OPTICAL COMMUNICATION	3/0/0/3
1		
Nature of Course	:G (Theory & Analytical)	
Pre requisites	18EC601 Antennas and Wave Propagation	
Course Objectives:		
1	To study the basics of Microwave network and characterization of passive microwave components.	
2	To enable the students to understand the principles and operations of Microwave tubes	
3	To enable the students to understand the principles and operations of Microwave semiconductor devices.	
4	To enable the students to understand the fundamentals of optical fibre communication.	
5	To enable the students to understand characteristics of optical transmitters and receivers	
Course Outcomes:		
Upon completion of the course, students shall have ability to		
C701.1	Understand the concepts of microwave network characterization	[U]
C701.2	Understanding microwave passive components and to apply for various design implementation.	[AP]
C701.3	Design and Implementation of semiconductor devices.	[AP]
C701.4	Understand the operation of optical fiber and their operational modes.	[U]
C701.5	Understand the concepts of optical transmitter and apply knowledge to modern fiber optic systems.	[AP]
C701.6	Understand the concepts of optical receiver and apply knowledge to modern fiber optic systems	[AP]
Course Contents:		
<p>Network Characterization and Passive Components: Microwave Frequency band and S parameter representation of N ports- Losses in terms of s parameters- Properties of S parameters, Directional Coupler- Microwave Hybrid circuits-Circulator and isolator- Matched loads and movable shorts.</p> <p>Tubes and Semiconductor Devices: Two cavity klystron - Reflex Klystron- Travelling Wave Tube Gunn Diode, Avalanche Multiplication, Avalanche Breakdown diodes (TRAPATT,IMPATT,BARITT) - Manley – Rowe Power Relations, Microwave Resonators: Series and Parallel Resonant Circuits, Transmission Line Resonators.</p> <p>Optical Transmitters and Receivers: Optical Fibers: Ray and Mode theories, Multimode and Single-mode fibers, Optical Fiber Modes and Configuration, Fiber Loss, Dispersions. Power coupling: splices, connectors, coupler, Light Emitting diode and Laser diodes, Laser modes. PIN and APD, Optical Amplifier, Erbium Doped Fiber Amplifier.</p>		
Total Hours:		45
Text Books:		
1	Annapurna Das and Sisir K Das, Microwave Engineering, Third Edition, Tata McGraw Hill, Inc., 2014.	
2	D.M.Pozar, Microwave Engineering, 4 th Edition, John Wiley & sons, Inc., 2011.	
3	Gerd Keiser, Optical Fiber Communications, 5th Ed, McGrawHill, 2013.	

Reference Books:	
1	Samuel Y Liao, Microwave Devices & Circuits, Third Edition, Pearson Education, 2011.
2	Robert E.Collin,Foundations for Microwave Engineering,Second Edition,Wiley IEEE Press,2001.
3	S. Kumar and M. J. Deen,Fiber Optic Communications, John Wiley & sons,2014.

Web References:	
1	https://onlinecourses.nptel.ac.in/noc18_ee22
2	https://onlinecourses.nptel.ac.in/noc18_ee28
3	https://nptel.ac.in/courses/108101112/
4	https://nptel.ac.in/courses/117101054/

Online Resources:	
1	https://radfiz.org.ua/.../Collin.%20Foundations%20for%20Microwave%20Engineering.p
2	https://www.slac.stanford.edu/slac/sass/talks/opticalfiber.pdf
3	https://www.utdallas.edu/~torlak/courses/ee4367/lectures/FIBEROPTICS.pdf
4	https://www.cse.wustl.edu/~jain/tutorials/ftp/t_3opt.pdf

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C701.1	Understand	Quiz	3
C701.2	Apply	Problem Solving	4
C701.3	Apply	Problem Solving	4
C701.4	Understand	Group Assignment	3
C701.5	Apply	Problem Solving	3
C701.6	Apply	Problem Solving	3

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment			End Semester Examination[50 Marks]
	CIA1[10 Marks]	CIA2[10 Marks]	CIA3[10 Marks]	
Remember	-	-	-	-
Understand	80	60	60	60
Apply	20	40	40	40
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

18EC702	Microwave And Optical Communication Laboratory	0/0/2/1
Co requisites	18EC601 Antenna and Wave Propagation	
Nature of Course: M (Practical application)		
Course Objectives:		
1	To learn the various parameters of microwave networks.	
2	To measure the characteristics of optical diodes.	
3	To study the performance of different types of antenna and its radiation pattern.	

4	To gain knowledge about the reflex klystron.		
5	To study the performance of Microwave passive components using HFSS		
Course Outcomes			
C702.1	Analyze the power distribution in microwave components.	[AN]	
C702.2	Compute the impedance and frequency in microwave components.	[AN]	
C702.3	Design and analyze radiation pattern of antenna.	[AN]	
C702.4	Compute the optical fiber losses and parameters.	[AN]	
C702.5	Design and Simulation of Microwave Tee's .	[AP]	
Course Content:			
S.No	List of Experiments	CO Mapping	BT
1	Analyze the Mode characteristics of Reflex Klystron	C702.1	[AN]
2	Compute the V-I Characteristics of Gunn Diode.	C702.1	[AN]
3	Compute VSWR, frequency and wave length parameters of microwave components.	C702.2	[AN]
4	Directional Coupler (Directivity, Coupling Coefficient and S – parameter measurement).	C702.1	[AN]
5	Analyze the Radiation Pattern of Antennas.	C702.3	[AN]
6	Design and Simulation of E-Plane / H-Plane Tee in HFSS	C702.5	[AP]
7	Design and Simulation of Magic Tee in HFSS.	C702.5	[AP]
8	DC characteristics of PIN Photo Diode.	C702.1	[AN]
9	Compute bending losses in optical fiber	C702.4	[AN]
10	Analyze the performance of fiber optic analog and digital link.	C702.4	[AN]
11	Compute the numerical aperture for optical fiber.	C702.4	[AN]
Total Hours			30
Reference Books:			
1. Annapurna Das and Sisir K Das, Microwave Engineering, Third Edition, Tata McGraw Hill, Inc., 2014.			
2. D.M.Pozar, Microwave Engineering, 4 th Edition, John Wiley & sons, Inc., 2011.			
3. Gerd Keiser, Optical Fiber Communications, 5th Ed, McGrawHill, 2013.			
4. Samuel Y Liao, Microwave Devices & Circuits, Third Edition, Pearson Education, 2011			
Web References:			
1. https://www.antennatheory.com			
2. https://www.mwrf.com/technologies/passive-components			
3. https://www.ansys.com/search?keyword=hfss			

Assessment Methods & Levels (based on Bloom's Taxonomy)

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Rubric based Continuous Assessment [60 marks] (in %)	End Semester Examination [40 marks] (in %)
Remember	10	10
Understand	20	20
Apply	30	30
Analyse	20	20
Evaluate	10	10
Create	10	10

18EC901	VLSI Fabrication Technology		3/0/0/3
Nature of Course	:G (Theory & Analytical)		
Pre requisites	18EC201 Electron Devices		
Co requisites	VLSI Circuits		
Course Objectives:			
1	To Understand the basics of semiconductor crystal properties		
2	To Understand the concepts of diffusion and Ion implantation		
3	To Define the process of oxidation, etching		
4	To Develop patterns for the process of Lithography.		
5	To Build an idea on device and circuit fabrication		
Course Outcomes:			
Upon completion of the course, students shall have ability to			
C901.1	Outline the basics of semiconductor crystal properties		[R]
C901.2	Understand the concepts of diffusion and Ion implantation		[U]
C901.3	Characterise the process of oxidation, etching		[U]
C901.4	Develop patterns for the process of Lithography.		[U]
C901.5	Identify the fundamentals of IC fabrication		[U]
C901.6	Fabricate a circuit and Implement specific device		[AP]
Course Contents:			
<p>Crystal Growth, Diffusion & Ion Implantation: Crystal structure- axes & planes, Crystal defects- Point defects & dislocations Crystal growth- Bridgman, Czochralski techniques & Zone process, Doping in the melt. Diffusion & Ion Implantation: Nature of diffusion-interstitial, Substitutional, interstitial substitutional movements, Diffusion constant, Dissociate process, Diffusion equation- D is constant & function, Diffusion systems, problems in Si Diffusion, Evaluation Techniques Ion Implantation: Penetration range, Implantation Damage, Annealing, Implantation Systems.</p> <p>Oxidation, Etching & Lithography: Thermal Oxidation-Intrinsic, Extrinsic silicon Glass, Oxide formation, Kinetics of Oxide growth, Oxidation systems, Faults, Anodic Oxidation. EPITAXY: Vapour Phase Epitaxy (VPE)- transport, reaction and growth, Chemistry of growth, Insitu etching, Selective epitaxy, imperfections, Liquid Phase Epitaxy, LPE system, Evaluation of epitaxial layers.: LITHOGRAPHY: Pattern generation & Masking, Printing & Engraving-Optical, E-Beam, ion Beam, X-Ray, Photo resists, Defects. ETCHING: Wet chemical etching- anisotropic etchants, Etching for non-crystalline films-Plasma etching, Plasma-assisted etching, cleaning.</p> <p>Device & Circuit Fabrication: Isolation- Mesa, Oxide, PN-junction isolations, Self Alignment, Local Oxidation, Planarisation, Metallisation and Packaging. Circuits – N, P and CMOS Transistors, Memory devices, BJT Circuits – Buried Layer, PNP and NPN Transistors, Diodes, Resistors, Capacitors.</p>			
Total Hours:			45
Text Books:			
1	Shban Tiku, Dhruves Biswas, "Integrated Circuit fabrication Technology", PAN Stanford Publishing, 2016		

2	Sorab K Gandhi, "VLSI Fabrication Principles – Silicon and Gallium Arsenide", Wiley Interscience Publications, New York 2007.			
3	Sze S M, "VLSI Technology", McGraw Hill, New York, 2003.			
Reference Books:				
1	Chang S Y and Sze S M, "ULSI Technology", McGraw Hill, New York, 2007.			
2	Groove A S, "Physics and Technology of Semiconductor Devices", Wiley Interscience Publications, New York, 2007.			
3	Sze S M and Kwok K Ng, "Physics of Semiconductor Devices", John Wiley, 2006			
Web References:				
1	https://electronicsforu.com/resources/learn-electronics/vlsi-developments-ic-fabrication			
2	https://www.edgefx.in/understanding-cmos-fabrication-technology/			
3	https://www.mepits.com/tutorial/384/vlsi/steps-for-ic-manufacturing			
Online Resources:				
1	https://global.oup.com/us/companion.websites/fdscontent/uscompanion/us/static/companion.websites/9780199339136/Appendices/Appendix_A.pdf			
2	https://nptel.ac.in/courses/117101058/12			
3	http://www.circuitstoday.com/ic-fabrication-techniques			
Assessment Methods & Levels (based on Blooms' Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component	Marks	
C301.1	Remember	Quiz	3	
C301.2	Understand	Quiz	3	
C301.3	Understand	Quiz	3	
C301.4	Understand	Group Assignment	3	
C301.5	Understand	Group Assignment	3	
C301.6	Apply	Group Assignment	5	
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination[50 Marks]
	CIA1[10 Marks]	CIA2[10 Marks]	CIA3[10 Marks]	
Remember	50	-	10	10
Understand	50	100	20	70
Apply	-	-	70	20
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

18EC902	HIGH SPEED DIGITAL DESIGN	3/0/0/3
Nature of Course	: F (Theory Programming)	
Pre requisites	18EC301 Digital electronics	
Course Objectives:		

1	To help students with a good understanding of the high speed digital design circuit models.	
2	To enable the students to understand the types of noise, power supply and interconnections of circuits.	
3	To build the ability of demonstrating basic signalling techniques of circuits.	
4	To enable the students for designing skills of measuring time and performance of high speed digital circuits.	
5	To attribute the timing analysis and clocking schemes of high speed circuits.	
Course Outcomes:		
Upon completion of the course, students shall have ability to		
C902.1	Adapt to venture deep into the realm of high speed digital design	[R]
C902.2	Relate to the inventory of wire models, noise, signaling and synchronization concepts associated with high speed design	[U]
C902.3	Demonstrate an understanding of the concepts, thumb rules and design of basic high speed systems	[U]
C902.4	Apply the design of high speed systems and other allied fields appreciating the trade-offs between noise immunity, power, speed etc.	[AP]
C902.5	Analyze the timing characteristics of digital circuits and clocking schemes.	[AN]
Course Contents:		
<p>Introduction to high speed digital design: Modeling of interconnects - electrical models of wires, lumped single-element models, lumped multi-element models, transmission line model, thumb rules for the applicability of models Power supply network – local regulation with bypass capacitors, regulation with active regulators, power supply isolation Noise sources in digital system – Noise budgeting and SNR</p> <p>Signalling convention and circuits: Signalling modes for lumped-C medium, distributed RC medium and transmission lines - simultaneous bi-directional signalling - terminations .Transmitter circuits – full swing & low swing voltage drivers, current mode drivers, Gunning transceiver logic, rise-time control Receiver circuits – voltage & time domain performance specifications, eye diagram, static and regenerative amplifiers, integrating receivers.</p> <p>Timing convention and synchronisation: Timing properties of clocked storage elements, open loop timing, level sensitive clocking, pipeline timing, closed loop timing Off-chip and on-chip clock distribution, PLL and DLL based clock aligners. Synchronisation failure and metastability, probability of synchronization failure .Hierarchy of synchronizer design – delay line, 2-register and FIFO mesochronous synchronizers</p>		
Total Hours:		45
Text Books:		
1	William J. Dally & John W. Poulton, “Digital Systems Engineering”, Cambridge University Press, 2008.	
2	Howard Johnson & Martin Graham, “High Speed Digital Design” A Handbook of Black Magic, Pearson education, 2003.	
3	Stephen H. Hall, Garrett W. Hall & James A. McCall, High-Speed Digital System Design - A Handbook of Interconnect Theory and Design Practices, John Wiley & Sons, 2000	
Reference Books:		
1	Jan M, Rabaey, et al, “Digital Integrated Circuits”, A Design Perspective, Prentice Hall India, Second edition, 2003.	
2	Tom Granberg, ”Digital Techniques for High-speed Design”, Prentice Hall, 2004	
3	Eric Bogatin, Signal and Power Integrity- Simplified, , Prentice Hall, Second	

	edition,2010			
Web References:				
1	https://dl.acm.org/citation.cfm?id=151151			
2	https://courses.soe.ucsc.edu/courses/ee173			
Online Resources:				
1	https://courses.soe.ucsc.edu/courses/ee173			
2	https://www.atcourses.com/High-Speed-Digital-Design-PCB.htm			
Assessment Methods & Levels (based on Blooms' Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component	Marks	
C301.1	Remember	Quiz	3	
C301.2	Understand	Quiz	3	
C301.3	Understand	Group Assignment	5	
C301.4	Apply	Problem Solving	4	
C301.5	Analyze	Case study	5	
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination[50 Marks]
	CIA1[10 Marks]	CIA2[10 Marks]	CIA3[10 Marks]	
Remember	60	20	10	20
Understand	40	60	20	30
Apply	-	20	40	20
Analyse	-	-	30	30
Evaluate	-	-	-	-
Create	-	-	-	-

18EC903	HARDWARE DESCRIPTION LANGUAGES	3/0/0/3
Nature of Course	:F (Theory Programming)	
Pre requisites	18EC301 Digital electronics	
Course Objectives:		
1	To provide students with a good understanding of the Hardware Description Language for prototyping digital circuits.	
2	To help the students develop the ability to solve problems using the VHDL and Verilog language.	

3	To build the ability of digital circuits analysis for students.	
4	To develop skills of digital circuits design and synthesis.	
5	To understand various modelling styles in coding.	
Course Outcomes: Upon completion of the course, students shall have ability to		
C903.1	Understand the FPGA design flow	[U]
C903.2	Develop code for any digital circuits using VHDL modeling styles	[AP]
C903.3	Develop code for any digital circuits using Verilog modeling styles	[AP]
C903.4	Implement the methodology for testing a program using test benches	[AP]
C903.5	Integrate the synthesis of combinational and sequential logic circuits	[AN]
C903.6	Identify the knowledge in digital system design of various logic circuits.	[R]
Course Contents:		
<p>VHDL Overview – FPGA Design Flow Process –Libraries– Data Objects - Data Types – Data Operators –Entities – Architectures. Basic Concurrent Statements– Usage of Blocks In Dataflow Modeling. Component Declarations-Component Instantiation – Types of Component Instantiation- Test Benches –Process – Delays – Basic Sequential Statements – Usage of Variables Inside TheProcess –Multi Process Statements – Generics – Operator Overloading – Conversion Functions –Attributes – File Concepts - Packages – Functions & Procedures – Predefined & User Defined Library Implementations</p> <p>VHDL Synthesis: Synthesis basics-modeling a wire- modeling combinational logic- modelling sequential logic- Modeling Flip-flop with Synchronous/ Asynchronous Preset and clear-Modeling a latch. Verilog :Design Methodology – Module – Ports –Operators –Data Types – Arrays – Parameters – Gate Delays – Operator Types – Conditional Statements –Modeling Elements - Dataflow Modeling- Continuous Assignment. Delays, Expression, Operators and Operands-Behavioral Modeling-Procedural Assignments, Timing Controls, Loops- implementation of Basic Circuit Using Dataflow & Behavioral Modeling. Switch Level Modeling-FSM Implementation – Test Benches</p> <p>Verilog Synthesis: Synthesis of combinational logic and sequential logic - synthesis of explicit and implicit state machines- Synthesis of gated clocks and clock enables -synthesis of Loops</p>		
Total Hours:		45
Text Books:		
1	M. D. Ciletti, “Advanced VLSI Design with the Verilog HDL”, Prentice-Hall of India, 2008.	
2	J. Bhaskar, “A VHDL Synthesis Primer”, BS Publications, II Edition, 2001.	
3	Samir Palnitkar, “Verilog HDL: A Guide to Digital Design and Synthesis” Prentice Hall, Second Edition, 2009	
Reference Books:		
1	“VHDL Programming By Examples”, Douglas L. Perry, McGraw-Hill, 2002.	
2	Kevin Skahill “VHDL for PROGRAMMABLE LOGIC” Pearson Publications,2004.	
3	Sudhakar Yalamanchili, Introductory VHDL From Simulation to Synthesis, Prentice Hall, 2001.	
4	“Verilog Quickstart”, James M. Lee, Kluwer Academic Publishers, 2002.	
Web References:		

1	IEEE standard 1076.6 VHDL Register Transfer Level (RTL) Synthesis			
2	https://www.mepits.com/tutorial/143/vlsi/hardware-description-language			
Online Resources:				
1	https://forums.xilinx.com/xlnx/attachments/xlnx/SIMANDVERIBD/12141/1/Verilog%20-%20LRM.pdf			
2	https://onlinecourses.nptel.ac.in/noc18_cs48/preview			
Assessment Methods & Levels (based on Blooms' Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component	Marks	
C903.1	Understand	Quiz	3	
C903.2	Apply	Coding exercise on VHDL	3	
C903.3	Apply	Coding exercise on Verilog	3	
C903.4	Apply	Problem Solving on testbench	3	
C903.5	Analyze	Case study	3	
C903.6	Remember	Group Assignment	5	
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination[50 Marks]
	CIA1[10 Marks]	CIA2[10 Marks]	CIA3[10 Marks]	
Remember	-	-	30	20
Understand	40	-	-	20
Apply	60	60	30	40
Analyze	-	40	40	20
Evaluate	-	-	-	-
Create	-	-	-	-

18EC904	ASIC AND FPGA DESIGN	3/0/0/3
Nature of Course	:C (Theory)	
Pre requisites	18EC301 Digital Electronics	
Course Objectives:		
1	To study the design flow of different types of ASIC	
2	To familiarize with the different types of programming technologies and logic devices	
3	To gain knowledge about partitioning, floor planning, placement and routing of ASIC	
4	To learn the architecture of different types of FPGA	
5	To learn the High-level Programming	
Course Outcomes:		
Upon completion of the course, students shall have ability to		
C904.1	Design various digital systems using PLDS	[AP]
C904.2	To understand the Physical Design of VLSI	[U]

C904.3	Analyse the different FPGA Architecture and optimise system design	[AN]
C904.4	Apply C/C++ flows in the context of generic digital design	[AP]
C904.5	Analyse different FPGAs to design complex digital systems	[AN]
Course Contents:		
<p>Overview of ASIC and PLD: Types of ASICs – Design Flow – CAD tools used in ASIC Design- Programming Technologies. Antifuse – Static RAM- EPROM and EEPROM technology, Programmable Logic Devices: ROMs and EPROMs – PLA- PAL, Gate Arrays – CPLDs and FPGAs.</p> <p>ASIC Physical Design: System Partition – partitioning methods – interconnect delay models and measurement of delay – floor planning- placement – Routing: Global routing – detailed routing – special routing – Circuit Extraction – DRC. Logic Synthesis, Simulation and Testing</p> <p>FPGA: Field Programmable Gate Arrays – Logic Blocks, routing architecture, Design Flow Technology – mapping for FPGAs, Xilinx XC 4000 – ALTERA's FLEX 8000/10000, ACTEL's ACT 1,2,3 and their speed performance. Case studies: Altera MAX 5000 and 7000 – Altera MAX 9000- Spartan II and Virtex II FPGAs – Apex and Cyclone FPGAs.</p> <p>FPGA:FPGA Fabrics-FPGA Architecture-SRAM –Based FPGAs-Permanently Programmed FPGAs-Chip I/O- Circuit Design of FPGA Fabrics- Architecture of FPGA Fabrics-C/C++ Based Design Flows-Problems with traditional HDL-Based flows- C versus C++ and concurrent versus sequential- System C based flows- Augmented C/C++ -based flows- Pure C/C++ -based flows- Different levels of synthesis abstraction- Mixed –language design and verification environments</p>		
Total Hours:		45
Text Books:		
1	M.J. S. Smith, “ Application Specific Integration Circuits”, Addison – Wesley Longman, 1997	
2	Wayne Wolf, “ FPGA- Based System Design”, Pearson Education, Indian reprint 2005	
3	Clive “Max” Maxfield , “The Design warrior’s guide to FPGA’S: devices, tools and flows “,Elsevier, 2006	
Reference Books:		
1	S. Trimberger, “Field Programmable Gate Array Technology”, Kluwer Academic Publications, 1994.	
2	John V. Oldfield, Richard C Dore, “ Field Programmable Gate Arrays”, Wiley Publications 1995.	
3	P. K. Chan, S. Mourad, “ Digital System Design using Field Programmable Gate Array”, Prentice Hall Publications, 1994.	
Web References:		
1	https://docs.numato.com/kb/learning-fpga-verilog-beginners-guide-part-1-introduction/	
2	https://www.tutorialspoint.com/vlsi_design/vlsi_design_fpga_technology.htm	
3	https://www.xilinx.com/support/documentation/sw_manuals/xilinx10/isehelp/ise_c_fpga_design_flow_overview.htm	
4	https://www.design-reuse.com/articles/7330/fpga-programming-step-by-step.html	
Online Resources:		
1	https://www.coursera.org/lecture/intro-fpga-design-embedded-systems/1-the-fpga-design-flow-cDnJk	
2	https://www.udemy.com/vhdl-and-fpga-development-for-beginners-and-intermediates/	

3	https://nptel.ac.in/courses/117108040/			
4				
Assessment Methods & Levels (based on Blooms' Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component	Marks	
C904.1	Apply	Assignment	2	
C904.2	Understand	Quiz	3	
C904.3	Analyse	Class presentation	5	
C904.4	Apply	Mini Project	5	
C904.5	Analyse	Case Study	5	
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination[50 Marks]
	CIA1[10 Marks]	CIA2[10 Marks]	CIA3[10 Marks]	
Remember	20	20	10	10
Understand	40	40	40	40
Apply	40	20	30	30
Analyse	-	20	20	20
Evaluate	-	-	-	-
Create	-	-	-	-

