ಬಿ.ಎಂ.ಎಸ್. ತಾಂತ್ರಿಕ ಮಹಾವಿದ್ಯಾಲಯ, ಬೆಂಗಳೂರು

(ಸ್ವಾಯತ್ತ ವಿದ್ಯಾ ಸಂಸ್ಥೆ)

ಬುಲ್ ಟೆಂಪಲ್ ರಸ್ತೆ, ಬೆಂಗಳೂರು – ೫೬೦ ೦೧೯

BMS COLLEGE OF ENGINEERING

(Autonomous college under VTU)

BANGALORE-560019

ELECTRONICS & INSTRUMENTATION ENGINEERING

Scheme & syllabus

2014-2018
Core & Cluster Electives
(III-VIII Semesters)

SCHEME OF INSTRUCTION FOR THIRD SEMESTER

SL no.	Code	Course Title	Credits				
			L	T	P	S	Total
1	15MA3GCADM	Advanced Engineering Mathematics	3	1	0	0	4
2	15ES3GCLCA	Linear Circuit Analysis	3	1	0	0	4
3	15ES3GCAMC	Analog Microelectronics	3	0	1	2	6
4	15ES3GCDEC	Digital Electronics	3	0	1	2	6
5	15EI3DCMSI	Measurements & instrumentation	3	0	1	0	4
6	15EI3DCLST	Simulation Techniques	0	0	1	0	1
		Total	15	2	4	4	25

SCHEME OF INSTRUCTION FOR FOURTH SEMESTER

SL no.	Code	Course Title	Credits				
			L	T	P	S	Total
1	15MA4GCDMP	Discrete Mathematics and probability	3	1	0	0	4
2	15ES4GCAIC	Analog Integrated Circuits	3	0	1	2	6
3	15ES4GCMCS	Microcontrollers	3	0	1	2	6
4	15ES4GCCST	Control Systems	3	1	0	0	4
5	15ES4GCSAS	Signals and Systems	3	1	0	0	4
6	15EI4DCPCB	PCB Design	0	0	1	0	1
		Total	15	3	3	4	25

SCHEME OFINSTRUCTION FOR FIFTH SEMESTER

SL no.	Code	Course Title	Credits				
			L	T	P	S	Total
1	16EI5DCPCS	Process Control	3	0	1	2	06
2	16EI5DCSET	Sensors &Transducers	3	0	1	2	06
3	16EI5DCDSP	Digital Signal Processing	3	0	1	0	04
4	16EI5DC MFT	Electro -Magnetic field Theory	2	1	0	0	03
5	16EI5DCCST	Communication Systems	3	0	0	0	03