18EC905	TESTING AND VERIFICATION OF VLSI CIRCUITS	3/0/0/3
Nature of Course :G (Theory & Analytical)		
Pre requisites 18EC603 VLSI Circuits		
Course Objectives:		
1	To introduce the concepts of fault identification.	
2	To develop a clear insight into techniques generation of test vectors.	
3	To introduce the fundamental concepts of built in self-test.	
4	To allow students to design and analyze synchronous sequential circuits	
5	To introduce verification of digital circuits	
Course Outcomes: Upon completion of the course, students shall have ability to		
C905.1	Understand how to abstract physical faults in VLSI circuits as logical fault models	[U]
C905.2	Apply core decision principles based on Boolean and algebraic reasoning to test and verify digital systems	[AP]
C905.3	Understand chip level, system level test strategies	[U]
C905.4	Analyse different methods to generate test vectors.	[AN]
C905.5	Analyse different design circuits which is easier to test	[AN]
C905.6	Analyse and find verify whether a circuit implementation is bug free or	[AN]

	functionally equivalent to its specification.			
Course Contents:				
<p>Motivation for testing and design for testability – Faults in digital circuits -Modeling of faults - Logical Fault Models - Fault detection - Fault location - Fault dominance-CMOS testing – Manufacturing test principles – Design Strategies for test– chip level test techniques - System level test techniques- Testability features for board test</p> <p>ATPG & Built in self-test :Fault Table, Boolean difference – Path sensitization, D algorithm – Sequential circuits – Random test vectors-Serial, Single-fault propagation, Deductive, Parallel and Concurrent Simulation Built in self-test: Scan-in Scan-out design – Signature analysis - Built-In Self-Test – Test pattern generation for BIST - Circular BIST – BIST Architectures - Testable Memory Design - Test algorithms – Test generation for Embedded RAMs</p> <p>Fault diagnosis: Logic Level Diagnosis - Diagnosis by UUT reduction - Fault Diagnosis for Combinational Circuits - Self-checking design - System Level Diagnosis Verification: Design verification techniques based on simulation, analytical and formal approaches-function verification-timing verification-formal verification-basics of equivalence checking and model checking- hardware emulation</p> <p>Case studies: Built in Self-test for System on chip</p>				
Total Hours:				45
Text Books:				
1	M. Abramovici M.A, Breuer and A.D Friedman, “Digital Systems Testing and Testable Design”, Computer Sciences Press, 2002.			
2	M.L. Bushnell and V.D. Agarwal, "Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits", Kluwer Academic Publishers, 2002.			
3	P.K. Lala, "Digital Circuit Testing and Testability", Academic Press, 2002			
Reference Books:				
1	Robert J.Feuguat, Jr. Steven M.Mcintyre, “Introduction to VLSI testing’, Prentice Hall, Englewood Cliffs, 1998.			
2	Kropf.T, “Introduction to Formal Hardware verification”, Springer Verlag 1999			
3	Rashinkar,Patterson and Singh, “ System on chip verification methodology and techniques” Kluwer academics, 2001.			
4	LaungTerngWang,Cheng Wen Wu, XiaoqingWen,”VLSI test principles and architectures” Morgan Kaufmann,2011.			
Web References:				
1	https://nptel.ac.in/courses/117103125/18			
2	http://www.cs.colostate.edu/~malaiya/530/08/resources.html			
Online Resources:				
1	www.ee.iitb.ac.in/~viren/Courses/2012/EE709.htm			
2	https://nptel.ac.in/syllabus/syllabus_pdf/117103125.pdf			
Assessment Methods & Levels (based on Blooms’Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom’s Level	Assessment Component	Marks	
C905.1	Understand	Quiz	3	
C905.2	Apply	Problem Solving	3	
C905.3	Understand	Assignment	3	
C905.4	Analyse	Problem Solving	3	
C905.5	Analyse	Group Assignment	3	

C905.6	Analyse	Case Study	5	
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination[50 Marks]
	CIA1[10 Marks]	CIA2[10 Marks]	CIA3[10 Marks]	
Remember	20	20	10	10
Understand	40	40	40	40
Apply	40	20	30	30
Analyse	-	20	20	20
Evaluate	-	-	-	-
Create	-	-	-	-

18EC906	Digital Low Power VLSI Design	3/0/0/3
Nature of Course	:G (Theory & Conceptual)	
Pre requisites	18EC603-VLSI DESIGN	
Course Objectives:		
1	To clearly explain students for better understanding of the sources of power consumption	
2	To cover low-power design methodologies at various design levels (from system level to transistor level)	
3	To make the students to understand and adapt the design procedures to design circuit within power budget	
Course Outcomes:		
Upon completion of the course, students shall have ability to		
C906.1	Understand the sources of power consumption in CMOS circuits	[U]
C906.2	Apply simulation techniques to estimate both static and dynamic power consumption in CMOS circuits	[AP]
C906.3	Apply mathematical models for theoretical analysis of power dissipation	[AP]
C906.4	Implement various power reduction techniques at various levels for power optimization	[AN]
C906.5	Design a system which consumes power within the power budget limits	[AN]
Course Contents:		
Introduction: Needs for Low Power VLSI Chips - Charging and Discharging Capacitance - Short-circuit Current in CMOS Circuit - CMOS Leakage Current - Static Current - Basic Principles of Low Power Design.		

Simulation Power Analysis: SPICE Circuit Simulation -Discrete Transistor Modelling and Analysis - Gate-level Logic Simulation - Architecture-level Analysis - Data Correlation Analysis in DSP Systems - Monte Carlo Simulation- **Probabilistic Power Analysis-** Random Logic Signals - Probability and Frequency - Probabilistic Power Analysis Technique. **Circuit:** Transistor and Gate Sizing - Equivalent Pin Ordering - Network Restructuring and Reorganization - Special Latches and Flip-flops - Low Power Digital Cell Library - Adjustable Device Threshold Voltage- **Logic:** Gate Reorganization - Signal Gating - Logic Encoding - State Machine Encoding - Precomputation Logic.

Special Techniques: Power Reduction in Clock Networks - CMOS Floating Node - Low Power Bus -Delay Balancing -Low Power Techniques for SRAM- Architecture and System. Power and Performance Management: Switching Activity Reduction - Parallel Architecture with Voltage Reduction - Flow Graph Transformation- Advanced Techniques: Adiabatic Computation - Pass Transistor Logic Synthesis Asynchronous Circuits- **Introduction to software power estimation and optimization techniques.**

Total Hours:	45
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Text Books:

1	Gary Yeap “Practical Low Power Digital VLSI Design”, Springer US,Kluwer Academic Publishers, 2002
2	Jan M Rabeay, low power Design Essentials, Springer , 2009
3	Massoud Pedram, Jan M. Rabaey” Low Power Design Methodologies”,Springer Science,1996

Reference Books:

1	Kaushik Roy, Sharat Prasad, Low Power CMOS VLSI Circuit Design, 1 st edition, Wiley-Interscience Publication, 2000
2	Anantha P. Chandrakasan, R. W. Brodersen, Low Power Digital CMOS Design, Kluwer Academic Publishers, 1995
3	Kiat-Seng Yeo, Kaushik Roy, “Low Voltage Low Power VLSISubsystems”, Mc-Graw Hill India, 2009

Web References:

1	https://drive.google.com/file/d/0BzoKWH8M1BoTOTI5ZEZtdXhMSW8/view
2	https://drive.google.com/file/d/0BzoKWH8M1BoTQI9CUUpOYIpuYjQ/view
3	https://drive.google.com/file/d/0BzoKWH8M1BoTdzR6UjR6S2E5SHc/view

Online Resources:

1	https://drive.google.com/file/d/0BzoKWH8M1BoTZi11R3QzWldxWVvk/view
2	https://drive.google.com/file/d/0BzoKWH8M1BoTaIFUSFhCVXg3dnM/view

Assessment Methods & Levels (based on Bloom’sTaxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom’s Level	Tentative Assessment Component	Marks
C906.1	Understand	Quiz	4
C906.2	Apply	Class Presentation	4
C906.3	Apply	Group Assignment	4
C906.4	Apply	Problem solving	4
C906.5	Analyse	Simulation Exercise	4

Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination[50 Marks]
	CIA-I [10 marks]	CIA-II [10 marks]	CIA-III [10 marks]	
Remember	20	20	10	10
Understand	60	20	20	40
Apply	20	30	30	30
Analyse	-	30	40	20
Evaluate	-	-	-	-
Create	-	-	-	-

18EC907	ANALOG CMOS CIRCUIT DESIGN	3/0/0/3
Nature of Course		:G (Theory & Analytical)
Pre requisites		18EC603-VLSI circuits
Course Objectives:		
1	To teach students the fundamentals of analog/mixed-signal (analog & digital) circuit design	
2	To teach students to use commercial design tools for schematic entry, simulation, and layout close to the state of the art for analog design	
3	To prepare students for higher-level courses in analog & RF circuits, and analog-digital conversion	
Course Outcomes:		
Upon completion of the course, students shall have ability to		
C907.1	Understand basic MOS device physics in deep triode region	[U]
C907.2	Design of MOSFET and CMOS based analog integrated circuits	[AP]
C907.3	Understand and analyse the importance of noise and distortion in analog circuits	[AP]
C907.4	Analyse the trade-offs involved in analog integrated circuit design	[AN]
C907.5	Analyse the performance of analog CMOS circuits atleast to the first order	[AN]
Course Contents:		
<p>CMOS Matrices: Introduction to analog VLSI and mixed signal issues in CMOS technologies- Basic MOS models, SPICE Models and frequency dependent parameters- Basic MNOS/CMOS gain stage, cascade and Cascode circuits- Frequency response, stability and noise issues in amplifiers.</p> <p>CMOS analog blocks: Current Sources and Voltage references; Differential amplifier and OP-AMP Design – active loaded differential pair – Performance Study of Gain and Frequency Response- Frequency Synthesizers and Phased lock-loops.</p> <p>Non-linear analog blocks: comparators, charge-pump circuits and multipliers- Basics of data converters- Analog Testing and Layout issues- Low Voltage and Low Power Circuits- Introduction to RF Electronics- phased array radar.</p>		
Total Hours:		45
Text Books:		
1	B. Razavi, Design of Analog CMOS Integrated Circuits, McGraw Hill 2001	

2	P. E. Allen and D. R. Holberg, CMOS Analog Circuit Design, 2nd edition, Oxford University Press, 1997			
3	Philip.E.Allen "CMOS Analog Circuit Design", Oxford University Access, 2013			
Reference Books:				
1	T.C.Carusone ,D.A.Johnsand, K.W.Martin, Analog Integrated Circuit Design,Second Edition, John WileyInc,2012			
2	David. A. Johns and K. Martin, Analog Integrated Circuit Design, Wiley Student Edition, 2002.			
3	P. R. Gray and R. G. Meyer, Analysis and design of Analog Integrated circuits 4th Edition, Wiley Student Edition, 2001.			
Web References:				
1	https://core.ac.uk/download/pdf/4870163.pdf			
2	https://www.intechopen.com/books/advances-in-analog-circuits/analog-design-issues-for-mixed-signal-cmos-integrated-circuits			
3	http://engineering.nyu.edu/mechatronics/Control_Lab/Criag/Craig_RPI/2001/Freq_Response_Analysis_Design.pdf			
Online Resources:				
1	https://www.ucursos.cl/usuario/9553d43f5ccb1cca06cc02562b4005e/mi_blog/r/%5BGray___Meyer%5D_Analysis_and_Design_of_Analog_Integrated_Circuits_5th_cropped.pdf			
2	https://nptel.ac.in/courses/117101105/downloads/L2.pdf			
3	https://nptel.ac.in/courses/117101105/downloads/L1.pdf			
Assessment Methods & Levels (based on Bloom's Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Tentative Assessment Component	Marks	
C907.1	Understand	Quiz	4	
C907.2	Apply	Class Presentation	4	
C907.3	Apply	Group Assignment	4	
C907.4	Analyse	Problem solving	4	
C907.5	Analyse	Simulation Exercise	4	
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination [50 marks]
	CIA-I [10 marks]	CIA-II [10marks]	CIA-III [10 marks]	
Remember	20	10	10	10
Understand	60	20	20	40
Apply	20	40	30	30
Analyse	-	30	40	20
Evaluate	-	-	-	-
Create	-	-	-	-

18EC908	CAD FOR VLSI CIRCUITS		3/0/0/3
Nature of Course :G (Theory & Analytical)			
Pre requisites 18EC301 Digital Electronics			
Co requisites 18EC603 VLSI Circuits			
Course Objectives:			
1	To study various physical design methods in VLSI		
2	To illustrate the concepts behind layout compaction, Placement and partitioning techniques		
3	To understand the concepts of various algorithms used for Floor planning and routing techniques.		
4	To impart knowledge on the simulation and synthesis of systems.		
5	To use the various modelling and scheduling algorithms for VLSI system design.		
Course Outcomes:			
Upon completion of the course, students shall have ability to			
C908.1	Understand various physical design methods and VLSI design flow.		[U]
C908.2	Understand about methods for combinational optimization		[U]
C908.3	Interpret the design rule set to achieve optimization in layout compaction, placement and floor planning.		[AN]
C908.4	Analyze and apply various automation algorithms for partitioning and routing		[AN]
C908.5	Analyze different levels of simulation and synthesis in VLSI circuits		[AN]
C908.6	Analyze about scheduling algorithms , Assignment and High level transformation		[AN]
Course Contents:			
<p>VLSI design methodologies: Introduction to VLSI design methodologies - review of data structures and algorithms - review of VLSI design automation tools - algorithmic graph theory and computational complexity- tractable and intractable problems – general purpose methods for combinatorial optimization.</p> <p>Placement, Partitioning and Floor planning: Layout compaction - design rules - problem formulation - algorithms for constraint graph compaction - placement and partitioning - circuit representation - placement algorithms – partitioning- Partitioning algorithms-KL algorithm, FM algorithm. Floor planning: floor planning concepts - shape functions and floor plan sizing - types of local routing problems - area routing - channel routing - global routing - algorithms for global routing, Clock routing.</p> <p>Simulation and Synthesis : Simulation - gate-level modelling and simulation - switch-level modelling and simulation- combinational logic synthesis - binary decision diagrams - two level logic synthesis. High level synthesis-hardware models-internal representation -allocation assignment and scheduling - simple scheduling algorithm - assignment problem - high level transformations</p>			
Total Hours:			45
Text Books:			
1	S.H.Gerez, "Algorithms for VLSI Design Automation", JohnWiley & Sons, 2008.		
2	N.A.Sherwani, "Algorithms for VLSI Physical Design Automation", Kluwer Academic		

	Publishers,Third Edition,2013.
3	Sadiq M.Sait,Habibyousef," VLSI Physical design automation:Theory and practice",World scientific 2010.

Reference Books:

1	Steven M.Rubin,"Computer Aids for VLSI Design",Addison Wesley Publishing 2017.
2	Trimburger," Introduction to CAD for VLSI", Kluwer Academic publisher, 2013
3	Sung Kyu Lim, "Practical Problems in VLSI Physical Design Automation", Springer,2011.

Web References:

1	http://www.vlsi-expert.com/p/vlsi-basic.html
2	https://www.engineersgarage.com/articles/vlsi-design-future
3	https://nptel.ac.in/courses/106106089/
4	https://pdfs.semanticscholar.org/d99c/fbb8fcb1872dd4a02d84357a37ca7eb3316.pdf

Online Resources:

1	http://cse.iitkgp.ac.in/~debdeep/teaching/VLSI/slides/Intro.pdf
2	http://nptel.ac.in/courses/IIT-MADRAS/CAD_for_VLSI_Design_I
3	https://www.coursera.org/learn/vlsi-cad-logic
4	https://www.youtube.com/watch?v=jZ6LAcHmvng

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C908.1	Understand	Quiz	3
C908.2	Understand	Quiz	3
C908.3	Analyse	Tutorials	3
C908.4	Analyse	Tutorials	3
C908.5	Analyse	Group Assignment	3
C908.6	Analyse	Group Assignment	5

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment			End Semester Examination[50 Marks]
	CIA1[10 Marks]	CIA2[10 Marks]	CIA3[10 Marks]	
Remember	40	20	20	10
Understand	60	20	20	10
Apply	-	30	30	40
Analyse	-	30	30	40
Evaluate	-	-	-	-
Create	-	-	-	-

18EC909	NANO ELECTRONICS		3/0/0/3
Nature of Course	:G (Theory)		
Pre requisites	18EC603 VLSI Circuits		
Course Objectives:			
1	To present the state of the art in the areas of semiconductor device physics and materials technology to enable the Nano electronics.		
2	The various synthesis methods and characterization techniques of nanomaterial will be elaborated.		
3	In this context the need for quantum electronics with new device structure will be elucidated.		
4	The applications of Tunneling effect in nano electronics		
5	The application of magnetic devices and the molecular electronics in nanoelectronics will be enumerated.		
Course Outcomes:			
Upon completion of the course, students shall have ability to			
C909.1	Explore the principles and adequate knowledge in basics of nano electronics.		[R]
C909.2	Understand the CMOS technology		[U]
C909.3	Understand the synthesis methods and Lithography		[U]
C909.4	Understand and remember the characterization techniques of nanomaterial.		[U]
C909.5	Apply the acquired knowledge on the Quantum electronic devices.		[AP]
C909.6	Understand the concept of nano electronics tunneling devices		[U]
Course Contents:			
<p>BASICS OF NANOELECTRONICS – Capabilities of nanoelectronics- physical fundamentals of nanoelectronics: Scaling principles, limits to scaling, power constrained scaling limits - basics of information theory - basics of lithographic techniques for nanoelectronics. Description of typical 65nm CMOS technology, high k-dielectrics. 0D, 1D, 2D and 3D materials, confinement and degrees of freedom.</p> <p>SYNTHESIS OF NANO MATERIALS: PVD, CVD, Sol-gel processing, Microwave assist synthesis, atomic layer deposition, Pulsed layer deposition, Magnetron sputtering, Self-assembled monolayer, Langmuir Blodgett films. Lithography: Optical Lithography, E-Beam Lithography, Focused ion beam lithography, Nano Imprint lithography. Characterisation Of Nanomaterials:AFM, STM, X-ray Diffraction, FTIR, Scanning Electron microscopy, Transmission Electron Microscopy, EDAX, Ellipsometry for thickness measurement.</p> <p>QUANTUM ELECTRON DEVICES - from classical to quantum physics: upcoming electronic devices - electrons in mesoscopic structure - short channel MOS transistor - split gate transistor - electron wave transistor - electron spin transistor - quantum cellular automate - quantum dot array. Principles of Single Electron Transistor (SET), SET circuit design, MESFETS-FINFETS - Nanoelectronics With Tunneling Devices: Tunnelling element technology - RTD: circuit design based RTD, Nano structured LEDs, photo detectors. Superconducting devices: Macroscopic characteristics, macroscopic model, super conducting switching devices, memory cells, flux quantum devices - application of Superconducting devices. Molecular electronics - Nano tubes and fullerene based switches,</p>			

elementary circuits. Quantum Computing Using Superconductors .		Total Hours:	45
Text Books:			
1	Michael Wilson, KamaliKannangara, Geoff Smith, Michelle Simmons, Burkhard Raguse, "Nanotechnology Basic Science and Emerging Technologies", Chapman & Hall/CRC, 2014.		
2	Karl Goser, Peter Glosekotter and Jan Dienstuhl, "Nanoelectronics and Nanosystems", Springer, New Jersey, 2014.		
3	Plummer, Deal, Griffin, "Silicon VLSI Technology", Pearson Education India, 2009.		
Reference Books:			
1	Brundle, C.Richard; Evans, Charles A. Jr. Wilson, Shaun, "Encyclopaedia of Materials Characterization", Elsevier, 2013.		
2	Rainer Waser, "Nanoelectronics and Information Technology: Advanced Electronic Materials and Novel and Devices", Wiley Vch Verlag, Weiheim, 2012		
3	George W. Hanson, —Fundamentals of NanoelectronicsII, Pearson, New Delhi, 2009.		

Assessment Methods & Levels (based on Blooms' Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Tentative Assessment Component	Marks	
C909.1	Remember	Assignment	5	
C909.2	Understand	Quiz	2	
C909.3	Understand	Quiz	2	
C909.4	Understand	Assignment	5	
C909.5	Apply	Seminar	3	
C909.6	Understand	Assignment	3	
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination [50 marks]
	CIA-I [10 marks]	CIA-II [10 marks]	CIA-III [10 marks]	
Remember	20	-	-	20
Understand	80	60	40	40
Apply	-	40	60	40
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

18EC910	MIXED SIGNAL DESIGN	3/0/0/3
Nature of Course :G (Theory & Analytical)		
Pre requisites 18EC201 Electron Devices		
Course Objectives:		

1	To introduce students to mixed signal circuits like DAC, ADC, PLL etc.	
2	To enable the students to investigate filter design in mixed signal mode.	
3	To update students on the design skills used in modern communication systems and consumer electronic products.	
4	To enable students to gain knowledge on non-linear and Dynamic Analog Circuits	
5	To enable students to acquire knowledge on design different architectures in mixed signal mode.	
Course Outcomes:		
Upon completion of the course, students shall have ability to		
C910.1	Examine and Implementation of PLL and sampling circuits	[U]
C910.2	Research and design the architecture of the different architectures of Sample and Hold circuits	[AP]
C910.3	Analyse the performance of A/D converters and D/A converters	[AP]
C910.4	Compare and Observe the characteristics of A/D and D/A converters	[U]
C910.5	Design a CMOS circuit and analyse its characteristics Designing and analysing circuits with switched capacitors	[AP]
C910.6	Examine and Implementation of PLL and sampling circuits	[AP]
Course Contents:		
<p>PLL & Sampling Circuits : Characterization of a comparator, basic CMOS comparator design, analog multiplier design, PLL - simple PLL, charge-pump PLL, Jitter and phase noise – period jitter, P-cycle jitter, adjacent period jitter, other spectral representations of jitter, probability density function of jitter- applications of PLL; Basic sampling circuits for analog signal sampling, performance metrics of sampling circuits, different types of sampling switches. Sample-and-Hold Architectures- Open-loop & closed-loop architectures, open-loop architecture with miller capacitance, multiplexed-input architectures, recycling architecture, switched capacitor architecture, current-mode architecture.</p> <p>D/A & A/D Converters: Input/output characteristics of an ideal D/A converter, performance metrics of D/A converter, D/A converter in terms of voltage, current, and charge division or multiplication, switching functions to generate an analog output corresponding to a digital input. Resistor-Ladder architectures, Current steering architectures, Input/output characteristics and quantization error of an A/D converter, Pipelined A/D converters – one-bit-per-stage pipelined converter, 1.5 bit per stage pipelined converter, pipelined converter circuits, generalized k-bit-per-stage pipelined converters, performance metrics of pipelined architectures, Successive approximation architectures, interleaved architectures.</p> <p>Non-Linear & Dynamic Analog Circuits: Basic CMOS Comparator Design, Adaptive Biasing, Analog Multipliers, MOSTFET Switch, Switched Capacitor circuits: Switched Capacitor Integrator, dynamic circuits.</p>		
Total Hours:		45
Text Books:		
1	Behad Razavi, “Design of analog CMOS integrated circuits”, McGraw-Hill, 2 nd edition, 2017.	
2	Razavi, “Principles of data conversion system design”, Wiley IEEE Press, 1st Edition, 1995.	
3	Gregorian, Temes, “Analog MOS Integrated Circuit for signal processing”, John Wiley & Sons, 1986.	
Reference Books:		
1	R. Jacob Baker, “CMOS circuit design, layout and simulation” by Revised third edition, IEEE press, 2010	

2	R. Jacob Baker “CMOS mixed-signal circuit design” second edition, Wiley India, 2009.			
3	Baker, Li, Boyce, “CMOS: Circuit Design, layout and Simulation”, PHI, 2000.			
Web References:				
1	http://www.nptel.ac.in/syllabus/117101006/			
2	https://dl.acm.org/citation.cfm			
3	https://www.ece.ucsb.edu/~long/ece594a/SubrangingADC_CMOS_1204.pdf			
Online Resources:				
1	https://www.analog.com/en/education/education-library/tutorials/mixed-signal-electronics-systems.html			
2	https://nptel.ac.in/syllabus/117101006/			
3	http://web.iitd.ac.in/~shouri/eel786/			
Assessment Methods & Levels (based on Blooms' Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component	Marks	
C910.1	Understand	Quiz	3	
C910.2	Apply	Group Assignment	3	
C910.3	Apply	Problem Solving	3	
C910.4	Understand	Problem Solving	3	
C910.5	Apply	Group Assignment	3	
C910.6	Apply	Case Study	5	
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination [50 Marks]
	CIA1 [10 Marks]	CIA2 [10 Marks]	CIA3 [10 Marks]	
Remember	30	30	20	10
Understand	60	50	30	40
Apply	10	20	30	30
Analyse	-	-	20	20
Evaluate	-	-	-	-
Create	-	-	-	-

18EC911	EMBEDDED PROCESSORS	3/0/0/3
Nature of Course	:G (Theory & Analytical)	
Pre requisites	18EC501 Microcontrollers and Interfacing	
Course Objectives:		
1	To introduce the concepts of embedded systems and intertwine it with network	
2	To Familiarize with design and debugging of embedded systems	
3	To introduce the concept of real time applications of embedded systems	
4	To allow students to design and analyze various scheduling algorithm in real time application	
5	To enable the students to evaluate the performance of different embedded processors.	
Course Outcomes:		
Upon completion of the course, students shall have ability to		
C911.1	Design the hardware and software components in embedded field.	[AP]
C911.2	Construct and analyze the various embedded processors.	[AN]
C911.3	Design embedded systems for different types of applications.	[AN]
C911.4	Describe the different interfacing techniques	[R]
C911.5	Identify the processor technology and memory organization	[U]
C911.6	Design scheduling algorithms in multiprocessors and operating systems.	[AN]
Course Contents:		
INTRODUCTION OF EMBEDDED SYSTEMS		
Complex Systems and Microprocessor - Embedded Computers, Characteristics of Embedded Computing Applications, Challenges in Embedded Computing system design, Embedded system design process- Requirements, Specification, Architectural Design, Designing Hardware and Software Components, System Integration, Formalism for System Design - Structural description, Behavioural description - Preliminaries.Design Example: Model Train Controller		
EMBEDDED PROCESSOR AND COMPUTING SYSTEMS		
ARM Processor - Processor and Memory organization, Data operations, Flow of Control, TIC55xDSP - Processor and Memory organization Addressing modes, Data operations, Flow of Control, parallelism with instructions, The CPU Bus, Memory devices, Input/output devices, Component interfacing, designing with microprocessor development and debugging. Design Example: Alarm Clock.		
MULTIPROCESSORS AND OPERATING SYSTEMS		
Multiprocessors- CPUs and accelerators - Multiprocessors performance analysis - Multiple tasks and multiple processes - Preemptive real time operating systems - Priority based scheduling – Interprocess communication mechanisms - Evaluating operating system performance - Power management and optimization for processes. Design Example: Telephone Answering Machine		
Total Hours:		45
Text Books:		
1	Wayne Wolf, Computers as Components: Principles of Embedded Computing System Design,Morgan Kaufman Publishers, 2011.	
2	Frank Vahid and Tony Givargis, Embedded System Design: A Unified Hardware/Software Introduction, John Wiley & Sons, 2011.	
3	Jane.W.S. Liu, Real-Time systems, Pearson Education Asia, 2009.	

Reference Books:				
1	C. M. Krishna and K. G. Shin, Real-Time Systems, McGraw-Hill, 2007			
2	Raj Kamal, Embedded Systems: Architecture, Programming and Design, Tata McGraw-Hill, 2012.			
Web References:				
1	https://exploreembedded.com			
2	https://www.codrey.com/embedded-systems/embedded-systems-introduction/			
3	www.eeherald.com/section/design-guide/esmod19.html			
4	https://www.embedded.com/design/operating-systems/.../Tasks-and-scheduling			
Online Resources:				
1	https://www.coursera.org/learn/introduction-embedded-systems			
2	www.circuitstoday.com/embedded-systems-an-introduction			
3	https://www.embedded.com/design/prototyping-and.../Deadline-Scheduling			
4	https://nptel.ac.in/courses/Webcourse-contents/.../Embedded%20systems/.../Lesson-29..			
Assessment Methods & Levels (based on Blooms' Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component	Marks	
C911.1	Apply	Quiz	3	
C911.2	Analyze	Problem Solving	3	
C911.3	Analyze	Problem Solving	3	
C911.4	Remember	Group Assignment	3	
C911.5	Understand	Group Assignment	3	
C911.6	Analyze	Case Study	5	
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination[50 Marks]
	CIA1[10 Marks]	CIA2[10 Marks]	CIA3[10 Marks]	
Remember	40	20	30	20
Understand	40	20	40	40
Apply	20	20	20	20
Analyse	-	40	10	20
Evaluate	-	-	-	-
Create	-	-	-	-

18EC912	ARM Processor Architecture & Programming	3/0/0/3
Nature of Course	: (Theory - Programming)	
Pre requisites	: 18EC602 : Embedded Systems	
Course Objectives:		

1	To study the concepts of Architecture and Assembly language programming of ARM Processor.	
2	To study the concepts of Architectural Support for High level language and memory Hierarchy.	
3	To study the concepts of Cache memory and ,memory management protection	
4	To learn the application development with ARM processor	
Course Outcomes: Upon completion of the course, students shall have ability to		
C912.1	Analyse ARM architecture, execution and implementation of instructions set.	[U]
C912.2	Analyze various types of coprocessors and design suitable co-processor interface to ARM processor.	[AN]
C912.3	Identify the architectural support of ARM for operating system	[U]
C912.4	Analyze the function of memory unit and multiple level cache	[U]
C912.5	Identify the Architectural support for system Development in ARM Processor	[AN]
C912.6	Develop an application related to ARM processor	[AP]
Course Contents:		
<p>ARM Architecture: Abstraction in hardware design – MUO -Acorn RISC Machine – Architecture Inheritance – ARM programming model – ARM Development Tools – 3 and 5 Stage Pipeline ARM Organization – ARM Instruction Execution and Implementation – ARM Co-Processor Interface; ARM Assembly Language programming, ARM Instruction Types – data Transfer, Data Processing and Control Flow Instructions – ARM Instruction set – Co-Processor Instruction</p> <p>Architectural Support for High Level Language and Memory Hierarchy: Data Types – Abstraction in software design – expressions – Loops – Functions and Procedures – Conditional Statements – use of memory- Memory size and speed – On Chip Memory – Caches, Design – an example –Memory management; Cache and memory management protection: Memory Technologies - Need for memory Hierarchy - Hierarchical Memory Organization - Virtual Memory. Cache Memory - Mapping Functions - Cache Design - Unified or split cache, multiple level of caches, ARM cache features, - Co-Processes Memory Map - Protected Systems - ARM systems with MPU - memory Protection Unit (MPU). Physical Vs Virtual Memory – Paging - Segmentation.</p> <p>Architectural support for system Development: Advance Microcontroller Bus Architecture – ARM memory Interface – ARM Reference Peripheral Specification – Hardware System Prototyping Tools – Emulator – Debug Architecture- Arm Application Development: Introduction to DSP on ARM – FIR Filter – IIR Filter – Discrete Fourier transform – Exception Handling – Interrupts – Interrupt handling schemes</p>		
Total Hours:		45
Text Books:		
1	Steve Furber, <i>ARM System on Chip Architecture</i> , Addison –Wesley Professional, 2000.	
2	Andrew N. Sloss, Dominic Symes, Chris Wright, John Rayfield 'ARM System Developer's Guide Designing and Optimizing System Software', Elsevier 2007.	
3	William Stallings , "Operating Systems", 5th Edition.	
4	Andrew N. SLOSS, Dominic Symes and Chris Wright, "ARM System Developers Guide, Designing and Optimizing System Software" ELSEVIER, 3004	

Reference Books:				
1	Ricardo Reis, Design of System on a Chip: Devices and Components, Springer, 2004.			
2	Jason Andrews, o-Verification of Hardware and Software for ARM System on Chip Design (Embedded Technology), ewnes, BK and CD-ROM, Aug 2004.			
3	William Hohl, ' ARM Asseby Language' Fundamentals and Techniques			
4	ARM Architecture Reference Manual			
Web References:				
1	http://infocenter.arm.com/help/index.jsp?topic=/com.arm.doc.set.swdev/index.html			
2	http://www.dauniv.ac.in/downloads/MController_PPTs/MicroC2_eCh15L08ARMDDevelopmentTools.pdf			
Online Resources:				
1	http://nptel.ac.in/courses/108102045/5			
2	http://nptel.ac.in/courses/117106111/			
Assessment Methods & Levels (based on Blooms' Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component		Marks
C912.1	Understand	Group Assignment		3
C912.2	Analyse	Problem Solving		3
C912.3	Understand	Quiz		3
C912.4	Understand	Problem Solving		3
C912.5	Analyse	Group Assignment		3
C912.6	Apply	Case Study		5
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination[50 Marks]
	CIA1[10 Marks]	CIA2[10 Marks]	CIA3[10 Marks]	
Remember	-	-	-	-
Understand	40	10	40	40
Apply	-	-	20	20
Analyse	10	40	10	30
Evaluate	-	-	-	-
Create	-	-	-	-

18EC913	SENSORS FOR INDUSTRIAL APPLICATIONS	3/0/0/3
Nature of Course (G Theory)		
Pre requisites 18EC201 Electron Devices		
Course Objectives:		
1	To study the sensor characteristics and the fundamental principles of Sensing.	
2	To understand the sensor interface electronics.	
3	To study selected motion-related sensors.	
4	To study light and radiation detectors.	
5	To study selected temperature sensors and selected chemical sensors.	
Course Outcomes: Upon completion of the course, students shall have ability to		
C913.1	Classify and describe resistive, inductive and capacitive transducers which are used for measuring various parameters like displacement, temperature, humidity etc.	[U]
C913.2	Define units and standards, their conversions, characteristics and error analysis of measurement systems.	[U]
C913.3	Analyse about interface electronics and motion related sensors	[AN]
C913.4	To integrate various sensors in developing Flexible Manufacturing Systems.	[U]
C913.5	To identify the various transducers used for various application	[U]
C193.6	Acquire knowledge about signal conditional circuits like amplifiers, filters, ADC, etc. for working industrial measurement systems.	[R]
Course Contents:		
<p>PRINCIPLES OF PRINCIPLES OF SENSING - Data Acquisition – sensor characteristics – electric charges, fields, potentials – capacitance – magnetism – inductance – resistance – piezoelectric – pyroelectric – Hall effect – thermoelectric effects – sound waves – heat transfer – light – dynamic models of sensors. Optical components and interface electronics-radiometry – Photometry – mirrors – lenses – fibre optics – concentrators – Interface circuits – amplifiers – light-to-voltage – excitation circuits – ADC – Digitization – Capacitance-to-voltage –bridge circuits – data transmission – noise in sensors and circuits – calibration – low power sensors.</p> <p>MOTION RELATED SENSORS-Occupancy and motion detectors: ultrasonic – microwave – capacitive detectors – triboelectric –Optoelectronic motion sensors – optical presence sensor – Pressure Gradient sensors Velocity and acceleration sensors: Accelerometer characteristics – capacitive accelerometers –Piezoelectric accelerometers – piezoresistive accelerometers – thermal accelerometers –Gyroscopes – piezoelectric cables – gravitational sensors.</p> <p>LIGHT AND RADIATION DETECTORS-Light Detectors: Photo diodes – photo transistor – photo resistor – cooled detectors – CCD and CMOS image sensors – thermal detectors – optical design – gas flame detectors Radiation Detectors: scintillating detectors – ionization detectors – cloud and bubble chambers. Temperature and chemical sensors-Temperature Sensors: coupling with objects – temperature reference points – thermo resistive sensors – thermo electric contact sensors – semiconductor sensors – acoustic sensors –iezoelectric sensors Chemical sensors: characteristics – classes of chemical sensors – biochemical sensors – multisensory arrays – electronic noses and tongues - ETSI eHealth Project.</p>		
Total Hours:		45

Text Books:				
1	Jacob Fraden, "Handbook of Modern Sensors: Physics, Designs, and Applications", Fourth Edition, Springer, 2010.			
2	Kaveh Pahlavan, Prasanth Krishnamoorthy, "Principles of Wireless Networks", First Edition, Pearson Education, 2003.			
3	Burkhardt, " Pervasive Computing", First Edition, Pearson Education, 2003			
Reference Books:				
1	John Vetelino, Aravind Reghu, "Introduction to Sensors", CRC Press 2010.			
2	John P. Bentley, "Principles of Measurement Systems", 4th Edition, Pearson Education, 2005.			
3	E.A. Doebelin, Measurement Systems – Applications and Design", Tata Mc Graw Hill, New York, 2012.			
Web References:				
1	http://courses.csail.mit.edu/6.141/spring2011/pub/lectures			
2	http://web.eecs.umich.edu/~jfr/embeddedctrls/files			
Online Resources:				
1	http://nptel.ac.in/courses/112103174/3			
Assessment Methods & Levels (based on Blooms' Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component	Marks	
C913.1	Understand	Group Assignment	3	
C913.2	Understand	Quiz	3	
C913.3	Analyse	Quiz	3	
C913.4	Understand	Group Assignment	3	
C913.5	Understand	Group Assignment	3	
C193.6	Remember	Quiz	5	
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination[50 Marks]
	CIA1[10 Marks]	CIA2[10 Marks]	CIA3[10 Marks]	
Remember			30	10
Understand	50	10	10	40
Apply	-	-	-	30
Analyse	-	30	-	10
Evaluate	-	-	-	
Create	-	-	-	

18EC914	AUTOMOTIVE ELECTRONICS AND APPLICATIONS	3/0/0/3
Nature of Course	:G (Theory)	
Pre requisites	18EC201 Electron Devices	
Course Objectives:		

1	To understand the working of various batteries and starter motor in automotive system.	
2	To study about the ignition system.	
3	To understand the principles of sensors and actuators used in automotive systems.	
4	To Introduce electronic engine control system and its Control modules.	
5	To allow students to get familiarized with the concept of Lighting System, understanding CAN concept and applications.	
Course Outcomes: Upon completion of the course, students shall have ability to		
C941.1	Understand the concepts of batteries and working principle of starter motor	[U]
C914.2	Understand the operation of various Ignition Systems.	[U]
C914.3	Apply the sensor concepts in automotive system	[AP]
C914.4	Understand and remembering the concepts of various Electronic Engine Controls	[U]
C914.5	Understand the operation of Lighting System, CAN and applications.	[AP]
Course Contents:		
<p>Batteries and Starter Motor: Lead acid and alkaline batteries, battery rating. Principle and construction of starter motor, working of different starter drive units. DC and AC Generators – principle, construction and working, regulation. Ignition System-Electronic ignition system, transistor ignition system, capacitor discharge ignition system, distributorless ignition system and solid state ignition system.</p> <p>Sensors And Actuators: Classification of sensors, sensor for speed, throttle position, exhaust oxygen level, manifold pressure, crankshaft position, coolant temperature, exhaust temperature, air mass flow for engine application. Solenoids, stepper motors and relay. Electronic Engine Controls-Concept of an electronic engine control system, electronic fuel injection –throttlebody fuel injection, multi point fuel injection, gasoline direct injection, common rail direct injection, electronic ignition control, engine mapping, on-board diagnostics –engine control module and power train control module.</p> <p>Lighting System: Insulated and earth return system, details of head light and side light, LED lighting system, head light dazzling and preventive methods. Horn, wiper system and trafficator fuses, cables, connectors and selection. Introduction to CAN and CAN Open, Automotive Cruise Control (ACC).</p>		
Total Hours:		45
Text Books:		
1	Robert Bosch, “Bosch Automotive Electrics and Automotive Electronics: Systems and Components, Networking and Hybrid Drive” Springer Vieweg ,Plochingen, Germany, 2014.	
2	William B Ribbens, “Understnading Automotive Electronics-An Engineering Persepective”, The Boulevard, Langford Lane, Kidlington, Oxford, 2014.	
3	Olaf Pfeiffer, Andrew Ayre and Christian Keydel, ‘Embedded Networking with CAN and CANopen’Copperhill Technologies Corporation, Revised First Edition, 2008	
Reference Books:		

1	Barry Holebeak, "Automotive Electricity and Electronics" Delmar Publishers, Clifton Park, USA, 2010.			
2	James D Halderman, "Automotive Electricity and Electronics" Prentice Hall, USA, 2013.			
3	Al Santini, "Automotive Electricity and Electronics" Delmar Learning, 2011.			
Web References:				
1	http://www. allaboutcircuits.com			
2	http://www. circuitstoday.com			
Online Resources:				
1	https://www.araiindia.com			
2	http://www.autoshop101.com			
3	https://link.springer.com/chapter/10.1007/978-3-658-03972-1_18			
Assessment Methods & Levels (based on Blooms' Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component	Marks	
C914.1	Understand	Assignment	5	
C914.2	Understand	Assignment	5	
C914.3	Apply	Seminar	2	
C914.4	Understand	Assignment	5	
C914.5	Apply	Classroom or Online Quiz	3	
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination [50 marks]
	CIA-I [10 marks]	CIA-II [10 marks]	CIA-III [10 marks]	
Remember	30	30	30	20
Understand	30	30	30	40
Apply	40	40	40	40
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

18EC915	EMBEDDED LINUX & RTOS	3/0/0/3
Nature of Course : C (Theory Concepts)		
Pre requisites : 18EC602 Embedded Systems and its Applications 18EC501 Microcontrollers & Interfacing		
Course Objectives:		
1	To learn and understand the basic concepts of Embedded linux fundamentals	
2	To study on programming logic of modelling Process based on range of OS features	
3	To learn and apply the knowledge of embedded linux for device development	
4	To compare types and Functionalities in commercial OS, application development using RTOS	
5	To learn the need for RTOS in embedded systems and comparison of different RTOS	

Course Outcomes:		
Upon completion of the course, students shall have ability to		
C915.1	Understand the basic concepts of linux OS	[U]
C915.2	Recall & Understand the primitives of GNU & Kernal Systems	[R]
C915.3	Apply the knowledge of linux system to design SDRAM interface	[AP]
C915.4	Apply the working principles of USB ,MTD Subsystems	[AP]
C915.5	Understand the concepts of RTOS & various scheduling	[U]
C915.6	Apply the RTOS Basics to understanding the VXworks OS & Develop the application based on RTOS.	[AP]
Course Contents:		
<p>EMBEDDED LINUX FUNDAMENTALS : Introduction ,host-target development setup , hardware Support ,development languages and tools ,RT linux , Embedded Linux versus Desktop Linux, Commercial Embedded Linux Distribution , Choosing a distribution , Embedded Linux Distributions , Architecture of Embedded Linux , Linux Kernel Architecture , Porting Roadmap , GNU Cross Platform Tool chain, Initialization Linux kernel and kernel initialization , system initialization boot loaders ,Device handling :Device driver basics ,module utilities , file systems , MTD subsystems ,busybox.</p> <p>DEVELOPMENT TOOLS & APPLICATIONS :Embedded development environment, GNU debugger tracing & profiling tools, binary utilities, kernel debugging , debugging embedded Linux applications, porting Linux, Linux and real time, SDRAM interface, Asynchronous serial communication interface , parallel port interfacing - USB interfacing - memory I/O interfacing - using interrupts for timing.</p> <p>RTOS: Introduction to basic concepts of RTOS, Task, process & threads, interrupt routines in RTOS, Multiprocessing and Multitasking, Event Based, Process Based and Graph based Models, Real Time Languages, RTOS Tasks, RT scheduling, Interrupt processing, Synchronization, Control Blocks, Memory Requirements, Critical section, Semaphores, Classical synchronisation problem, Deadlocks ,Preemptive and non-pre emptive scheduling, Task communication, shared memory, message passing, Inter process Communication, Mailbox, pipes, priority inversion, priority inheritance-comparison of commercial RTOS features, Linux supportive RTOS , C Executive, RTOS Lite, Full RTOS, VxWorks, μC/OS-II,</p>		
Total Hours:		45
Text Books:		
1	Karim Yaghmour, Jon Masters, Gillad Ben Yossef, Philippe Gerum, "Building embedded linux systems", O'Reilly, 2008.	
2	P.Raghavan,Amol Lad,Sriram Neelakandan,"EmbeddedLinux System Design & Development,Auerbach Publications, 2012	
3	Wang , K.C. "Embedded and Real-Time Operating Systems" , Springer Publications , 2017	
Reference Books:		
1	Qing Li, "Real-Time Concepts for Embedded Systems", Elsevier - CMP Books, 2003	
2	CCorbet Rubini, Kroah-Hartman, "Linux Device Drivers", O'reilly, 2016.	
3	Rajkamal, "Embedded Systems- Architecture, Programming and Design",TMH, 2007	
Web References:		

1.	https://www.freertos.org/about-RTOS.html
2.	https://www.engineersgarage.com/articles/rtos-real-time-operating-system
3.	https://www.highintegritysystems.com/rtos/what-is-an-rtos/
4.	https://www.arm.com/resources/education/education-kits/embedded-linux

Online Resources:

1	https://www.evelta.com/embedded-linux-resources
2	https://www.doulos.com/content/training/embedded_linux_online.php
3	https://www.catapult-elearning.com/resources/rto-online-training-resources

Assessment Methods & Levels (based on Bloom's Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Tentative Assessment Component	Marks
C915.1	Understand	Quiz	2
C915.2	Remember	Quiz	3
C915.3	Apply	Programming Assignments	3
C915.4	Apply	Group Assignment	3
C915.5	Understand	RTOS Programming	5
C915.6	Apply	Mini Project	4

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment			End Semester Examination [50 marks]
	CIA-I [10 marks]	CIA-II [10 marks]	Term End Examination [10 marks]	
Remember	20	10	10	10
Understand	80	30	30	30
Apply	-	30	40	40
Analyse	-	30	20	20
Evaluate	-	-	-	-
Create	-	-	-	-

18EC918	ROBOTICS	3/0/0/3
Nature of Course	C (Theory Concept)	
Pre requisites	18EC602 Embedded Systems and its applications	
Course Objectives:		
1	To learn the basics of robotics and hardware.	
2	To study the Robotic arm equations and Principles of edge detection.	
3	To study the Robots in material handling, processing assembly and storage.	
Course Outcomes:		
Upon completion of the course, students shall have ability to		
C918.1	Understand the basics of robotics and its behaviour	[U]
C918.2	Understand the various types hardware used in the design of robotics	[U]
C918.3	Apply the concepts of various arm equations used in robotics and develop programming skills in robotics	[AP]
C918.4	To know about the various types of sensors used in robotics and its applications	[R]
C918.5	Analyze the different types of sensors used in robots	[A]
Course Contents:		

Overview of Robots and Hardware: Introduction- Robot Behaviors-Specification of Robots-Types of Robots-Design Challenge-Engineering design Process-Programming-Motors-Sensors-Chassis-Direct Drive-Indirect Drive –Gearing-End Effectors-Wheels Vs Tnk Tread. Parts Identification-Building Instruction for the Tetrax Platform, DC Motor and Servo Motor wiring Configuration and Power Supplies-Transmitters-Receiver-DC Motor-Speed-Controllers-Loops-Switch blocks-DC Motor-Servo Motor-Using sensors and actuators with ROS-SCOR BOT-Structures and Programming-IS.14533:2005 Manipulating Industrial robots.

Robot ARM Kinematics: Forward Kinematics- Arm equation-two axis-three axis –four axis-five axis-A 6-axis Robot-Inverse Kinematics-Trajectories-Joint Space Motion-Cartesian Motion-Motion through a singularity installing ROS.

Embedded Robotics and recent trends in Robotics: Interfaces-Operating System-Sensors-Categories-Binary Sensors-Analog Vs Digital Sensor-Soft encoder-A/D convertor-Position sensitive Device- Compass-Gyroscope-Accelerometer-Actuators-DC motors-H bridge-Pulse Width Modulation-Stepper Motors-Servos-Controls-On-Off Control-PID Control-Velocity Control and Position control-Multiple motors-Driving Straight-V-Omega Interface-Multitasking-Co-operative-Preemptive-Synchronization-Scheduling-Interrupts. Appetites-Collaborative Robots-Robotics as a Service- Logistics and materials handling-Parallel actuated robots and closed loop robots. Introduction about nano robotics

Total Hours:	45
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Text Books:

1	Koren, Robotics for EngineersII ,TMHInternationalCompany,1995.
2	Vokopravotic,-IntroductiontoRoboticsII ,Springer,1988.
3	RathmillK.,-Robot Technology and Application II ,Springer,1985.
4	Charniak and McDarmott,-IntroductiontoArtificialIntelligencell ,TMH,1986.

Reference Books:

1	FuK.S,GonzallyR.C, LeeC.S.G.,-RoboticsControl,Sensing,VisionandIntelligencell ,T MH Book Company,2008.
2	BarryLeathamandJones,-ElementsofIndustrialRoboticsII ,PittmanPublishing,1987.
3	Mikell P. Groover, Mitchell Weiss, Roger N. Nagel, Nicholas G. Odrey, —Industrial Robotic Technology ProgrammingandApplicationsII ,TMHBookCompany,2008
4	Fu K.S, Gonzalez, R.C., & Lee, C.S.G., “Robotics control, sensing, vision and intelligence”, McGraw Hill Book Co., Singapore, Digitized 2007.

Web References:

1	https://www.scribd.com/document/33112950/Robotics-and-Its-Applications
2	https://www.elprocus.com/robots-types-applications/
3	https://link.springer.com/chapter/10.1007/978-3-319-62533-1_1

Online Resources:

1	https://onlinecourses.nptel.ac.in/noc18_me61/preview
2	https://www.futurelearn.com/courses/begin-robotics
3	https://www.edx.org/learn/robotics

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
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C918.1	Understand	Quiz	3	
C918.2	Understand	Group Assignment	5	
C918.3	Apply	Problem Solving	5	
C918.4	Remember	case study	2	
C918.5	Analyze	Problem solving	5	
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination[50 Marks]
	CIA1[10 Marks]	CIA2[10 Marks]	CIA3[10 Marks]	
Remember	20	20	10	10
Understand	40	40	40	40
Apply	40	40	30	30
Analyze	-	-	20	20
Evaluate	-	-	-	-
Create	-	-	-	-

18EC919	MEDICAL ELECTRONICS AND INSTRUMENTATION	3/0/0/3
Nature of Course	G (Theory)	
Pre requisites	18EC302 - Electronic Circuits	
Course Objectives:		
1	To learn the concepts of biopotentials and the methods adopted to record them	
2	To know about the methods and instruments used in diagnostic data collection and treatment of human body.	
3	To learn the therapeutic methods followed to analyse human body conditions	
4	To learn the various radiological and medical imaging systems	
5	To update the advances in biomedical instrumentation and telemetry principles	
Course Outcomes:		
Upon completion of the course, students shall have ability to		
C919.1	To understand the various methods of biopotential recording and biopotential electrodes	[U]
C919.2	To analyse the basic operations and working methodology of various diagnostic equipments.	[AN]
C919.3	To apply proper therapeutic equipment for understanding the functionalities of human body	[AP]
C919.4	To understand the functionalities of various therapeutic equipments and medical imaging techniques.	[U]
C919.5	To apply the knowledge of safety principles in handling medical equipment and VLSI tools in medical electronics	[AP]
C919.6	To obtain the knowledge of advances in biomedical instrumentation and telemetry principles.	[U]
Course Contents:		
Biopotential Recording and Diagnostic equipments : The origin of Bio-potentials; biopotential electrodes, biological amplifiers, ECG, EEG, EMG, BCG, EGG, EOG, lead systems and recording methods, typical waveforms and signal characteristics. Blood Gas Analyser, Electrophoresis, Colorimeter, Photometer, Auto analyser, Blood flow meter, Cardiac output, Respiratory measurement, Blood pressure, temperature, pulse, Blood cell counters		

Therapeutic Equipments and Modern imaging Systems: Cardiac pacemakers, DC Defibrillator, Dialysers, Heart Lung Machine, Oxygenators , Nerve and muscle stimulators, Ionising radiation, X-ray, Design considerations of X-ray tubes, Diagnostic X-ray equipment, Computer Axial Tomography, MRI and NMR scan,, Radio Isotopes in diagnosis, Radiation Therapy, Ultrasonic Imaging systems, Nuclear Imaging Techniques, Medical Thermograph.

Biotelemetry and Recent Trends in Medical Instrumentation: Telemetry principles, frequency selection, Bio-telemetry, Radio-pill and Tele-stimulation, E-Health, Pattern Recognition techniques , Endoscopy , Laser in medicine, Diathermy units, Computers in biomedical instrumentation, Electrical safety in medical equipment, Application of VLSI design tools in Bio electronics.

Total Hours: **45**

Text Books:

1	Leslie Cromwell, "Biomedical Instrumentation and Measurement ", Prentice Hall of India, New Delhi, 2018.
2	Khandpur, R.S., "Handbook of Biomedical Instrumentation", TATA McGraw -Hill, New Delhi, 2E, 2003
3	Joseph D Bronzino (ed), "The Biomedical Engineering Handbook", Volume I & II, 2E, CRC Press, Florida USA, 2000

Reference Books:

1	Enderle, J Blanchard, S Bronzino, J (Eds), "Introduction to Biomedical Engineering", Academic Press UK, 2011, 3E
2	Shakti Chatterjee, Aubert Miller," Biomedical instrumentation systems", Clifton Park, NY : Delmar Cengage Learning, 2010,3E.
3	Joseph J.Carr and John M.Brown, "Introduction to Biomedical equipment Technology", John Wiley and Sons, New York, 2008.

Web References:

1	https://www.worldscientific.com/
2	https://www.nature.com/subjects/biomedical-materials
3	https://ocw.mit.edu/courses/materials-science-and-engineering/3-051j-materials-for-biomedical-applications-spring-2006/
4	https://onlinecourses.nptel.ac.in/noc16_hs03&nptel.ac.in/courses/103103027/pdf/mod9.pdf

Online Resources:

1	https://www.edx.org/course/so-you-want-become-biomedical-engineer-ieee-biomed01x-1
2	http://ee.bonabu.ac.ir/uploads/31/CMS/user/file/103/Biomedical-Instrumentation/Bio-Instrument-1-Intro-5.pdf
3	textofvideo.nptel.iitm.ac.in/117106092/lec1.pdf
4	https://www.ausmed.com/articles/medical-imaging-types-and-modalities/

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C919.1	Understand	Group Assignment	3
C919.2	Analyse	Class Presentation/Power point presentation	5
C919.3	Apply	Class Presentation/Power point presentation	3
C919.4	Understand	Group Assignment	3
C919.5	Apply	Classroom or Online Quiz	3
C919.6	Understand	Classroom or Online Quiz	3

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment			End Semester Examination[50 Marks]
	CIA1[10 Marks]	CIA2[10 Marks]	CIA3[10 Marks]	
Remember	20	30	30	20
Understand	20	30	30	20
Apply	20	40	40	30
Analyse	40		-	30
Evaluate	-	-	-	-
Create	-	-	-	-

18EC920	INTERNET OF THINGS & APPLICATIONS		3/0/0/3
Nature of Course			
		G (Theory Analytical)	
Pre requisites			
		18EC501- Micro Controllers & Interfacing	
Course Objectives:			
1	To Understand the vision of IOT from a global context.		
2	To enable the students to understand the State of the Art – IOT Architecture.		
3	To interpret the use of internet principles, protocols and network management in IOT.		
4	To help the students to understand the principles of design in prototyping and provide ability to change and modify it.		
5	Being able to analyze how the related concepts helps to challenge the product idea a well-thought-out model of the business		
6	Application of IOT in Industrial and Commercial Building Automation and Real World Design Constraints.		
Course Outcomes:			
Upon completion of the course, students shall have ability to			
C920.1	Interpret the vision of IOT from a global context		[R]
C920.2	Implement state of the art architecture in IOT.		[U]
C920.3	Compare and Contrast the use of network layers, protocols and Data Management in IOT.		[U]
C920.4	Exploring the features of prototyping the embedded devices for IOT applications.		[AP]
C920.5	Design and develop an effective usage of IOT deployment for different sectors.		[AN]
C920.6	Illustrate the application of IOT in Industrial Automation and identify Real World Design Constraints.		[AN]
Course Contents:			
<p>Fundamentals of IoT : Overview, Flavour of the IOT, The “Internet of Things”, Technology, Enchanted objects, Making of Internet of things, Design Principles for connected devices.IOT Architecture: Background and initial visions, Definitions and Functional requirements, Opportunities and Motivation Introduction – Characteristics - Physical design - Protocols – Logical design – Enabling technologies –Input and output devices for IoT- IoT Levels – Domain Specific IoTs – IoT vs M2M. Future developments, Possible Architecture for the future IoT.</p> <p>IoT Protocols and challenges: Internet communication, IP addresses, MAC addresses, TCP and UDP ports, Application layer protocols, IEEE 802 committee family of protocols, physical layer, Media access control layer. Design challenges, development challenges and Security challenges.</p> <p>BUILDING IOT WITH RASPBERRY PI & GALILEO/ARDUINO : Physical device –</p>			

Raspberry Pi Interfaces – Programming – APIs / Packages – Web services - Intel Galileo with Arduino - Interfaces - Arduino IDE – Programming APIs and Hacks Various Real time applications of IoT- Connecting IoT to cloud – Cloud Storage for IoT– Data Analytics for IoT. **Prototyping:** Prototypes and production, Open source versus closed source, Prototyping embedded devices-Electronics, Embedded computing basics, Arduino, Raspberry Pi, Electric Imp. **Prototype to reality:** Business Models-Business model canvas, Models, Funding an Internet of Things start-up, lean start up. **Applications:** Smart grid introduction, Marginal cost of electricity: Base and peak production, Managing demand, Demand response for transmission system operators, smart home, smart city, Health care.
Applications- Home automation, Surveillance applications, smart city, Health care, Agriculture and Industry Automation.

Total Hours: 45

Text Books:

1	Adrian McEwen and Hackim Cassimally,” Designing the Internet of Things” ,John wiley and Sons Ltd.,UK,2014.
2	Dieter Uckelmann ,Mark Harrison, Florian Mlchahelles,”Architecting the Internet of Things”,Springer,Newyork,2011.
3	Arshdeep Bahga, Vijay Madiseti, “Internet of Things – A hands - on approach”, Universities Press, 2015

Reference Books:

1	Vijay Madiseti and Arshdeep Bahga, “Internet of Things (A Hands- on-Approach)”, 1 st Edition, VPT, 2014.
2	Marco Schwartz, “Internet of Things with the Arduino Yun”, Packt Publishing, 2014
3	A Bahaga, V. Madiseti, “Internet of Things- Hands on approach”, VPT publisher, 2014

Web References:

1	http://www.cisco.com/c/en_in/solutions/internet-of-things/resources.html
2	https://openwsn.atlassian.net/wiki

Online Resources:

1	http://iot.ieee.org/newsletter/january-2016/hypercat-resource-discovery-on-the-internet-of-things.html
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Assessment Methods & Levels (based on Blooms’ Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom’s Level	Assessment Component	Marks
C920.1	Remember	Quiz	2
C920.2	Understand	Quiz	2
C920.3	Understand	Quiz	2
C920.4	Apply	Group Assignment	4
C920.5	Analyze	Simulation Exercise	5
C920.6	Analyze	Simulation Exercise	5

Summative assessment based on Continuous and End Semester Examination

Bloom’s Level	Continuous Assessment			End Semester Examination[50 Marks]
	CIA1[10 Marks]	CIA2[10 Marks]	CIA3[10 Marks]	
Remember	20	10	10	10
Understand	80	30	40	40
Apply		30	30	30
Analyse	-	30	20	20
Evaluate	-	-	-	-
Create	-	-	-	-

Nature of Course : D (Theory Application)

Course Objectives:

1. To understand the concepts of AI and Intelligent Agents.
2. To explore Problem solving using search techniques in AI.
3. To understand Logical Agents and First-Order logic.
4. To explore knowledge Representation issues.
5. To understand concepts of learning from examples.

Course Outcomes:

Upon completion of the course, students shall have ability to

- C403.1: Understand foundation and basic concepts of AI and Intelligent Agents. [U]
C403.2: Apply Searching techniques for problem solving in AI. [AP]
C403.3: Apply First-order Logic and chaining techniques for problem solving. [AP]
C403.4: Understand knowledge representation techniques in problem solving. [U]
C403.5: Apply supervised learning and Neural Networks for solving problem in AI. [AP]

Course Contents:

Introduction: What Is AI, the Foundations of Artificial Intelligence, The History of Artificial Intelligence, The State of the art. Intelligent Agents: Agents and Environments, Good Behavior: The Concept of Rationality, The Nature of Environments and the Structure of Agents. Solving Problems by Searching: Problem-Solving Agents, Uninformed Search Strategies, Informed (Heuristic) Search Strategies, Heuristic Functions. Beyond Classical Search: Local Search Algorithms and Optimization Problems, Searching with Nondeterministic Actions and Partial Observations, Online Search Agents and Unknown Environments. Constraint Satisfaction Problems: Definition, Constraint Propagation, Backtracking Search, Local Search, The Structure of Problems.

Logical Agents: Knowledge-Based Agents, Propositional Logic, Propositional Theorem Proving, Effective Propositional Model Checking, Agents Based on Propositional Logic. First-Order Logic: Syntax and Semantics, Knowledge Engineering in FOL, Inference in First-Order Logic, Unification and Lifting, Forward Chaining, Backward Chaining, Resolution. Planning: Definition, Algorithms, Planning Graphs, Hierarchical Planning, Multiagent Planning. Knowledge Representation: Ontological Engineering, Categories and Objects, Events, Mental Events and Mental Objects, Reasoning Systems for Categories, Reasoning with Default Information, The Internet Shopping World.

Learning from Examples: Forms of Learning, Supervised Learning, Learning Decision Trees, Evaluating and Choosing the Best Hypothesis, The Theory of Learning, Regression and Classification with Linear Models, Artificial Neural Networks. Applications: Human computer interaction (HCI), Knowledge management technologies, AI for customer relationship management, Expert systems, Data mining, text mining and Web mining.

Text books:

1. Russel S, Norvig P, Artificial Intelligence: A Modern Approach, 3rd edition, Pearson Education, 2010.

- Margaret H. Dunham, Data Mining: Introductory and Advanced Topics, Prentice Hall, ISBN: 0130888923, 2003.

Reference books:

- Rich E, Knight K, Nair S B, Artificial Intelligence, 3rd edition, Tata McGraw-Hill, 2009.
- Luger George F, Artificial Intelligence: Structures and Strategies for Complex problem solving, 6th edition, Pearson Education, 2009
- S.Balakrishnan, J.Janet, Artificial Intelligence and Expert Systems, LAP LAMBERT Academic Publishing, 2017.

Web References:

- <https://nptel.ac.in/courses/106105077/>
- <https://grid.cs.gsu.edu/~cscyz/courses/ai/aiLectures.html>

Online Resources:

- <http://www.cs.toronto.edu/~fbacchus/csc384/Lectures/lectures.html>
- <https://www.doccity.com/en/artificial-intelligence-24/881073/>

Assessment Methods & Levels (based on Blooms' Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component		Marks
C403.1	Understand	Online Quiz		2
C403.2	Apply	Online Quiz		2
C403.3	Apply	Technical presentation		6
C403.4	Understand	Group Assignment		4
C403.5	Apply	Problem Solving		6
Summative Assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination [50]
	CIA1 [10 Marks]	CIA2 [10 Marks]	Term End Assessment [10 Marks]	
Remember	30	10	20	10
Understand	30	30	20	20
Apply	10	40	40	60
Analyse	-	-	-	-
Evaluate	30	20	20	10
Create	-	-	-	-

18EC921	MICROWAVE INTEGRATED CIRCUITS	3/0/0/3
Nature of Course :G (Theory & Analytical)		
Pre requisites Microwave Theory		
Course Objectives:		
1	To enable the students to understand the different types of MICs	
2	To enable the students to explore the interpretation and analysis of microstrip line	
3	To make the students to apply the design of Passive and active microstrip line	
4	To enable the students to apply the design of non-reciprocal components, active devices, filters circuits	
5	To enable the students to understand fabrication techniques and interaction with system design strategies	
Course Outcomes: Upon completion of the course, students shall have ability to		
C921.1	Learn the concepts involved in microwave integrated Circuits	[R]
C921.2	Understand the design and fabrication of various elements	[U]
C921.3	Understand the functional and operational features of passive and active Components in MIC	[U]
C921.4	Apply the design ideas of various transformers and Filters in real world application	[AP]
C921.5	Understand the concepts of fabrication of MMIC and Hybrid MICs features.	[U]
C921.6	Analyse the testing methods and encapsulation concepts .	[AN]
Course Contents:		
<p>Analysis of MIC-Introduction, types of MICs and their technology, Propagating models. Strip Line and Microstrip Line, Hybrid mode analysis and Analysis of MIC by conformal transformation, Losses in microstrip, Introduction to slot line and coplanar waveguide Couplers and Lumped Elements in MIC-Introduction to coupled microstrip, Even and odd mode analysis, Branch line couplers, Design of Matching Circuits using Lumped Elements, Matching Network Design using Distributed Elements Comparison with distributed circuits.</p> <p>Passive and Active Components in MIC-Ferrimagnetic substrates and inserts, Microstrip circulators, Phase shifters, Microwave transistors, Parametric diodes and amplifiers, Microstrip Isolator.MIC Circuits and its Applications-Introduction, Impedance transformers-Quarter wave transforms, Binominal transforms and Chepy-Shev transforms, Design of Filters, MICs in Radar and satellite.</p> <p>Fabrication Process-Fabrication process of MMIC, Hybrid MICs, Dielectric substances, Thick film and thin film technology and materials, Testing methods, Encapsulation, Mounting of devices</p>		
Total Hours:		45
Text Books:		
1	Leo G. Maloratsky, "Passive RF and Microwave Integrated circuits", Elsevier, 2 nd Edition,2004.	
2	David M. Pozar, "Microwave Engineering", 4 th Edition, 2011	
3	Thomas H.Lee, "Planar Microwave Engineering", Cambridge University Press, 2004	
Reference Books:		

1	John Rogers and Calvin Plett, "Radio Frequency Integrated Circuit Design", Artech House, 2002			
2	Robert.E.Collin- Foundations of Microwave Engineering, Second Edition, 2007			
3	Peter A.Rizzi- Microwave Engineering Passive Circuits,PHI,2005			
Web References:				
1	https://www.springer.com/in/book/9780412547003			
2	http://plaza.eng.uci.edu/course/eecs/182/outline/2016-2017			
3	https://www.microwaves101.com/encyclopedias/lumped-elements			
4	www.informit.com/articles/article.aspx?p=2354942			
Online Resources:				
1	https://onlinecourses.nptel.ac.in/noc17_ee16			
2	https://onlinecourses.nptel.ac.in/courses/108102042/30			
3	https://onlinecourses.nptel.ac.in/courses/117105130/18			
4	https://www.researchgate.net/publication/275645488_An_Overview_on_Monolithic_Microwave_Integrated_Circuits			
Assessment Methods & Levels (based on Blooms' Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component	Marks	
C921.1	Remember	Quiz	3	
C921.2	Understand	Group Assignment	3	
C921.3	Understand	Group Discussion	3	
C921.4	Apply	Group Assignment	3	
C921.5	Understand	Class Presentation	3	
C921.6	Analyse	Case Study	5	
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination[50 Marks]
	CIA1[10 Marks]	CIA2[10 Marks]	CIA3[10 Marks]	
Remember	40	20	10	10
Understand	60	40	40	40
Apply		40	30	30
Analyse	-	-	20	20
Evaluate	-	-	-	-
Create	-	-	-	-

18EC922	Mobile Communication	3/0/0/3
Nature of Course	C(Theory Concept)	
Pre requisites	18EC502 Digital Communication	
Course Objectives:		
1	Interpret the cellular system design and various methods to improve the efficiency of cellular system.	

2	To Understand the evolution of cellular communication systems upto and beyond 3G	
3	Describe the various propagation techniques in wireless communication system	
4	Describe the various kinds of mitigation techniques used for multipath propagation.	
5	Apply the constraints such as fixed bandwidth channel spacing and signal to noise ratio in the cellular systems	
Course Outcomes: Upon completion of the course, students shall have ability to		
C922.1	To know the cellular structure developed for wireless mobile communication and its standards.	[U]
C922.2	Design mobile communication system by appropriately selecting necessary techniques.	[AN]
C922.3	To analyze different propagation models and their impact on communication system performance.	[AN]
C922.4	To study about various fading and Multiple access techniques.	[U]
C922.5	To analyze the various interference in wireless digital communication	[AN]
C922.6	To provide extensive knowledge about the noise performance in mobile communication.	[AN]
Course Contents:		
<p>Cellular Concept & Wireless standards: Cellular mobile telephone architecture overview.; Cellular radio system design-- Frequency assignments, frequency reuse channels. Concept of cell splitting. Handover in cellular systems. Handoff algorithms Wireless Standards: GSM, GPRS, WCDMA, LTE, WiMAX.</p> <p>Mobile Radio Wave Propagation : Small- Scale fading and multipath propagation, Rayleigh and Ricean Distributions Multiple access schemes in mobile communications TDMA, FDMA, CDMA. OFDM, Random Multiple Access Schemes.</p> <p>Interference In Wireless Digital Communication: Carrier-to-Interference and Carrier-to-Noise Limited Systems, Cochannel Interference, Adjacent Channel Interference. Externally caused Cochannel Interference, Definitions and performance of Spectral and Power Efficiency, Relationship of the Bit-Energy to Noise-Density Ratio and the Carrier-to-Noise Ratio, Power Efficiency and Bit-Error-Rate performance in an Additive White Gaussian Noise Environment.</p>		
Total Hours:		45
Text Books:		
1	T. S. Rappaport, Wireless digital communications: Principles and practice, 2 nd Ed., Prentice Hall India, 2010.	
2	W. C. Y. Lee, Wireless and cellular telecommunications, 3rd Ed., MGH, 2006.	
3	DR Kamilo Feher Wireless Digital Communications, Prentice Hall of India, New Delhi – 2015	
Reference Books:		
1	Simon Haykin and Michael Moher, Modern Wireless Communication, Pearson education, 2011.	
2	G. L. Stuber, Principles of mobile communications, 2nd Ed., Springer, 2007.	
3	David Tse and Pramod Viswanath, "Fundamentals of Wireless Communication", Cambridge University Press, 2011.	

Web References:				
1	https://nptel.ac.in/courses/117102062/			
2	https://www.coursera.org/learn/wireless-communications			
Online Resources:				
1	https://web.stanford.edu/class/ee359/			
2	https://ocw.mit.edu/...communications.../lecture-20-introduction-of-wireless-communici...			
Assessment Methods & Levels (based on Blooms' Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component	Marks	
C929.1	Understand	Quiz	5	
C929.2,3	Analyse	Technical Presentation	5	
C929.4,	Understand	Assignment	5	
C929.5,6	Analyse	Case study	5	
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination[50 Marks]
	CIA1[10 Marks]	CIA2[10 Marks]	CIA3[10 Marks]	
Remember	20	20	20	20
Understand	15	15	15	15
Apply	15	15	15	15
Analyse	50	50	50	50
Evaluate	-	-	-	-
Create	-	-	-	-

18EC923	SATELLITE COMMUNICATION AND GPS	3/0/0/3
Nature of Course	:G (Theory & Analytical)	
Pre requisites	18PH101 Physics for Electronics	
Course Objectives:		
1	To enable the students to understand the concept of Orbital Mechanics	
2	To enable the students to understand the concept spacecraft subsystems and earth station	
3	To study the design of satellite power budget	
4	To enable the students to understand multiple access techniques and network aspects	

5	To enable the students to study the concept of GPS and its applications	
Course Outcomes: Upon completion of the course, students shall have ability to		
C923.1	Understand the basic concepts of Orbit Dynamics.	[U]
C923.2	Analyse the concept of space segment and design the satellite link.	[AN]
C923.3	Understand various Satellite Access systems.	[U]
C923.4	Apply the concepts of satellite test equipments.	[AP]
C923.5	Understand the concepts of GPS & its applications	[U]
Course Contents:		
ORBITAL MECHANICS Kepler's laws of motion, Orbits, Orbit Equations, Orbit Description, Locating the Satellite in the Orbit and with Respect to Earth, Orbital Elements-Look Angle Determination and Visibility, Orbital Perturbations, Orbit Determination, Launch Vehicles, Orbital Effects in Communication System, Performance Attitude control, Satellite launch vehicles - spectrum allocations for satellite systems.		
SPACECRAFT SUB SYSTEMS AND EARTH STATION Spacecraft Subsystems, Altitude and Orbit Control, Telemetry and Tracking, Power Systems, Communication Subsystems, Transponders, Antennas, Equipment Reliability, Earth Stations, Example of payloads of operating and planned systems. SPACE LINKS The Space Link, Satellite Link Design - Satellite uplink -down link power Budget, Basic Transmission Theory, System Noise Temp, G/T Ratio, Noise Figure, Downlink Design, Design of Satellite Links for Specified C/N - Microwave Propagation on Satellite-Earth Paths, Interference between satellite circuits, Energy Dispersal, Propagation characteristics of fixed and mobile satellite links.		
MULTIPLE ACCESS TECHNIQUES AND NETWORK ASPECTS Single access vs. multiple access (MA), Classical MA techniques: FDMA, TDMA, Single channel per carrier (SCPC) access-Code division multiple access (CDMA), Demand assignment techniques, Examples of MA techniques for existing and planned systems (e.g. the satellite component of UMTS), Mobile satellite network design, ATM via satellite, TCP/IP via satellite - Call control, handover and call set up procedures, Hybrid satellite-terrestrial networks. Services and Applications: Fixed and mobile services - Multimedia satellite services.Advanced applications based on satellite platforms - INTELSAT series - INSAT, VSAT.Remote Sensing - Mobile satellite service: GSM. GPS, INMARSAT, Navigation System, Direct to Home service (DTH). Special services: E-mail, Video conferencing, Internet connectivity Satellite navigation & GPS :Introduction-GPS and GLONASS - GALILEO Satellite System COMPASS - Indian Regional Navigation Satellite System Overview - Differential and Augmented GPS, Applications.		
Total Hours:		45
Text Books:		
1	Bruce R.Elbert, "The Satellite Communication:Ground Segment and Earth Station",Artech House Inc.,second edition,2014	
2	Dennis Roddy, "Satellite Communications", Mc Graw Hill International Editions, 4th Edition 2008.	
3	Timothy Pratt, Charles W. Bostian, Jeremy Allnutt, "Satellite Communications", Wiley, John& Sons, 2nd Edition, 2003.	
Reference Books:		
1	Tri T.Ha, "Digital satellite communication", 2nd Edition, McGraw Hill, New york1990.	
2	Mohinder S.Grewal , Lawrence R.Weill, Angus P.Andrews, "Global positioning	

	systems -Inertial Navigation and Integration", John wily & sons,second edition, 2007			
3	Ahmed El-Rabbany , "Introduction to GPS: Global Positioning System", Artech House, 2006			
Web References:				
1	http://www.braeunig.us/space/orbmech.htm			
2	http://tele.rb.railnet.gov.in/raw-attachment/wiki/UpLoads/Chapter_22.pdf			
3	http://ecb6212.weebly.com/uploads/1/2/9/8/12983968/multiple_access_techniques_and_network_aspects.pptx			
Online Resources:				
1	https://lecturenotes.in/subject/102/satellite-communication-system-scs			
2	textofvideo.nptel.ac.in/117105131/lec2.pdf			
3	https://nptel.ac.in/courses/117105131/			
Assessment Methods & Levels (based on Blooms' Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component	Marks	
C923.1	Understand	Quiz	4	
C923.2	Analyse	Group Assignment 1	5	
C923.3	Understand	Group Assignment 2	3	
C923.4	Apply	Problem Solving 1	5	
C923.5	Understand	Quiz	3	
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination[50 Marks]
	CIA1[10 Marks]	CIA2[10 Marks]	CIA3[10 Marks]	
Remember	50	30	20	20
Understand	50	50	40	40
Apply	-	-	40	20
Analyse	-	20	-	20
Evaluate	-	-	-	-
Create	-	-	-	-

18EC924	LONG TERM EVOLUTION TECHNOLOGIES	3/0/0/3
Nature of Course :G (Theory & Analytical)		
Pre requisites 18EC502 Digital Communication		
Course Objectives:		
1	To study the basics of Rate distortion theory and achievability of rate distortion function.	
2	To enable the students to understand the principles of conditional limit theorem.	
3	To enable the students to apply the principles of maximum entropy.	
4	To analyse the fundamentals of Interactive codes.	
5	To enable the students to understand and analyse the turbo codes and its algorithms.	
Course Outcomes: Upon completion of the course, students shall have ability to		
C924.1	Understand the concepts of rate distortion function and its computation.	[U]
C924.2	Understand the concepts of conditional limit theorem.	[U]
C924.3	Apply the spectrum estimation techniques.	[AP]
C924.4	Apply the various types of coding and its applications.	[AP]
C924.5	Analyse the concepts of Iterative codes and turbo codes.	[AN]
Course Contents:		
Rate Distortion theory: Calculation of the rate distortion function, achievability of the rate distortion function, computation of the rate distortion function		

Theory and Statistics: Source and channel coding, Sanov's theorem, conditional limit theorem, Chernoff-Stein lemma, Fisher Information **Maximum Entropy:** Spectrum estimation, Burg's maximum entropy theorem

Iterative Codes: LDPC Codes, Tanner graph, Cycles, irregular codes, Message-passing decoder and density evolution **Turbo codes** : Definition, BCJR algorithm and EXIT charts, **Fundamental Theorem of Galois Theory (FTGT).**

Total Hours: 45

Text Books:

1	Cover & Thomas, "Elements of Information Theory", Wiley Publications, Second Edition, 2006.
2	Csisz'ar & K'orner, "Information Theory: Coding Theorems for Discrete Memory less Systems", Cambridge university press, 2011.
3	R. W. Yeung, "Information Theory And Network Coding", Springer US, 2010.

Reference Books:

1	El Gamal, Y.-H. Kim, "Network Information Theory", Cambridge University Press, 2018
2	Robert M. Gray, "Entropy and Information Theory", Springer, 2013.
3	F. J. Mac Williams and N. J. A Sloane, The Theory of Error-Correcting Codes, Elsevier Science, 1988.

Web References:

1	https://www.sanfoundry.com/best-reference-books-information-theory-coding/
2	http://web.iitd.ac.in/~rbose/initiative/MOOCs.pdf
3	http://web.mit.edu/6.933/www/Fall2001/Shannon2.pdf

Online Resources:

1	https://onlinecourses.nptel.ac.in/noc18_ee39/preview
2	https://nptel.ac.in/courses/117101053/

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C924.1	Understand	Quiz 1	3
C924.2	Understand	Quiz 2	5
C924.3	Apply	Group Assignment 1	3
C924.4	Apply	Group Assignment 2	4
C924.5	Analyse	Class Presentation	5

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment			End Semester Examination[50 Marks]
	CIA1[10 Marks]	CIA2[10 Marks]	CIA3[10 Marks]	
Remember	50	40	-	10
Understand	50	40	20	30
Apply	-	20	40	30
Analyse	-	-	40	30
Evaluate	-	-	-	-
Create	-	-	-	-

18EC925	MEMS	3/0/0/3
Nature of Course : G (Theory analytical)		
Pre requisites : 18EC302 - Electronic Circuits		
Course Objectives:		
1.	To provide knowledge of semiconductors and solid mechanics to fabricate MEMS devices.	
2.	To educate on the rudiments of Micro fabrication techniques.	
3.	To introduce various sensors and actuators	
4.	To introduce different materials used for MEMS	
5.	To educate on the applications of MEMS to disciplines beyond Electrical and Mechanical engineering.	
Course Outcomes:		
Upon completion of the course, students shall have ability to		
C925.1	Understand the basic concepts of MEMS and its various processes	[U]
C925.2	Differentiate between the sensors and actuators	[AN]
C925.3	Illustrate the various applications of sensors and actuators	[AP]
C925.4	Define the concept of micromachining process	[R]
C925.5	Explain about the Polymers in MEMS	[U]
C925.6	Describe about the Active Optical MEMS	[U]
Course Contents:		
<p>INTRODUCTION RF FUNDAMENTALS Intrinsic Characteristics of MEMS – Energy Domains and Transducers- Sensors and Actuators – Introduction to Micro fabrication – Silicon based MEMS processes – New Materials Stress and strain analysis – Flexural beam bending-Torsional deflection.</p> <p>SENSING AND ACTUATION Electrostatic sensing and actuation-parallel plate capacitor - Thermal sensing and Actuators-thermal sensors-Actuators - Piezoresistive sensors-piezoresistive sensor material- stress in flexural cantilever and membrane - Magnetic actuation- Micro magnetic actuation principle- deposition of magnetic materials-Design and fabrication of magnetic coil.</p> <p>MICROMACHINING, POLYMER AND OPTICAL MEMS Basic surface micromachining process- structural and sacrificial material, stiction and antistiction methods, Foundry process Polymers in MEMS- polyimide-SU-8 liquid crystal polymer(LCP)-PDMS-PMMA-Parylene-</p>		

Fluorocarbon Optical MEMS-passive MEMS optical components-lenses-mirrors-Actuation for active optical MEMS.

Total Hours:

45

Text Books:

1	Chang Liu, 'Foundations of MEMS', Pearson Education Inc., 2012.
2	Stephen D Senturia, 'Microsystem Design', Springer Publication, 2000.
3	Tai Ran Hsu, "MEMS & Micro systems Design and Manufacture" Tata McGraw Hill, New Delhi, 2002.

Reference Books:

1	Nadim Maluf, " An Introduction to Micro Electro Mechanical System Design", Artech House, 2000.
2	Mohamed Gad-el-Hak, editor, " The MEMS Handbook", CRC press Boca Raton, 2001
3	Julian w. Gardner, Vijay K. Varadan, Osama O.Awadelkarim, Micro Sensors MEMS and Smart Devices, John Wiley & Son LTD, 2002.
4	James J.Allen, Micro Electro Mechanical System Design, CRC Press Publisher, 2005.
5	Thomas M.Adams and Richard A.Layton, "Introduction MEMS, Fabrication and Application," Springer, 2010.

Web References:

1	https://www.mems-exchange.org/MEMS/what-is.html
2	textofvideo.nptel.ac.in/117105082/lec1.pdf

Online Resources:

1	http://nptel.ac.in/courses/117105082/
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Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Tentative Component	Assessment	Marks
C925.1	Understand	Assignment I		4
C925.2	Analyse	Assignment II		4
C925.3	Apply	Quiz		4
C925.4	Remember	Power Point Presentation		4
C925.5	Understand	Quiz		4

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment			End Semester Examination [50 Marks]
	CIA1 [10 Marks]	CIA2 [10 Marks]	CIA3 [10 Marks]	
Remember	20	20	10	10
Understand	40	40	40	40
Apply	30	30	30	30

Analyse	10	10	20	20
Evaluate	-	-	-	-
Create	-	-	-	-

18EC926	SMART ANTENNAS	3/0/0/3
Nature of Course	:G (Theory & Analytical)	
Pre requisites	18EC601 Antennas and Wave Propagation	
Course Objectives:		
1	To gain knowledge in smart antenna radiation properties.	
2	To enable students to understand and analyze various narrow band signal processors.	
3	To gain knowledge in adaptive signal processing.	
4	To acquire knowledge in broad band signal processing in time domain and frequency domain	
5	To enable students to understand and analyze direction of arrival estimation and diversity combining methods	
Course Outcomes:		
Upon completion of the course, students shall have ability to		
C926.1	Recall the basic components of antenna and smart antennas	[R]
C926.2	Analysis and optimization of various Narrowband Signals processors in the absence of errors	[AN]
C926.3	Analysis of various algorithms to show how estimated solution converges to optimal solution	[AN]
C926.4	Apply Broadband Signal processing in time domain and frequency domain and realize broadband signal processors	[AP]
C926.5	Analyze performance of smart antenna using various direction of arrival estimation methods	[AN]
C926.6	Analyze diversity Combining schemes for antenna design	[AN]
Course Contents:		
<p>Introduction: Antenna gain, Phased array antenna, power pattern, beam steering, degree of freedom, optimal antenna, adaptive antennas, smart antenna - key benefits of smart antenna technology, wide band smart antennas, Digital radio receiver techniques and software radio for smart antennas. Narrow Band Processing: Signal model conventional beamformer, null steering beamformer, optimal beamformer, Optimization using reference signal, beam space processing</p> <p>Adaptive Processing and Broadband Processing: Sample matrix inversion algorithm, unconstrained LMS algorithm, Gradient Estimate, Recursive Least Mean Squares(RLS) Algorithm, normalized LMS algorithm, Constrained LMS algorithm, Perturbation algorithms, Neural network Approach, Adaptive Beam Space Processing, Implementation issues. Tapped delay line structure, Partitioned realization, Derivative constrained processor, Digital beam forming, Broad band processing using DFT method.</p> <p>Direction Of Arrival Estimation Methods: Spectral estimation methods, linear prediction method, Maximum entropy method, Maximum likelihood method, Eigen structure methods, Music algorithm- Spectral MUSIC, root music, Constrained MUSIC, Beam Space MUSIC, Minimum Norm Method, and cyclic music algorithm, the ESPRIT algorithm. DIVERSITY</p>		

COMBINING: Spatial diversity selection combiner, switched diversity combiner, equal gain combiner, maximum ratio combiner, optical combiner.

Total Hours:	45
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Text Books:	
1	Lal Chand Godara, "Smart Antennas" ,CRC press, 1 st edition,2004.
2	Balanis, "Antenna Theory", John Wiley and Sons, 4 th edition, 2016.
3	R. S. Elliot, "Antenna Theory and Design", Wiley-IEEE Press, revised edition,2003

Reference Books:	
1	Joseph C Liberti.Jr and Theodore S Rappaport, "Smart Antennas for Wireless Communication: IS-95 and Third Generation CDMA Applications", Prentice Hall, 1 st edition,1999
2	Robert A.Monzingo, R.L.Haupt, T.W. Miller, "Introduction to Adaptive Arrays",Yesdee Publishing Pvt. Ltd.,Reprint, 2012
3	Frank B.Gross,"Smart Antennas for wireless Communications",Mcgraw Hill, 1 st edition,2005

Web References:	
1	http://nptel.ac.in/courses/117107035/
2	www.ece.nus.edu.sg/.../Lecture%20Notes/Smart%20Antennas%20and%20Spatial%20...
3	http://nptel.ac.in/courses/117107035/
4	www.ece.nus.edu.sg/.../Lecture%20Notes/Smart%20Antennas%20and%20Spatial%20...

Online Resources:	
1	downloads.hindawi.com/books/9789775945099.pdf
2	https://www.electronics-tutorials.com/basics/antenna-basics.htm
3	https://www.university.youth4work.com > ... > Lectures
4	https://lecturenotes.in/subject/14/smart-antennas-dec

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C926.1	Remember	Quiz	3
C926.2	Analyze	Problem Solving	3
C926.3	Analyze	Group Assignment	3
C926.4	Apply	Problem Solving	3
C926.5	Analyze	Group Assignment	3
C926.6	Analyze	Case Study	5

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment			End Semester Examination [50 Marks]
	CIA1 [10 Marks]	CIA2 [10 Marks]	CIA3 [10 Marks]	
Rememb	20	10	10	10

er				
Understand	20	10	10	10
Apply	20	40	40	30
Analyse	40	40	40	50
Evaluate	-	-	-	-
Create	-	-	-	-

18EC927	RF SYSTEM DESIGN	3/0/0/3
Nature of Course	:G (Theory & Analytical)	
Pre requisites	18EC503 Digital Signal Processing	
Course Objectives:		
1	To understand the fundamentals of RF circuit design.	
2	To differentiate and design basic RF Filters.	

3	To design and analyze RF Active components.	
4	To design and analyze RF transistor amplifier.	
5	To understand the operation of Oscillators and mixers used in RF design.	
Course Outcomes: Upon completion of the course, students shall have ability to		
C927.1	Understand different RF Components such as passive components, chip Components.	[U]
C927.2	Design RF filters and analyse different types of RF filters.	[AN]
C927.3	Design RF Active Components and analyze their operations in matching networks	[AN]
C927.4	Design high and low gain RF amplifiers and analyze their characteristics	[AN]
C927.5	Understand the operation of RF oscillators.	[U]
C927.6	Understand the concepts of mixers.	[U]
Course Contents:		
<p>RF FUNDAMENTALS AND RF FILTER DESIGN Importance of RF Frequency Design , RF behaviour of Passive Components, Chip Components and Circuit Board Considerations ,Basic Resonator and Filter Design, Butterworth – Type Filter, Chebyshev-Type Filter, Filter Implementation-coupled filter.</p> <p>ACTIVE RF COMPONENTS ,APPLICATIONS IMPEDANCE MATCHING AND RF TRANSISTOR AMPLIFIER DESIGNS RF diodes, BJT, RF FET'S, High electron mobility transistors, matching and biasing networks- impedance matching using discrete components, microstripline matching networks, amplifier-classes of operation and biasing networks. Characteristics of Amplifiers, Amplifier Power Relations, Stability Considerations, Constant Gain and VSWR Circles</p> <p>RF OSCILLATORS AND MIXERS Basic Oscillator Model, High Frequency Oscillator Configurations – Fixed Frequency Oscillator, Dielectric Resonator Oscillator, Basics Concepts of Mixer and Frequency domain Considerations</p>		
Total Hours:		45
Text Books:		
1	Reinhold Ludwig, Gene Bogdanov, "RF circuit design, theory and applications", Pearson Asia Education, 2nd edition, 2009	
2	Tai Ran Hsu, "MEMS & Micro systems Design and Manufacture", Tata McGraw hill, New Delhi, 2002. 6. Liu, "MEMS", Pearson education, 2007.	
3	Joseph. J. Carr, "Secrets of RF Circuit Design " , McGraw Hill Publishers, Third Edition,2000.	
Reference Books:		

1	Stephen Santuria, "Microsystems Design", Kluwer Publishers, 2000
2	Mathew M. Radmanesh, "Radio Frequency & Microwave Electronics", Pearson Education Asia, Second Edition, 2002
3	Ulrich L. Rohde and David P. NewKirk, "RF / Microwave Circuit Design", John Wiley & Sons USA 2000.

Web References:

1	www.tf.uni-kiel.de/matwis/amat/semitech_en/kap_7/illustr/i7_1_3.html
2	www.memsjournal.com/.../an-overview-of-rf-mems-technologies-and-applications.ht .

Online Resources:

1	http://www.ssc.pe.titech.ac.jp/materials/VLSICS03_shortcourse_matsu_homepage.pdf
2	http://www.ti.com/lit/ml/slap127/slap127.pdf
3	https://www.radio-electronics.com/info/rf-technology-design/
4	https://cds.cern.ch/record/1407402/files/p223.pdf

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C927.1	Understand	Quiz	3
C927.2	Analyse	Problem Solving	3
C927.3	Analyse	Group Assignment	3
C927.4	Analyse	Problem Solving	3
C927.5	Understand	Group Assignment	3
C927.6	Understand	Case Study	5

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment			End Semester Examination[50 Marks]
	CIA1[10 Marks]	CIA2[10 Marks]	CIA3[10 Marks]	
Remember	20	20	10	10
Understand	40	20	30	20
Apply	-	-	20	20
Analyse	40	60	40	50
Evaluate	-	-	-	-
Create	-	-	-	-

18EC928	COGNITIVE RADIO COMMUNICATION	3/0/0/3
Nature of Course : G (Theory analytical)		
Pre requisites : 18EC502 Digital Communication		
Course Objectives:		
1.	Know the basics of the software defined radios.	
2.	Learn the design of the wireless networks based on the cognitive radios	
3.	Understand the concepts of wireless networks and next generation networks	
Course Outcomes:		
Upon completion of the course, students shall have ability to		
C928.1	Explain the concept of SDR and its architectures	[U]
C928.2	Examine the concept of Cognitive Radios and its architectures	[AN]
C928.3	Describe the various techniques in Cognitive Radios	[R]
C928.4	Illustrate the concept of Building the Cognitive Radio Architecture on SDR	[AP]
C928.5	Identify the role of SDR and Cognitive radio communication in XG	[U]

	networks.		
C928.6	Explain The Concepts Behind The Wireless Networks And Next Generation Networks	[U]	
Course Contents:			
<p>INTRODUCTION TO SOFTWARE DEFINED RADIO AND ARCHITECTURE Definitions and potential benefits, software radio architecture evolution –foundations, technology trade-offs and architecture implications - Essential functions of the software radio, basic SDR, hardware architecture, Computational processing resources, software architecture.</p> <p>INTRODUCTION TO COGNITIVE RADIOS AND ARCHITECTURE Marking radio self-aware, cognitive techniques – position awareness, environment awareness in cognitive radios, optimization of radio resources, Artificial Intelligence Techniques - Cognitive Radio – functions, components and design rules, Cognition cycle – orient, plan, decide and act phases, Inference Hierarchy, Architecture maps, Building the Cognitive Radio Architecture on Software defined Radio Architecture.</p> <p>NEXT GENERATION WIRELESS NETWORKS The CR Network architecture The XG Network architecture, spectrum sensing, spectrum management, spectrum mobility, spectrum sharing, upper layer issues, cross – layer design.</p>			
Total Hours:		45	
Text Books:			
1.	Joseph Mitola III, "Software Radio Architecture: Object-Oriented Approaches to Wireless System Engineering", John Wiley & Sons Ltd. 2000.		
2.	Thomas W.Rondeau, Charles W. Bostain, "Artificial Intelligence in Wireless communication", ARTECH HOUSE .2009.		
3.	Mohammed A. Matin, "Spectrum Access and Management for Cognitive Radio Networks", Springer, Signals and Communication Technology, September 2016.		
Reference Books:			
1.	Simon Haykin, "Cognitive Radio: Brain –Empowered Wireless Communications", IEEE Journal on selected areas in communications, Feb 2005.		
2.	Hasari Celebi, Huseyin Arslan, "Enabling Location and Environment Awareness in Cognitive Radios", Elsevier Computer Communications , Jan 2008.		
3.	Alexander M. Wyglinski, Maziarnekov, Y. Thomas Hu, "Cognitive Radio Communication and Networks", Elsevier, 2010		
Web References:			
1	http://www.radio-electronics.com/info/rf-technology-design/cognitive-radio-cr/technology-tutorial.php		
2	https://www.sciencedirect.com/science/book/9780123747150		
3	https://www.xgtechnology.com/innovations/cognitive-radio-networks/		
Online Resources:			
1	http://nptel.ac.in/courses/108107107/		
2	http://technav.ieee.org/tag/401/cognitive-radio		
3	https://www.comsoc.org/publications/best-readings/cognitive-radio		
Assessment Methods & Levels (based on Blooms' Taxonomy)			
Formative assessment based on Capstone Model (Max. Marks:20)			
Course Outcome	Bloom's Level	Tentative Assessment Component	Marks
C928.1	Understand	Power Point Presentation	3

C928.2	Analyse	Assignment I	4	
C928.3	Remember	Quiz I	4	
C928.4	Apply	Assignment II	3	
C928.5	Understand	Quiz II	3	
C928.6	Understand	Group Discussion	3	
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination [50 Marks]
	CIA1 [10 Marks]	CIA2 [10 Marks]	CIA3 [10 Marks]	
Remember	20	20	10	10
Understand	40	40	40	40
Apply	30	30	30	30
Analyse	10	10	20	20
Evaluate	-	-	-	-
Create	-	-	-	-

18EC929	MIMO AND MULTI CARRIER SYSTEMS	3/0/0/3
Nature of Course	G (Theory & Analytical)	
Pre requisites	18EC502 Digital Communication	
Course Objectives:		
1	To introduce the principles of Multiple Input Multiple Output (MIMO) Communication Systems.	
2	To enable the students to understand the Comparison of MIMO Systems with Single Input Single Output (SISO) Systems.	
3	To enable the students to analyse the concepts of the spatial multiplexing properties of MIMO.	
4	To allow students to design and analyze Space Time Block codes.	
5	To Impart knowledge on Space Time Trellis Codes and Trellis Diagram.	
Course Outcomes:		
Upon completion of the course, students shall have ability to		
C929.1	Introduce Multiple Input Multiple Output (MIMO) Communication Systems.	[U]
C929.2	Understand the concept of MIMO channel models.	[U]
C929.3	Understand the concept of MIMO Diversity and applying for various types.	[AP]
C929.4	Apply the spatial multiplexing properties in MIMO.	[AP]
C929.5	Representation of Space time Block codes and applying for real and complex orthogonal designs.	[AP]
C929.6	Analysis of Space Time Trellis Codes based on State-transition diagram and trellis diagram.	[AN]
Course Contents:		
Information Theoretic aspects of MIMO: Review of SISO fading communication channels,		

MIMO channel models, Classical i.i.d. and extended channels, Frequency selective and correlated channel models, Capacity of MIMO channels, Ergodic and outage capacity, Capacity bounds and Influence of channel properties on the capacity.

MIMO Diversity and Spatial Multiplexing: Sources and types of diversity, analysis under Rayleigh fading, Diversity and channel knowledge. Alamouti space time code, MIMO spatial multiplexing. Space time receivers. ML, ZF, MMSE and Sphere decoding, BLAST receivers and Diversity multiplexing trade-off.

Space Time Block Codes and Space Time Trellis Codes: Space time block codes on real and complex orthogonal designs, Code design criteria for quasistatic channels (Rank, determinant and Euclidean distance), Representation of STTC, shift register, generator matrix, state-transition diagram, trellis diagram, Code construction, Delay diversity as a special case of STTC and Performance analysis.

Total Hours:	45
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Text Books:

1	David Tse and Pramod Viswanath, "Fundamentals of Wireless Communication", Cambridge University Press 2013.
2	E. G. Larsson and P. Stoica, "Information Theory, Space-Time Block Coding for Wireless Communications", Cambridge University Press, 2008.
3	Paulraj, R. Nabar and D. Gore, "Introduction to Space-Time Wireless Communications", Cambridge University Press 2008.

Reference Books:

1	Ezio Biglieri , Robert Calderbank et al "MIMO Wireless Communications" Cambridge University Press 2007.
2	Hamid Jafarkhani, "Space-Time Coding: Theory and Practice", Cambridge University Press 2010.

Web References:

1	https://massivemimo.eu/
2	https://www.electronics-notes.com/articles/antennas-propagation/mimo/
3	https://www.rfmw.com/data/SWA-MIMO-Basics.pdf
4	https://ma-mimo.ellintech.se/2017/09/21/5-5-hours-of-massive-mimo-tutorials/

Online Resources:

1	https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-452-principles-of-wireless-communications-spring-2006/download-course-materials/
2	https://www.comsoc.org/best-readings/topics/massive-mimo
3	http://www.iitg.ac.in/engfac/krs/public_html/mimo.pdf
4	https://web.stanford.edu/~dntse/Chapters_PDF/Fundamentals_Wireless_Communication_chapter7.pdf

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C929.1	Understand	Quiz	3
C929.2	Understand	Assignment	3
C929.3	Apply	Assignment	3
C929.4	Apply	Quiz	3
C929.5	Apply	Group Assignment	3
C929.6	Analyse	Case Study	5

Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination [50 Marks]
	CIA1 [10 Marks]	CIA2 [10 Marks]	CIA3 [10 Marks]	
Remember	40	20	10	10
Understand	40	40	40	40
Apply	20	40	30	30
Analyse	-	-	20	20
Evaluate	-	-	-	-
Create	-	-	-	-

18EC930	Millimeter wave personal communication systems	3/0/0/3
Nature of Course	:C (Theory)	
Pre requisites	18EC601- Antennas & Wave Propagation	
Course Objectives:		
1	To understand the concepts of Millimetre waves and its characteristics.	
2	To know about the 60GHz MM wave and its technology	
3	To demonstrate the modulation techniques, MMW transceivers and Antennas	
4	To focus on the Millimetre wave MIMO techniques.	
5	To understand about Beam steering and beam forming technologies	
Course Outcomes:		
Upon completion of the course, students shall have ability to		
C930.1	Discuss the basics of millimetre wave and 60 GHz MMW technology	[AP]
C930.2	Illustrate the various modulation techniques of MM Wave	[U]
C930.3	Demonstrate the MMW transceivers and antennas	[A]
C930.4	Examine the various diversity techniques of MMW	[AP]
C930.5	Interpret the ideas about beam steering and beam forming antennas	[A]
Course Contents:		
INTRODUCTION TO MILLIMETER WAVE AND ITS CHARACTERISTICS:		
Indoor Propagation modelling Introduction- Interference – Indoor Propagation effects- ITU path loss model- Long distance path loss model – link budget Millimeter wave (MMW) Characteristics- 60 GHz MMW radio Principle and technology - Channel Performance at 60 GHz- Gigabit Wireless Communications - Development of Millimeter Wave Standards - Coexistence with Wireless Backhaul.		
MODULATIONS TECHNIQUES AND TRANSCEIVERS FOR MILLIMETER WAVE COMMUNICATIONS:		
PSK – QAM - OFDM. MMW Transceivers- Transceiver Architecture- Research Trend: Transceiver Siliconization. MILLIMETER WAVE ANTENNAS- Path Loss and Antenna Directivity - Antenna Beamwidth- Beam Steering Antenna- Millimeter Wave Design		

Consideration.

MILLIMETER WAVE MIMO:

Spatial Diversity of Antenna Arrays - Multiple Antennas. Multiple Transceivers - Noise Coupling in a MIMO System- **DIVERSITY OVER MIMO CHANNELS** - Potential Benefits for Millimeter Wave Systems- Spatial and Temporal Diversity - Spatial and Frequency Diversity - Dynamic Spatial, Frequency, and Modulation Allocation- **ADVANCED BEAM STEERING AND BEAM FORMING:**The Need for Beam-Steering/Beam-Forming - **Advanced Beam Steering Technology- Advanced Beam Forming Technology.**

Total Hours: 45

Text Books:

1	Kao-Cheng Huang , Zhaocheng Wang , “Millimeter Wave Communication Systems” Wiley-IEEE Press 2011
2	Robert W.Heath, James N Murdock, Robert C Daniels, Theodore S Rappaport, “Millimetre Wave Wireless Communication”, Prentice hall, September 2014.

Reference Books:

1	John s. Seybold, "introduction to rf propagation", john wiley and sons, 2005
2	Chia -chin chong, Kiyoshi hamaguchi, Peter F.M. Smulders and Su-Khiong," Millimeter wave Wireless Communication systems: Theory and Applications," Hindawl Publishing Corporation. 2007

Web References:

1	https://www.oreilly.com/library/view/millimeter-wave-wireless/9780132173636/
2	https://jwcn-urasipjournals.springeropen.com/articles/10.1155/2007/72831

Assessment Methods & Levels (based on Blooms’Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom’s Level	Assessment Component	Marks
C930.1	Apply	Quiz	4
C930.2	Understand	Assignment	3
C930.3	Analyse	Problem Solving	4
C930.4	Apply	Group Assignment	4
C930.5	Analyse	Technical Presentation	5

Summative assessment based on Continuous and End Semester Examination

Bloom’s Level	Continuous Assessment			End Semester Examination[50 Marks]
	CIA1[10 Marks]	CIA2[10 Marks]	CIA3[10 Marks]	
Remember	20	10	10	10
Understand	40	40	40	40
Apply	40	30	30	30
Analyse	-	20	20	20
Evaluate	-	-	-	-
Create	-	-	-	-

18EC931	WIRELESS SENSOR NETWORKS	3/0/0/3
Nature of Course :C (Theory Concept)		
Pre requisites : 18EC504- Computer Networks & Interfacing		
Course Objectives:		
1	To obtain a broad understanding of the technologies and applications for the emerging and exciting domain of wireless sensor networks	
2	To study the challenges and latest research results related to the design and management of wireless sensor networks	
3	To focus on network architectures and energy efficiency	
4	To study the concept of Time Synchronization and Localization	
5	To focus on Routing Protocols and Operating Systems	
Course Outcomes:		
Upon completion of the course, students shall have ability to		
C931.1	Learn the basics of wireless sensor networks and its applications in enabling technologies.	[R]
C931.2	Understand the architecture and elements of wireless sensor networks	[U]
C931.3	Analysing the idea on MAC protocols for wireless sensor networks.	[A]
C931.4	Apply the concept of Topologies, Synchronization and Localization for sensor networks	[AP]
C931.5	To be able to understand the various routing protocols	[U]
C931.6	Know the tools and platforms needed to establish sensor networks	[R]
Course Contents:		
Concepts of Body Area Networks:		
Overview of Wireless Sensor Networks:		
Challenges for Wireless Sensor Networks - Enabling Technologies for Wireless Sensor Networks - Single-Node Architecture: Hardware Components - Energy Consumption of Sensor Nodes - Operating Systems and Execution Environments -Network Architecture: Sensor Network Scenarios - Optimization Goals and Figures of Merit -Gateway Concepts - Physical Layer and Transceiver design Considerations		
Time Synchronization and Localization:		
MAC Protocols for Wireless Sensor Networks - S-MAC - Wakeup radio concepts - Introduction to the time synchronization problem - Protocols based on sender/receiver synchronization - Single-hop localization - Positioning in multi-hop environments - Topology-control: Aspects of topology-control algorithms		
Routing Protocols and Operating Systems:		
Energy-Efficient unicast - Broadcast and multicast - Geographic Routing- Mobile nodes - Operating Systems for Wireless Sensor Networks: Operating System Design Issue - Examples of Operating Systems: Tiny OS, Mate, Magnet OS and OSPM - Application specific support: Target detection and tracking		

Total Hours:		45		
Text Books:				
1	Holger Karl and Andreas Willig, Protocols And Architectures for Wireless Sensor Networks , John Wiley,2007.			
2	KazemSohraby, Daniel Minoli and TaiebZnati, Wireless Sensor Network-Technology, Protocolsand Applications, John Wiley, 2007			
Reference Books:				
1	Feng Zhao and Leonidas J. Guibas, Wireless Sensor Networks - An Information Processing Approach", Elsevier, 2007.			
2	Anna Hac, Wireless Sensor Network Designs, John Wiley, 2004.			
3	Bhaskar Krishnamachari, Networking Wireless Sensors, Cambridge Press, 2009.			
Web References:				
1	www.tfb.edu.mk/amarkoski/WSN/Kniga-w02			
2	http://profsite.um.ac.ir/~hyaghmae/ACN/WSNbook.pdf			
3	https://nptel.ac.in/courses/106105160/21			
4	https://nptel.ac.in/courses/114106035/37			
Online Resources:				
1	http://ceng.usc.edu/~bkrishna/research/talks/WSN_Tutorial_Krishnamachari_ICISIP_05.pdf			
2	http://ijctjournal.org/Volume4/issue-8/IJCTT-V4I8P194.pdf			
3	profsite.um.ac.ir/~hyaghmae/ACN/WSNbook.pdf			
4	https://pdfs.semanticscholar.org/e552/059d73eef06be26fd0e1a1e4118d4f4e4b20.pdf			
Assessment Methods & Levels (based on Blooms' Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component	Marks	
C931.1	Remember	Quiz	3	
C931.2	Understand	Quiz	3	
C931.3	Analyse	Group Assignment	5	
C931.4	Apply	Group Assignment	5	
C931.5	Understand	Class presentation	2	
C931.6	Remember	Class presentation	2	
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination[50 Marks]
	CIA1[10 Marks]	CIA2[10 Marks]	CIA3[10 Marks]	
Remember	50	20	30	30
Understand	50	20	30	30
Apply	-	30	20	20
Analyse	-	30	20	20
Evaluate	-	-	-	-
Create	-	-	-	-

18EC932	BODY AREA NETWORKS	3/0/0/3
Nature of Course	:C (Theory Concept)	
Pre requisites	:17EC318 Computer Networks & Interfacing	
Course Objectives:		
1	To introduce the basic concepts of body area networks	
2	To understand the concept hardware development and systems for BAN	
3	To study about the protocols for BAN.	
4	To understand about the antennas for BAN applications	
5	To realize the importance of Ultra wideband for BAN.	
Course Outcomes:		
Upon completion of the course, students shall have ability to		
C932.1	Understand the standards and architecture of WBAN layers	[U]
C932.2	Understand the hardware design of body sensor nodes	[U]
C932.3	Apply the software program of implanted sensor nodes for WBAN	[AP]
C932.4	Analyse the topologies and protocols of WBAN	[AN]
C932.5	Understand the parameters of Implanted Antennas for BAN	[U]
C932.6	Recall the advantages, limitations and applications of UWB	[R]
Course Contents:		
Concepts of Body Area Networks:		
Introduction to WBAN-Standard-Architecture-WBAN layers-Drawback of WBAN; Hardware development and system for BAN: Wireless body sensors-Sensor nodes and hardware designs-Wireless systems and platforms- Wireless transceivers and microcontrollers -Existing sensor boards-Design of implanted sensor nodes for WBAN-WBAN Systems- Software programs and monitoring;		
Protocols and Antennas for BAN:		
Network topologies and configuration-Basics of MAC protocol-Traffic characteristics-Scheduled protocol-Random access protocol-Hybrid MAC protocol-Energy management in WBAN-Performance analysis of WBAN; Antenna parameters, Implanted Antennas and volume conduction antennas - Effects of radio frequency on tissues and organs and effects of human tissues on RF propagations.		
Ultra wideband for BAN :		
Introduction-Advantages and limitations of UWB for WBAN-UWB hardware development-PHY layer for UWB WBAN-UWB WBAN Application-Design and Implementation of an UWB -WBAN System.		
Total Hours:		45
Text Books:		

1	Huan-Bang Li, Kanya Yekeh Yazdandoost, Bin Zhen, "Wireless Body Area Network", River Publishers, 2010.
2	Muhannad Quwaider, Subir Biswas "Wireless Body Area Networks" VDM Publishing, 2010.

Reference Books:

1	Sandeep Kumar Shrinath Gupta, Tridib Mukherjee, Krishna Kumar Venkatasubramanian, "Body Area Networks safety, security and Sustainability ", Cambridge University Press ,2013.
2	Mehmet R. Yuce, Jamil Y. Khan "Wireless Body Area Networks" Pan Stanford Publisher, 2012.
3	Mark Andrew Hanson, Amy Nicole Miller, "Wireless Body Area Sensor Network Technology For Motion Based Health Assessment" BiblioBazaar Publishers, 2011.

Web References:

1	https://arxiv.org/abs
2	https://www.howstuffworks.com
3	https://onlinecourses.nptel.ac.in/noc17_ec01/preview

Online Resources:

1	https://www.sciencedirect.com/science/article/pii/S187705091630299X
2	https://www.waves.intec.ugent.be/research/wireless-body-area-networks

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C932.1	Understand	Quiz	3
C932.2	Understand	Quiz	3
C932.3	Apply	Group Assignment	4
C932.4	Analyse	Group Assignment	4
C932.5	Understand	Class Presentation	3
C932.6	Remember	Class Presentation	3

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment			End Semester Examination[50 Marks]
	CIA1[10 Marks]	CIA2[10 Marks]	CIA3[10 Marks]	
Remember	-	20	20	30
Understand	100	40	40	30
Apply	-	20	20	20
Analyse	-	20	20	20
Evaluate	-	-	-	-
Create	-	-	-	-

18EC933	SOFT COMPUTING		3/0/0/3
Nature of Course	: (G) Theory		
Prerequisites	18CS111 - Problem Solving using C Programming		
Course Objectives:			
1	To understand the Neural Network concepts		
2	To understand the concepts behind Fuzzy logic		
3	To acquire the basic knowledge of Genetic algorithms		
4	To equip the students with the latest application of soft computing		
5	To make the students capable of applying soft computational techniques to solve various problems		
Course Outcomes:			
Upon completion of the course, students shall have ability to			
C933.1	Understand the basic building block of neural network		[U]
C933.2	Describe the applications based neural network		[U]
C933.3	Recall the concept of associative memory, adaptive resonance theory		[R]
C933.4	Recall the functionality of fuzzy logic & Adaptive neuro fuzzy logic		[R]
C933.5	Provide the extensive knowledge of Genetic algorithm approaches		[U]
C933.6	Analysis of optimization methods using Hybrid GA techniques		[AN]
Course Contents:			
<p>NEURAL NETWORKS: Human Brain, Model of an Artificial Neuron -Basic concepts-knowledge based processing-single layer perceptron-multilayer perceptron-supervised and unsupervised learning - feed forward and back propagation and counter propagation networks- Kohensself organizing networks-Hopfield networks.</p> <p>MEMORY AND FUZZY LOGIC: Bidirectional Associative memories & Applications , Adaptive Resonance Theory - Fuzzy set theory-fuzzy rules and fuzzy reasoning-fuzzy inference systems-decomposition-fuzzy automata and languages-fuzzy control methods - Adaptive neuro fuzzy inference systems - classification and regression trees- data clustering-rule base structure identification-neuro fuzzy controls - Defuzzification methods, Applications - Autocorrelators, Heterocorrelators - Fuzzy versus Crisp sets - Crisp logic versus Fuzzy logic.</p> <p>GENETIC ALGORITHMS: Basics of GA- Working principle -choice of encoding-selection probability-mutation and crossover-fitness evaluation – improving convergence rate - Bit-wise operators, Generation cycle , simplex GA - Hybrid approach - Biological background, Creation of off springs, Fitness Function.</p>			
Total Hours:			45
Text Books:			
1	Jang J.S.R.,Sun C.T and Mizutani E, "Neuro Fuzzy and Soft computing", Pearson Education (Singapore), 2006.		
2	David E.Goldberg, Genetic Algorithms in Search, Optimization, and Machine Learning, Pearson Education, Asia, 2001.		
3	Laurene V. Fausett, " Fundamentals of Neural Networks: Architectures, Algorithms and Applications" Pearson Prentice Hall, 2008.		
Reference Books:			
1	S.Rajasekaran and G.A.VijayalakshmiPai : "Neural networks,Fuzzylogics,and Geneticalgorithms", PHI,2003.		
2	Timothy J.Ross: "Fuzzy Logic Engineering Applications", McGrawHill, Second Edition 2000.		
3	Hung T. Nguyen, Elbert A. Walker, "A First Course in Fuzzy Logic", Third Edition, CRC Press, 2005.		
4	Mitchell Melanie, "An Introduction To Genetic Algorithms", Prentice Hall of India, New Delhi, 1998.		
Web References:			
1	https://www.coursera.org/learn/neural-networks		

2	http://nptel.ac.in/courses/117105084/
3	https://onlinecourses.nptel.ac.in/noc18_cs13

Online References:

1	https://www.researchgate.net/journal/1432-7643_Soft_Computing
2	http://www.ijarcs.info/index.php/ijarcs/article/viewFile/5911/4830

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Tentative Assessment Component	Marks
C933.1	Understand	Quiz	3
C933.2	Understand	Assignment	3
C933.3	Remember	Group Assignment	3
C933.4	Remember	Assignment	3
C933.5	Understand	Seminar	3
C933.6	Analyze	Case study	5

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment			End Semester Examination [50 marks]
	CIA-I [10 marks]	CIA-II [10 marks]	CIA-III [10 marks]	
Remember	20	60	10	20
Understand	60	20	50	60
Apply	-	-	-	-
Analyze	20	20	40	20
Evaluate	-	-	-	-
Create	-	-	-	-

18EC934	Digital Image & Video Processing		3/ 0 / 0
Nature of Course C(Theory Concept)			
Pre requisites 18EC503-Digital Signal Processing			
Course Objectives:			
1	To provide knowledge about the basic steps and mathematical transforms in image processing		
2	To give a view on human visual perception		
3	To learn various techniques to improve the visual appeal of the image		
4	To analyse the noise and technique to remove noise from the degraded images		
5	Understand the implementation of algorithm for image analysis.		
Course Outcomes:			
Upon completion of the course, students shall have ability to			
C934.1	To have an idea about the basic definition of an image and human visual system.		[R]
C934.2	To learn the principles of image formation, sampling, quantization and the human visual system, which will allow them to investigate specific image processing techniques later on		[U]
C934.3	Understand the principles of colour video processing and motion estimation.		[U]
C934.4	Analyse various coding techniques to provide a better video enhancement		[AN]
C934.5	Be aware of the different video applications and the approaches of video processing.		[U]
C934.6	To analyse various errors in video communications and implement an effective error control codes to the appropriate error.		[AN]
Course Contents:			
Introduction to DIP			
Digital images definition & formation, Human visual system.Low-level image representation - the Pixel, Pixel-based model: Luminance and color, Space-frequency representation of images -Image filtering, 2D convolution and correlation.			
Introduction to Video Processing			
Principles of colour video processing, Video display, Sampling of video signals. Motion estimation- Two dimensional Optical flow, General methodologies, Pixel based motion estimation, Block matching algorithm, Deformable block matching algorithm Global motion estimation.Content dependent video coding -Two dimensional shape coding, Texture coding for arbitrarily shaped region, Joint shape and texture coding, Region based video coding, Object based video coding.			
Error control in video communications			
Overview of approaches, Video applications and communication networks, Transport level error control, Error resilient encoding, Decoder error concealment, Encoder-decoder interactive error control, Error resilience Tools in H.263 and MPEG-4.			

Total Hours:	45
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Text Books:

1	González, R.C.; Woods, R.E. Digital image processing. 3rd ed. Harlow: Pearson Prentice Hall, 2014.
2	Pratt, W.K. Digital image processing: PIKS scientific inside. 4th ed. New York: John Wiley, 2007.
3	Yao Wang, Jorn Ostermann, Ya-Qin Zhang, 'Video Processing and Communications', Prentice Hall, 2002

Reference Books:

1	A. Murat Tekalp, 'Digital Video Processing', Prentice Hall, edition 2, 2015
2	W. K. Pratt, ``Digital Image Processing," 2nd Edition, John Wiley and Sons, 2008
3	Alan C. Bovik, 'The Essential Guide to Video Processing', Elsevier Science, edition 2, 2009

Web References:

1	nptel.ac.in/downloads/117104020/
2	https://www.coursera.org/learn/digital
3	https://www.edx.org/course/computer-vision-image-analysis-1

Online Resources:

1	http://web.stanford.edu/class/ee368/handouts.html
2	http://www.ee.columbia.edu/~sfchang/course/dip/
3	http://diwakar-marur.blogspot.com/search/label/Digital%20Television

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C934.1	Remember	Classroom or Online Quiz	3
C934.2	Understand	Classroom or Online Quiz	2
C934.3	Understand	Class Presentation/Power point presentation	5
C934.4	Analyse	Group Assignment & Tutorial	3
C934.5	Understand	Group Assignment	2
C934.6	Analyse	Case study	5

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment			End Semester Examination[50 Marks]
	CIA1[10 Marks]	CIA2[10 Marks]	CIA3[10 Marks]	
Remember	20	0	0	0
Understand	20	20	20	20
Apply	60	60	60	60
Analyse	0	20	20	20
Evaluate	-	-	-	0
Create	-	-	-	0

18EC935	SPEECH AND AUDIO PROCESSING	3/0/0/3
Nature of Course	: G (Theory)	
Pre requisites	: 18EC503/Digital Signal processing	
Course Objectives:		
1	To enable the students to understand basics about speech and audio.	
2	To introduce speech production and related parameters of speech.	
3	To understand the concept of speech parameters and processing.	
4	To enable the students to understand speech recognition and analysis methodology	
5	To understand different speech modelling procedures and applications of speech recognition	
Course Outcomes:		
Upon completion of the course, students shall have ability to		
C935.1	Understand the basic concept of speech and audio signal	[R]

C935.2	Understand the speech production and related parameters of speech	[U]
C935.3	Understand the computation and use of techniques related to signal processing.	[U]
C935.4	Apply different methods of signal recognition techniques.	[AP]
C935.5	Apply different methods for comparing speech patterns.	[AP]
C935.6	Analyse different speech modelling procedures	[AN]
Course Contents:		
<p>Speech Production and Speech Signal Processing: basics of speech-Categorization of Speech Sounds-Physiological and Mathematical Model of speech-relevant properties of the fast Fourier transform and Z-transform for speech recognition, convolution, linear and Nonlinear filter banks-linear prediction (LP) analysis of speech.</p> <p>Speech Recognition Front End: Static and dynamic features for speech recognition- Mel frequency cepstral co-efficient (MFCC)-Linear prediction cepstral coefficients (LPCC)-Perceptual LPCC - Distance measures for comparing speech patterns - Log spectral distance-cepstral distances- weighted cepstral distances-distances for linear and warped scales real and complex cepstrum.</p> <p>Statistical models for speech recognition: Discrete and Continuous Hidden Markov modelling for isolated word and continuous speech recognition-application of cepstral analysis to speech signals.</p>		
Total Hours:		45
Text Books:		
1	Benard Gold, Nelson Morgan, Dan Ellis, "Speech, and Audio Signal Processing: Processing and Perception of Speech and Music", Wiley, Second edition, 2011.	
2	VijayMadiseti, "The Digital Signal Processing Handbook: Video, Speech, and Audio Signal Processing and Associated Standards", CRC Press, Second edition, 2010.	
3	Thomas F. Quatieri, Cloth, "Discrete-Time Speech Signal Processing: Principles and Practice", 2001.	
Reference Books:		
1	Lawrence Rabiner and Biing-Hwang Juang, "Fundamentals of Speech Recognition", Pearson Education, 2003.	
2	Steve Young, "Corpus-Based Methods in Language and Speech Processing", Springer, 1997.	
3	JR Deller, JG Proakis, JH Hansen, "Discrete Time Processing of Speech Signals", Wiley-IEEE Press, 1999.	
Web References:		
1	https://asa.scitation.org/doi/abs/10.1121/1.4742973?journalCode=jas	
2	https://www.researchgate.net/journal/1063-676_IEEE_Transactions_on_Speech_and_Audio_Processing	
3	https://freevidelectures.com/course/2504/elec9344-speech-and-audio-processing	
Online Resources:		
1	https://nptel.ac.in/courses/117105145/	

2	https://www. IEEE Transactions on audio, speech and language processing.			
Assessment Methods & Levels (based on Blooms' Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component	Marks	
C935.1	Remember	Quiz	3	
C935.2	Understand	Quiz	3	
C935.3	Understand	Seminar	3	
C935.4	Apply	Group Assignment	3	
C935.5	Apply	Group Assignment	3	
C935.6	Analyse	Simulation Exercise	5	
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination[50 Marks]
	CIA1[10 Marks]	CIA2[10 Marks]	CIA3[10 Marks]	
Remember	50	40	10	10
Understand	50	40	30	40
Apply	-	20	40	30
Analyse	-	-	20	20
Evaluate	-	-	-	-
Create	-	-	-	-

18EC936	DATA SECURITY		3/0/0/3
Nature of Course			
		M Theory	
Pre - requisites			
		18EC403: Data Communications And Networks	
Course Objectives:			
1	To learn the network security principles and measures to prevent vulnerabilities and security attacks in the networks		
2	To learn the network security and applications		
3	To study the concept of main security threats and techniques to diminish these threats in Communication networks.		
4	To study the Security Standards in current Wireless & Mobile Systems		
Course Outcomes:			
Upon completion of the course, students shall have ability to			
C936.1	Remember the basic concepts of networking devices and various attacks possible on networking devices		[R]
C936.2	Understand the concept of IP security and architecture		[U]
C936.3	Understand the various methods and protocols to maintain E-mail security , and web security		[U]
C936.4	Understand the various methods of password management and protocols to maintain system security		[U]
C936.5	Develop SSL or Firewall based solutions against security threats, employ access control techniques to the existing computer platforms		[AP]
C936.6	To analyze the Security and privacy in current Wireless & Mobile Systems		[AN]
Course Contents:			
<p>INTRODUCTION TO NETWORK SECURITY - Networking Devices(Layer1,2,3)- Different types of network layer attacks–Firewall (ACL, Packet Filtering, DMZ, Alerts and Audit Trials) – IDS,IPS and its types (Signature based, Anomaly based, Policy based, Honey pot based).</p> <p>VIRTUAL PRIVATE NETWORKS, MPLS AND MPLS VPN - VPN and its types – Tunneling Protocols – Tunnel and Transport Mode –Authentication Header- Encapsulation Security Payload (ESP)- IPSEC Protocol Suite – IKE PHASE 1, II – Generic Routing Encapsulation(GRE) -WAN Topologies- Standard IP based Switching – CEF based Multi-Layer switching-MPLS Characteristics- Frame Mode MPLS Operation – MPLS VPN.</p> <p>E-MAIL SECURITY AND WEB SECURITY - Security Services for E-mail-attacks possible through E-mail – establishing keys privacy- authentication of the source- Message Integrity-Non-repudiation-Pretty Good Privacy-S/MIME- SSL/TLS Basic Protocol-computing the keys- client authentication-PKI as deployed by SSL Attacks fixed in v3- Exportability-Encoding-Secure Electronic Transaction (SET), Kerberos</p> <p style="color: green;">Security Standards in current Wireless & Mobile Systems: WiFi Security (WEP, WPA, WPA-Enterprise); Cellular Security (GSM, 3G, LTE); Internet of Things / Wireless Sensor Networks / RFID, Emerging Privacy</p>			

concerns: location, tracking, traffic analysis, mobile and the cloud

		Total	45
Hours:			
Text Books:			
1	Charlie Kaufman, Radia Perlman, Mike Speciner, " <i>Network Security</i> ", Prentice Hall, 2 nd edition, ISBN-10: 0130460192, ISBN-13: 978-0130460196, 2002.		
2	Charles Pfleeger, " <i>Security in Computing</i> ", Prentice Hall, 4 th Edition, ISBN-10: 0132390779, ISBN-13: 978-0132390774, 2006.		
3	William Stallings, " <i>Cryptography and Network Security</i> ", Pearson Education, 6 th Edition, ISBN 10: 0133354695, 2013.		
Reference Books:			
1	Ulysess Black, " <i>Internet Security Protocols: Protecting IP Traffic</i> ", Prentice Hall PTR; 1 st edition, ISBN-10: 0130142492, ISBN-13: 978-0130142498, 2000.		
2	Amir Ranjbar, " <i>CCNP ONT Official Exam Certification Guide</i> ", Cisco Press [ISBN: 978-1-58720-176-3], 2007.		
3	Frank Adelstein, Sandeep K.S. Gupta, Golden G. Richard III, and Loren Schwiebert, " <i>Fundamentals of Mobile and Pervasive Computing</i> ", 2005.		
Online Resources:			
1	http://nptel.ac.in/courses/106105031/		
2	http://www.nptelvideos.in/2012/11/cryptography-and-network-security.html		
3	http://freevidelectures.com/Course/3027/Cryptography-and-Network-Security		
Web References:			
1	http://www.ccs.neu.edu/home/noubir/Courses/CS7780/F14/slides/introduction.pdf		
2	http://www.ccs.neu.edu/home/noubir/Courses/CS7780/F14/slides/crypto-use-misuse.pdf		
3	http://www1.se.cuhk.edu.hk/~eclt5740/		
Assessment Methods & Levels (based on Blooms' Taxonomy)			
Formative assessment based on Capstone Model (Max. Marks:20)			
Course Outcome	Bloom's Level	Tentative Assessment Component	Marks (20)
C936.1	Remember	Quiz	4
C936.2, C936.3, C936.4	Understand	Quiz	8
C936.5	Apply	Group Assignment	4
C936.6	Analyse	Group Assignment	4
Summative assessment based on Continuous and End Semester Examination			

Bloom's Level	Continuous Assessment [30 Marks]			End Semester Examination[50 Marks]
	CIA1[10 Marks]	CIA2[10 Marks]	CIA3[10 Marks]	
Remember	40	20	10	10
Understand	60	40	40	40
Apply	-	40	30	30
Analyse	-	-	20	20
Evaluate	-	-	-	-
Create	-	-	-	-

18EC937	PATTERN RECOGNITION TECHNIQUES		3/0/0/3
Nature of Course	:G (Theory & Analytical)		
Pre requisites	NIL		
Course Objectives:			
1	To enable the students to understand pattern recognition theories, such as Bayes classifier, linear discriminant analysis.		
2	To enable the students to gain knowledge about state-of-the-art algorithms used in pattern recognition research.		
3	To enable the students to identify various models and apply non-parametric techniques		
4	To allow students to understand and analyze neural networks in pattern recognition		
Course Outcomes:			
Upon completion of the course, students shall have ability to			
C937.1	Demonstrate knowledge on design principles of pattern recognition		[R]
C937.2	Understand the concepts of statistical pattern recognition		[U]
C937.3	Analyse the various Pattern Recognition models.		[AN]
C937.4	Apply the non parametric techniques in pattern Recognition in real time applications.		[AP]
C937.5	Analyse the various parametric estimation method in mathematical approach		[AN]

C937.6	Apply training and learning process involved in neural networks	[AP]
Course Contents:		
INTRODUCTION AND STATISTICAL PATTERN RECOGNITION		
Basics of pattern recognition – Design principles of pattern recognition system – Learning and adaptation – Pattern recognition approaches. Mathematical foundations: Linear algebra – Probability theory – Expectation – Mean and Covariance – Normal distribution – Multivariate normal densities – Chi square test of hypothesis. Statistical Patten Recognition: Bayesian Decision Theory – Classifiers – Normal density and discriminant functions.		
MODELS AND NON PARAMETRIC TECHNIQUES		
Parameter estimation methods: Maximum-Likelihood estimation – Bayesian Parameter estimation – Dimension reduction methods – Principal Component Analysis (PCA) – Fisher Linear discriminant analysis – Expectation – maximization (EM) – Hidden Markov Models (HMM) – Gaussian mixture models. Nonparametric Techniques: Density Estimation – Parzen Windows – K-Nearest Neighbor Estimation – Nearest Neighbor Rule – Fuzzy classification.		
NEURAL PATTERN RECOGNITION		
Introduction to Neural networks—Feedforward Networks and training by Back Propagation—Content Addressable Memory Approaches and Unsupervised Learning in Neural PR.		
Total Hours:		45
Text Books:		
1	Richard O. Duda, Peter E. Hart and David G. Stork, “Pattern Classification”, 2Nd Edition, John Wiley, 2012.	
2	Bishop, Christopher M., “Pattern Recognition and Machine Learning”, 1St Edition, Springer, 2011.	
3	Robert Schalkoff, “pattern Recognition: statistical, structural and neural approaches”, JohnWiley & sons , Inc, 2014.	
Reference Books:		
1	Chen C H, “Handbook of pattern recognition and computer vision”4thedition world scientific co, Pvt. Ltd., 2010	
2	Geoff Dougherty, “Pattern Recognition and classification: An introduction”, Springer 2013.	
3	S. Theodoridis, K. Koutroumbas, “Pattern Recognition”, 4thEdition, Academic Press, 2009.	
Web References:		
1	http://gandalf.psych.umn.edu/~schrater/schrater_lab/courses/PattRecog07/PattRecog.html	
2	http://www.statgraphics.com/nonparametric-methods	
3	https://www.investopedia.com/terms/n/nonparametric-method.asp	
4	https://ubiquity.acm.org/article.cfm?id=985625	
Online Resources:		
1	https://lmb.informatik.uni-freiburg.de/lectures/spr	
2	https://link.springer.com/chapter/10.1007/978-1-4757-0450-1_1	

3	https://nptel.ac.in/downloads/117108048/			
4	https://www.worldscientific.com/worldscibooks/10.1142/1486			
Assessment Methods & Levels (based on Blooms' Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component	Marks	
C937.1	Remember	Quiz	3	
C937.2	Understand	Group Assignment	3	
C937.3	Analyse	Group Assignment	3	
C937.4	Apply	Group Discussion	3	
C937.5	Analyse	Class Presentation	3	
C937.6	Apply	Case Study	5	
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination[50 Marks]
	CIA1[10 Marks]	CIA2[10 Marks]	CIA3[10 Marks]	
Remember	40	10	10	10
Understand	60	40	40	40
Apply		30	30	30
Analyse	-	20	20	20
Evaluate	-	-	-	-
Create	-	-	-	-

18EC938	HIGH SPEED NETWORKS		3/0/0/3
Nature of Course	(G) Theory		
Pre requisites	18EC403 – Data Communication and Networks		
Course Objectives:			
1	To understand the concepts of ATM and frame relay		
2	To understand the congestion and traffic management strategies		
3	To learn the concepts behind TCP and ATM congestion control		
4	To provide an in depth knowledge of Integrated and Differentiated Services		
5	To understand the protocols for QoS support		
Course Outcomes:			
Upon completion of the course, students shall have ability to			
C938.1	Illustrate the concepts behind ATM and Frame relay networks		[U]
C938.2	Understand the concepts of high speed LAN and Ethernet		[U]
C938.3	Analyze the concepts & congestions associated with TCP and ATM		[AN]
C938.4	Examine the various traffic management strategies of ABR & GFR		[AN]
C938.5	Categorize queuing disciplines of Integrated and Differentiated Services		[AN]
C938.6	Explore the various protocols for improvement of QoS support		[U]
Course Contents:			
<p>HIGH SPEED NETWORKS AND TRAFFIC MANAGEMENT: Introduction -Frame Relay Networks – Asynchronous transfer mode – ATM Protocol Architecture, ATM logical Connection - ATM Cell – ATM Service Categories – AAL. High Speed LAN, Gigabit Ethernet, Distributed Queue Dual Bus (DQDB). TRAFFIC MANAGEMENT: Congestion - Effects of Congestion – Traffic Management – Congestion Control in Frame Relay - Congestion Control - Congestion Control in Packet Switching Networks.</p> <p>TCP AND ATM CONGESTION CONTROL: TCP Flow control – TCP Congestion Control – Retransmission – Timer Management – KARN's Algorithm – Window management – Performance of TCP over ATM -TCP over 3G/4G wireless networks. Traffic and Congestion control in ATM – Requirements – Traffic Management Frame work, Traffic Control – ABR traffic Management – ABR rate control. RM cell formats – ABR Capacity allocations – GFR traffic management - Exponential RTO back off – ATM attributes.</p> <p>SERVICE ARCHITECTURE & PROTOCOLS FOR QOS SUPPORT: Integrated Services Architecture – Approach, Components, Services - Queuing Discipline – FQ – PS – BRFQ – GPS – WFQ – Random Early Detection – Differentiated Services. Protocols For QOS Support: RSVP – Goals & Characteristics, Data Flow, RSVP operations – Protocol Mechanisms – Multiprotocol Label Switching – Operations, Label Stacking – Protocol details – RTP – Protocol Architecture – Data Transfer Protocol – RTCP.</p>			
Total Hours:			45
Text Books:			
1	William Stallings, "High Speed Networks and Internet", Second Edition, Pearson Education, 2014.		
2	Warland, PravinVaraiya, "High Performance Communication Networks", Second Edition, Jean Harcourt Asia Pvt. Ltd., reprinted 2009.		
Reference Books:			

1	IrvanPepelnjk, Jim Guichard, Jeff Aparcar, "MPLS and VPN architecture", Cisco Press, Volume 1 and 2, 2005.
2	Abhijit S. Pandya, Ercan Sea, "ATM Technology for Broad Band Telecommunication Networks", CRC Press, New York, 2007.
3	Thomas PÖtsch "Future Mobile Transport Protocols Adaptive congestion control for unpredictable cellular networks", Springer, 2016.
4	Tere Parnell "Building High speed Networks", Osborne/McGraw-Hill, 1999.

Web References:

1	http://www.informit.com/articles/article.aspx?p=101655&seqNum=4
2	https://fenix.tecnico.ulisboa.pt/downloadFile/3779571512047/Generic%20Framing%20Procedure.pdf
3	http://www.nptel.ac.in/courses/117101050/3

Online References:

1	https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-263j-data-communication-networks-fall-2002/
2	https://www.techopedia.com/definition/24244/high-speed-downlink-packet-access-hsdpa

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Tentative Assessment Component	Marks
C938.1	Understand	Quiz	2
C938.2	Understand	Assignment	3
C938.3	Analyze	Problem solving	3
C938.4	Analyze	Assignment	3
C938.5	Analyze	Case study	4
C938.6	Understand	Seminar	5

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment			End Semester Examination [50 marks]
	CIA-I [10 marks]	CIA-II [10 marks]	CIA-III [10 marks]	
Remember	30	20	10	20
Understand	50	40	50	50
Apply	-	-	-	-
Analyse	20	40	40	30
Evaluate	-	-	-	-
Create	-	-	-	-

18EC940	Neural Networks and Deep Learning	3/0/0/3
Nature of Course		
	C (Theory Conceptual)	
Pre requisites		
	NIL	
Course Objectives:		
1	To learn the basics of Neural Networks.	
2	To enable the students to understand the concepts of various Feed forward networks	
3	To study about Auto correlation, BAM, Vector Quantization, ART1, ART2, Kohonen's Self Organizing Map in advanced neural networks	
4	To present the mathematical, statistical and computational challenges of building neural networks	
5	To study the concepts of deep learning	
6	To introduce dimensionality reduction techniques	
Course Outcomes:		
Upon completion of the course, students shall have ability to		
C940.1	Understand knowledge of Neural Networks ,Models and Topologies	[R]
C940.2	Illustrate the operation various methods Feed forward networks	[U]
C940.3	Understand the concepts of Auto correlation, Hetero Correlation, Exponential BAM, Applications	[U]
C940.4	Understand the concepts of Vector Quantization, ART1, ART2, applications, Kohonen's Self Organizing Map.	[U]
C940.5	Understand basics of deep learning	[U]
C940.6	Implement various deep learning models and realign high dimensional data using reduction techniques	[AP]
Course Contents:		
<p>SIMPLE NEURAL NETS :Introduction to Artificial Neural Networks- biological motivation – Terminology – Models of neuron – Topology – characteristics of artificial neural networks – types of activation functions. Advanced Neural Networks . Learning Laws : Learning methods – error correction learning – Hebbian learning – Perceptron – XOR Problem – Perceptron learning rule convergence theorem – Adaline .Feed forward networks : Multilayer Perceptron – Back Propagation learning algorithm – Universal function approximation – Associative memory: auto association, hetero association, recall and cross talk</p> <p>ADVANCED NEURAL NETWORKS :Associative Memory: Auto correlation, Hetero Correlation, Exponential BAM, Applications. Adaptive Resonance Theory: Vector Quantization, ART1, ART2, applications, Kohonen's Self Organizing Map.</p>		

INTRODUCTION TO DEEP LEARNING : Linear models - Intro to Neural Nets- Training a network: loss functions, back propagation and stochastic gradient descent- Neural networks as universal function approximates; **DEEP NETWORKS** : History of Deep Learning- A Probabilistic Theory of Deep Learning- Backpropagation and regularization, batch normalization- VC Dimension and Neural Nets-Deep Vs Shallow Networks ; **DIMENSIONALITY REDUCTION** : Linear (PCA, LDA) and manifolds, metric learning - Auto encoders and dimensionality reduction in networks - Introduction to Convnet
CASE STUDY AND APPLICATIONS : Imagenet- Detection-Audio WaveNet-Natural Language Processing Word2Vec - Joint Detection BioInformatics- Face Recognition- Scene Understanding- Gathering Image Captions

Total Hours: **45**

Text Books:

1	Laurene Fausett, "Fundamentals Of Neural Networks-Architectures, Algorithms and Applications", Pearson Education, 2014.
2	A. Freeman and David.M.Skapura, "Neural Networks Algorithms, Applications and Programming Techniques ", Pearson Education , 2011.
3	Deng & Yu, "Deep Learning: Methods and Applications", Now Publishers, 2013.

Reference Books:

1	B.Yegnanarayana, "Artificial Neural Networks", Prentice – Hall of India, 2014
2	Rajasekaran and G.A.V. Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis and Applications", PHI, 2012
3	Ian Goodfellow, Yoshua Bengio, Aaron Courville, "Deep Learning", MIT Press, 2016.

Web References:

1	https://machinelearningmastery.com/what-is-deep-learning/
2	https://www.udemy.com/deeplearning/
3	https://nptel.ac.in/courses/117105084/
4	https://www.analyticsvidhya.com/blog/2018/10/introduction-neural-networks-deep-learning/

Online Resources:

1	http://neuralnetworksanddeeplearning.com/chap1.html
2	http://cs231n.stanford.edu/
3	https://www.technologyreview.com/s/513696/deep-learning/
4	https://www.edx.org/professional-certificate/ibm-deep-learning

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C940.1	Remember	Quiz	3
C940.2	Understand	Quiz	3
C940.3	Understand	Group Assignment	3

C940.4	Understand	Technical Seminar	3	
C940.5	Understand	Group Assignment	3	
C940.6	Apply	Case Study	5	
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination[50 Marks]
	CIA1[10 Marks]	CIA2[10 Marks]	CIA3[10 Marks]	
Remember	20	20	20	30
Understand	80	80	30	40
Apply			50	30
Analyse	-	-		
Evaluate	-	-	-	-
Create	-	-	-	-

18EC001	Sensors and Actuators		3/ 0 /0/3
Nature of Course	C (Theory)		
Pre requisites			
Course Objectives:			
1	Understanding the basic laws and phenomena on which operation of sensors and actuators		
2	To impart knowledge about the various types of sensors and actuators and its applications		
3	To know about the interfacing methods using sensors and actuators.		
Course Outcomes:			
Upon completion of the course, students shall have ability to			
C001.1	Understand the fundamental physical and technical base of sensors and actuators .		[U]
C001.2	Define the basic laws and phenomena that define the behaviour of sensors and actuators.		[R]
C001.3	Analyze the various premises, approaches, procedures and results related to sensors and actuators		[AN]
C001.4	Create analytical design and development solutions for sensors and actuators		[U]
C001.5	Apply the concepts of sensors and actuators to interface the circuits		[AP]
Course Contents:			
<p>Introduction: Classification of sensors and actuators, sensing and actuating strategies, general requirements for interfacing and actuation, sensing, transduction, actuation ,Performance Characteristics of Sensors and Actuators- Input/output characteristics, accuracy, errors, repeatability, sensitivity analysis, hysteresis, nonlinearity, saturation, frequency response, dynamic characteristics, calibration, resolution,excitation, impedance, applications.</p> <p>Types of sensors and actuators : Optical sensors, Temperature Sensors, IOT sensors, wireless sensors, Mechanical Sensors, Acoustic sensors, chemical sensors, Radiation sensors, Smart sensors, ASIC based sensors,Magnetic and Electromagnetic Motors as actuators (linear, rotational, stepping motors), magnetic valves, inductive sensors ,(eddy current, LVDT, RVDT, Proximity), Hall effect sensors, Magnetoresistive sensors and actuators, Magnetometers (fluxgate, search-coil, Squid), Voice coil actuators (speakers and speaker-like actuators), Electrorheological and magnetorheological actuators, Piezoelectric actuators, Piezoelectric resonators, Microphones, hydrophones, speakers, buzzers),(Micro-Electro-Mechanical (MEMs) Sensors and Actuators, Wireless Sensors and Issues Associated with Wireless Sensors, Sensor Arrays</p> <p>Interfacing Methods and Circuits: Amplifiers: operational amplifiers, power amplifiers, A/D and D/A converters, Bridge circuits, Interfacing to microprocessors, Data transmission, Excitation methods and circuits, Power requirements, Signal translation, Isolation, Noise, Interference, Compensation(temperature, drift, etc.) General requirements for sensors and actuators, Input signal conditioning (offset, scaling, isolation, hysteresis, etc.), Output signals (level, power, isolation, etc.), Driving methods (direct, PWM), Errors (A/D and D/A))</p>			
Total Hours:			45

Text Books:				
1	J. Fraden, .“AIP Handbook of Modern Sensors, Physics, Designs and Applications,.”American Institute of Physics.			
2	C.W. de Silva, .“Sensors and Actuators, CRC Press,			
3	R.S. Muller and T.I. Kamins, "Device Electronics for Integrated Circuits," John Wiley & Sons.			
Reference Books:				
1	L. Ristic, .“Sensor Technology and Devices,.” Artech House, Inc.			
2	R. Seippel, .“Transducers, Sensors and Detectors,.” ,Reston Publishing Company			
3	“Microsensors,.” Eddited by RS. Muller, R. Howe, etc., IEEE Press			
Web References:				
1	https://www.elsevier.com/journals/sensors-and-actuators-b-chemical/0925-4005/guide-for-authors			
2	https://www.sciencedirect.com/journal/sensors-and-actuators-a-physical			
3	http://technav.ieee.org/tag/1527/sensors-and-actuators			
Online Resources:				
1	https://www.imt.kit.edu/lectures_321.php			
2	https://nptel.ac.in/courses/112103174/3			
3	https://www.mdpi.com/journal/jsan			
Assessment Methods & Levels (based on Blooms' Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component		Marks
C001.1	Understand	Quiz		3
C002.2	Remember	case study		5
C003.3	Analyze	Problem Solving		3
C004.4	Understand	Group Assignment		5
C005.5	Apply	Problem solving		4
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination[50 Marks]
	CIA1[10 Marks]	CIA2[10 Marks]	CIA3[10 Marks]	
Remember	60	-	-	20
Understand	40	50	-	20
Apply	-	50	50	30
Analyze	-	-	50	30
Evaluate	-	-	-	-
Create	-	-	-	-

18EC002	TELE MEDICINE	3/0/0/3
Nature of Course		
	M Theory	
Pre - requisites		
Course Objectives:		
1	To enable the students understand the key principles for telemedicine and health	
2	To make student understand telemedical technology	
3	To enable the students with the knowledge of telemedical standards, mobile telemedicine and its applications.	
Course Outcomes:		
Upon completion of the course, students shall have ability to		

C002.1	Understand the concept of telemedical system.	[U]
C002.2	Apply the basic communication system and its tools in telemedical Instrumentation.	[AP]
C002.3	Apply hardware and software tools employed for data exchange.	[AP]
C002.4	Understand the logic for data security	[U]
C002.5	Apply communication in teleradiology	[AP]
C002.6	Analyse different applications of telemedicine	[AN]
Course Contents:		
<p>TELEMEDICINE AND TELEMEDICAL TECHNOLOGY - Functional diagram of telemedicine system, Telemedicine, Tele health, Tele care, Organs of telemedicine, Global and Indian scenario, Ethical and legal aspects of Telemedicine - Confidentiality, Social and legal issues, Safety and regulatory issues, Advances in Telemedicine, Principles of Multimedia - Text, Audio, Video, data, Communication infrastructure for telemedicine , Internet technology and telemedicine using world wide web (www), Video and audio conferencing, Clinical data –local and centralized.</p> <p>TELEMEDICAL STANDARDS AND MOBILE TELEMEDICINE - Standards to be followed DICOM, HL7, H. 320 series (Video phone based ISBN) T. 120, H.324 (Video phone based PSTN), Video Conferencing, Real-time Telemedicine integrating doctors / Hospitals, Clinical laboratory data, Radiological data, and other clinically significant biomedical data, Administration of centralized medical data, security and confidentiality of medical records and access control, Cyber laws related to telemedicine. Tele radiology-basic system, Tele pathology, multimedia databases, Medical information storage and management for telemedicine- patient information medical history, test reports, medical images diagnosis and treatment. Hospital information system - Doctors, paramedics, facilities available. Pharmaceutical information system.</p> <p>TELEMEDICAL APPLICATIONS -Telemedicine access to health care services – health education and self care, Introduction to robotics surgery, telesurgery,Telecardiology, Teleoncology, Telemedicine in neurosciences, Electronic Documentation, e-health services security and interoperability., Telemedicine access to health care services – health education and self care, Business aspects - Project planning and costing, Usage of telemedicine.</p>		
Total Hours:		45
Text Books:		
1	.Norris, A.C. Essentials of Telemedicine and Telecare. Wiley (ISBN 0-471-53151-0), 2002	
2	Wootton R. Craig, J., Patterson, V. (Eds.), Introduction to Telemedicine. Royal Society of Medicine Press Ltd (ISBN 1853156779), 2006	
3	O'Carroll, P.W, Yasnoff W.A., Ward E.Ripp, L.H., Martin, E.L. (Eds), Public Health Informatics and Information Systems. Springer (ISBN 0-387-95474-0), 2003	
Reference Books:		
1	Ferrer-Roca, O., Sosa-Iudicissa, M. (editors), Handbook of Telemedicine. IOS Press (Studies in Health Technology and Informatics, Volume 54). (ISBN 90-5199-413-3), 2002.	
2	Simpson, W. 2006. Video over IP. A practical guide to technology and applications. Focal Press (Elsevier). ISBN-10: 0-240-80557-7	
3	Bemmel, J.H. van, Musen, M.A. (Eds.) (1997). Handbook of Medical Informatics. Heidelberg, Germany: Springer. (ISBN 3-540-63351-0)	
Online Resources:		

1	https://www.virtual-college.co.uk/courses/healthcare-courses/introduction-to-telemedicine			
2	https://www.nurse.com/ce/telemedicine			
Web References:				
1	www.amdtelemedicine.com			
2	www.telemedicine.knet.ca			
3	www.biomedical-engineering-online.com			
Assessment Methods & Levels (based on Blooms' Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Tentative Component	Assessment	Marks (20)
C002.1 & C002.4	Understand	Quiz		10
C002.2, C002.3 & C002.5	Apply	Group Assignment		5
C002.6	Analyse	Simulation		5
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment [30 Marks]			End Semester Examination [50 Marks]
	CIA1 [10 Marks]	CIA2 [10 Marks]	CIA3 [10 Marks]	
Remember	20	20	10	10
Understand	40	40	40	40
Apply	40	40	30	30
Analyse	-	-	20	20
Evaluate	-	-	-	-
Create	-	-	-	-

18EC003	ARTIFICIAL INTELLIGENCE AND DEEP LEARNING	3/0/0/3
Nature of Course		
	:G (Theory & Analytical)	
Pre requisites		
	18MA101/ Linear algebra and calculus	
Course Objectives:		
1	To understand the fundamentals of Artificial Intelligence and Different Perspectives, Historical background.	
2	To understand different problem solving techniques in AI	
3	To learn to represent knowledge in solving AI problems	
4	Apply AI problem solving techniques, knowledge representation, and reasoning methods in Knowledge based systems	
5	To understand the basics about Neural Networks and mechanisms by which an AI system can improve its behavior through its experience.	
Course Outcomes:		
Upon completion of the course, students shall have ability to		

C003.1	To Understand the basics about AI and to learn the different search strategies in AI	[U]
C003.2	To understand the elements of constituting problems and learn to solve it by various uninformed and informed (heuristics based) methods.	[U]
C003.3	To understand formal methods for representing the knowledge and the process of inference to derive new representations of the knowledge	[R]
C003.4	To analyse and evaluate a first order system / computer based system process, component or program to meet desired needs	[AN]
C003.5	To understand the notion of uncertainty and some of probabilistic reasoning methods to deduce inferences under uncertainty	[AP]
C003.6	To understand the basics about Neural Networks and Multilayer Perception to Deep Neural Networks	[U]
Course Contents:		
<p>INTRODUCTION AND SEARCHING TECHNIQUES – Fundamentals and history of AI. AI Problems and techniques - searching for solutions – uninformed search strategies - Searching with partial information. Informed search and exploration – Informed search strategies – heuristic function – local search algorithms and optimistic problems- Game Playing, Minimax & Alpha-Beta Pruning Algorithm.</p> <p>KNOWLEDGE REPRESENTATION AND APPLICATIONS: Knowledge Based Agents, Example, Propositional Logic, Reasoning Patterns in Propositional Logic, Propositional Inference First order logic – representation revisited – Syntax and semantics for first order logic -Acting under uncertainty, Basic Probability Notation, Inference Using Full Joint Distribution, Independence, Bayes’s Rule and its Use.</p> <p>DEEP LEARNING: Introduction to Neural Networks -Multilayer Perception to Deep Neural Networks with Auto encoder- Auto encoders for Representation Learning and MLP Initialization-Stacked-Sparse-Denoising Auto encoders and Ladder Training .</p>		
Total Hours:		45
Text Books:		
1	Stuart Russell, Peter Norvig, “Artificial Intelligence – A Modern Approach”, 2nd Edition, Pearson Education / Prentice Hall of India, 2004.	
2	George F Luger, Artificial Intelligence, Pearson Education, 6th edition 2009.	
3	Good fellow, Y, Bengio, A. Courville, “Deep Learning”, MIT Press, 2016. S. Haykin, “Neural Networks and Learning Machines”,3e,Pearson, 2008	
Reference Books:		
1	Elaine Rich and Kevin Knight, “Artificial Intelligence”, 2 nd Edition, Tata McGraw-Hill, 2003.	
2	Patrick Henry Winston,” Artificial Intelligence”, Addison Wesley, Third edition, 2000	
3	Nils J. Nilsson, “Artificial Intelligence: A new Synthesis”, Harcourt Asia Pvt.	

	Ltd., 2000.			
Web References:				
1	https://www.sanfoundry.com/best-reference-books-artificial-intelligence/			
2	https://www.tutorialspoint.com/artificial_intelligence/			
3	https://thenextweb.com/artificial-intelligence/2017/09/10/glossary-basic-artificial-intelligence-terms-concepts/			
4	https://www.deeplearningbook.org/			
Online Resources:				
1	https://www.coursera.org/learn/machine-learning			
2	https://nptel.ac.in/courses/106105077/11			
3	https://www.coursera.org/learn/neural-networks-deep-learning			
Assessment Methods & Levels (based on Blooms' Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component		Marks
C003.1	Remember	Quiz		3
C003.2	Understand	Group Assignment		3
C003.3	Remember	Seminar		5
C003.4	Analyse	Problem Solving Assignment		3
C003.5	Apply	Assignment		3
C003.6	Understand	Quiz		3
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination[50 Marks]
	CIA1[10 Marks]	CIA2[10 Marks]	CIA3[10 Marks]	
Remember	20	30	30	20
Understand	40	30	10	30
Apply	40	40	30	30
Analyse	-	-	30	20
Evaluate	-	-	-	-
Create	-	-	-	-

18EC004	BRAIN COMPUTER INTERFACE AND ITS APPLICATIONS	3/0/0/3
Nature of Course :G (Theory)		
Pre requisites 18IT403- Artificial Intelligence and its Applications		
Course Objectives:		
1	Understand the basic concepts of brain computer interface	
2	Apply the various signal acquisition methods	
3	Learn about Neural networks signal processing methods used in BCI	
4	Understand the various machine learning methods of BCI	
5	Learn the various applications of BCI	
Course Outcomes: Upon completion of the course, students shall have ability to		
C004.1	Comprehend and appreciate the significance and role of this course in the present contemporary world.	[U]
C004.2	Evaluate concept of BCI	[R]
C004.3	Assign functions appropriately to the human and to the machine	[AN]
C004.4	Select appropriate feature extraction methods.	[U]
C004.5	Use machine learning algorithms for translation.	[AP]
C004.6	Apply BCI and classify the signals for in various real time applications	[AP]
Course Contents:		
<p>Introduction to BCI – Brain structure and function, Brain Computer Interface Types – Synchronous and Asynchronous- Invasive BCI- Partially Invasive BCI- Non Invasive BCI, Structure of BCI System, BCI Monitoring Hardware, EEG, ECoG, MEG, fMRI, Brain activation patterns – Spikes, Oscillatory potential and ERD, slow cortical potentials, Movement related potentials- Mu rhythms, motor imagery, stimulus related potentials, potentials related to cognitive tasks, Artifacts Removal.</p> <p>Feature Extraction Methods – Data Processing- spike sorting, Frequency Domain Analysis, Wavelet analysis, Time domain analysis, Spatial filtering – Principal Component Analysis (PCA), Independent Component Analysis (ICA), Artefacts reduction, Feature Extraction – Phase synchronization and coherence. Machine Learning Methods for BCI – Classification techniques – Binary classification, Ensemble classification, Multiclass Classification, Evaluation of classification performance, Regression – Linear, Polynomial, RBF's, Perceptron's, Multilayer neural networks, support vector machine, Learning Vector Quantization and Hidden Markov Modeling, Graph theoretical functional connectivity analysis</p>		

Application of BCI – Case studies – Invasive BCIs: Decoding and tracking arm (hand) position, controlling prosthetic devices such as orthotic hands, cursor and robotic controlling using multi electrode array implant, Cortical control of muscles via functional electrical simulation, Noninvasive BCIs; P300 Mind Speller, VisualCognitive BCI, Emotion detection. [Software Tools for BCI Research - Introduction – Data Streaming – Online DataProcessing](#)
Ethics of Brain Computer Interfacing.

Total Hours: 45

Text Books:

1	Rajesh.P.N.Rao, “Brain-Computer Interfacing: An Introduction”, Cambridge University Press, First Edition, 2013
2	Ella Hassianien, A&Azar.A.T (Editors), “Brain-Computer Interaces Current Trends and Applications”, Springer, 2015
3	Bernhard Graimann, Brendan Allison, GertPfurtscheller, “Brain-Computer Interfaces: Revolutionizing Human-Computer Interaction”, Springer,2010
4	Ali Bashashati, MehrdadFatourech, Rabab K Ward, Gary E Birch,” A survey of signal Processing algorithms in brain–computer interfaces based on electrical brain signals” JOURNAL OF NEURAL ENGINEERING”, vol. .4, pp. 32-57, 2007.

Reference Books:

1	Ali Bashashati, MehrdadFatourech, Rabab K Ward, Gary E Birch, “A survey of signal Processing algorithma in brain-computer interfaces based on electrical brain signals” Journal of Neural Engineering, Vol.4. 2007, PP.33-57
2	Arnon Kohen, “Biomedical Signal Processing”, Vol I and II, CRC Press Inc, Boca Rato, Florida
3	Andrew Webb, “Statistical Pattern Recognition”, Wiley International, Second Edition, 2002.
4	Special Issue on Brain Control Interfaces, IEEE Transactions on Neural Systems and Rehabilitation Engineering, Vol 14, June 2006

Web References:

1	https://sccn.ucsd.edu/wiki/Introduction_To_Modern_Brain-computer_Interface_Design
2	https://www.ncbi.nlm.nih.gov/pubmed/21438193
3	https://www.sciencedirect.com/science/article/pii/S1110866515000237

Online Resources:

1	https://www.edx.org/course/circuits-electronics-1-basic-circuit
2	https://onlinecourses.nptel.ac.in/noc18_cs40/preview

Assessment Methods & Levels (based on Blooms’Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom’s Level	Assessment Component	Marks
C004.1	Understand	Quiz	3
C004.2	Remember	Assignment	3
C004.3	Analyse	Group Assignment	3
C004.4	Understand	Seminar	3
C004.5	Apply	Group Assignment	3
C004.6	Apply	Case Study	5

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment			End Semester Examination [50 Marks]
	CIA1 [10 Marks]	CIA2 [10 Marks]	CIA3 [10 Marks]	
Remember	20	20	20	10
Understand	40	40	40	40
Apply	-	40	40	30
Analyse	40	-	-	20
Evaluate	-	-	-	-
Create	-	-	-	-

18EC005	WIRELESS WEARABLE SENSORS	3/0/0/3
Nature of Course : C (Theory Conceptual)		
Pre requisites : 18EC602 Embedded Systems and its Applications		
Course Objectives:		
1	To understand the basics for the need of Wearable Devices	
2	To understand the operation of wearable devices and mobile sensing	

3	To Learn how to use software programs to perform varying and complex tasks	
4	To Expand upon the knowledge learned and apply it to solve real world problems	
5	To apply the wearable algorithms for developing Wearable sensing	
Course Outcomes:		
Upon completion of the course, students shall have ability to		
C005.1	Understanding the fundamental concepts of Wearable devices	[U]
C005.2	Recall the operation of different types of wearable sensing devices.	[R]
C005.3	Apply the knowledge of wearable sensing technology in monitoring & tracking of physical parameters	[AP]
C005.4	Apply the body sensor technology to the physical activity of Biomechanical Sensing devices	[AP]
C005.5	Developing the models for Intra Body Communication devices	[AP]
C005.6	Designing a wearable implant devices with obtained knowledge of WSN	[AN]
Course Contents:		
<p>Wearable's: Fundamentals, Advancements and a Roadmap of the wearable sensing technology , Social Aspects of Wear ability and Interaction - Adoption of Innovation and Aesthetic Change , On-Body Interaction , Wearable Haptics , Categories of Wearable Haptic and Tactile Display ,Display of Friction and Weight Illusions Based on Fingertip Manipulation, A Wearable Sensorimotor Enhancer , Wearable Bio and Chemical Sensors , Challenges in Chemical Biochemical Sensing , Wearable Inertial Sensors and Their Applications,</p> <p>Mobile and wearable sensing : Overview of smart phone/wearable sensors , Accelerometer, gyroscope, magnetometer, Smartphone orientation and heading detection , Activity recognition and healthcare , Identifying human activities and context through sensors ,Health monitoring and fitness tracking ,Wearable's overview , Wrist-worn wearables, gesture and remote interaction, Sensor fusion in body-area networks,Application of Optical Heart Rate Monitoring ,Photoplethysmography Basics ,Measurement of Energy Expenditure by Body-worn Heat-flow Sensor , Biomechanical Sensing , Non-Invasive Sweat Monitoring by Textile Sensors, Smart Fabrics and Interactive Textile Platforms for Remote Monitoring , Qoven Electronic Textiles, Physical Activity Body Sensor Technology</p> <p>Future Trends of Wearable Algorithms: Channel Models for On-Body Communications , Establishment in Wireless Body Area Networks , Wireless Body Area Networks , Wearable Sensors for the Monitoring of Physical and Physiological Changes in Daily Life , Wearing Sensors Inside and Outside of the Human Body for the Early Detection of Diseases , Wearable and Non-Invasive Assistive Technologies , Wireless Tracking of Tongue Motion ,Detection and Characterization of Food Intake by Wearable Sensors , Signal Processing and Pattern-Recognition Methods for Automatic Detection of Food Intake , future trends in wearable and implantable sensor technology</p> <p>CASE STUDY: Wearable Event Device.</p>		
Total Hours:		45
Text Books:		
1	Edward Sazonov, Michael R. Neuman (editors), Wearable Sensors: Fundamentals, Implementation and Applications, 2014, Academic Press/Elsevier, , ISBN 978-1439892992	

2	Honbo Zhou, Internet of Things in the Cloud – A Middleware Perspective, 2012, CRC Press
3	Claire Rowland, Elizabeth Goodman, Martin Chaliar, Ann Light, Alfred Lui, Designing Connected Products: UX for the Consumer Internet of Things, 2015, O'Reilly Media, Inc, ISBN 978-1449372569

Reference Books:

1	Practical Electronics for Inventors, Third Edition,” by Paul Scherz and Simon Monk. 2016
2	Fundamentals of Wearable Computers and Augmented Reality, Second Edition by Woodrow Barfield 2015

Web References:

1.	https://www.sciencedirect.com/science/book/9780124186620
2.	https://pdfs.semanticscholar.org/.../4331017b99da992456c4a6e9b98bd2d54a41.pdf
3.	https://www.elsevier.com/books/wearable-sensors/sazonov/978-0-12-418662-0

Online Resources:

1.	https://www.slideshare.net/Funk98/wearable-electronics-in-healthcare
2.	https://www.csd.uoc.gr/~hy541/Lectures_files/Lectures_pdfs/CS541_Lecture1.pdf

Assessment Methods & Levels (based on Bloom’s Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom’s Level	Tentative Assessment Component	Marks
C005.1	Understand	Quiz	2
C005.2	Remember	Quiz	3
C005.3	Apply	Technical Seminar	3
C005.4	Apply	Group Assignment	3
C005.5	Apply	Design of Basic Wearable sensor	5
C005.6	Analyse	Mini Project –I	4

Summative assessment based on Continuous and End Semester Examination

Bloom’s Level	Continuous Assessment			End Semester Examination [50 marks]
	CIA-I [10 marks]	CIA-II [10 marks]	Term End Examination [10 marks]	
Remember	20	30	10	10
Understand	80	40	20	20
Apply	-	30	50	50
Analyse	-	-	20	20
Evaluate	-	-	-	-
Create	-	-	-	-

18EC006	POWER MANAGEMENT FOR IOT DEVICES	3/0/0/3
Nature of Course	:G (Theory & Analytical)	
Pre requisites	Basic Electronics	
Course Objectives:		
1	To understand the various energy sources and energy harvesting devices	
2	Learn about the various Piezoelectric materials	
3	Understand the various Power sources for WSN	
4	Learn about the applications of Energy harvesting systems.	
Course Outcomes:		
Upon completion of the course, students shall have ability to		
C006.1	Demonstrate knowledge of various energy harvesting devices	[U]
C006.2	Analyze various methods to minimize the power in SOC and IOT systems.	[AN]
C006.3	Understand the various power sources for WSN	[U]
C006.4	Display skills in applying the concepts of energy harvesting.	[AP]
Course Contents:		
<p>ENERGY HARVESTING SYSTEMS – Introduction-Energy sources – energy harvesting based sensor networks – photovoltaic cell technologies – generation of electric power in semiconductor PV cells – Piezoelectric materials – transducers – harvesters – microgenerators – strategies for enhancing the performance of energy harvesters.</p> <p>POWER MANAGEMENT – micro fabricated coils and magnetic materials – scaling – power maximations – micro and macro scale implementations. Non-linear techniques – vibration control & steady state cases- ldo- switching regulators-buckboost converters-energy measurements</p> <p>WIRELESS SENSORS - Power sources for WSN – Power generation – conversion – Harvesting micro electronic circuits – power conditioning and losses- harvesting for RF sensors and ID tags – powering wireless SHM sensor nodes- future of power management</p>		
Total Hours:		45
Text Books:		
1	M. Morris Mano, Michael D.Ciletti., "Digital Design",5 th Edition, Pearson education, 2013	
2	Donald D. Givone, "Digital principles and Design", 2004, McGraw Hill Education India Private Ltd., 29 th Reprint, 2016	
Reference Books:		
1	Internet of Things - Arshdeep Bahga, Vijay Madiseti	
Web References:		
1	https://www.design-reuse.com/articles/42705/power-management-for-iot-soc-development.html	
2	https://www.imgtec.com/blog/power-management-for-iot-devices/	

Online Resources:				
1	https://nptel.ac.in/courses/108108098/7			
Assessment Methods & Levels (based on Blooms' Taxonomy)				
Formative assessment based on Capstone Model (Max. Marks:20)				
Course Outcome	Bloom's Level	Assessment Component		Marks
C006.1	Understand	Quiz		5
C006.2	Analyse	Group Assignment		5
C006.3	Understand	Test		5
C006.4	Apply	Problem Solving		5
Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	Continuous Assessment			End Semester Examination[50 Marks]
	CIA1[10 Marks]	CIA2[10 Marks]	CIA3[10 Marks]	
Remember	20	20	10	10
Understand	40	40	40	40
Apply	40	40	30	30
Analyse	-	-	20	20
Evaluate	-	-	-	-
Create	-	-	-	-

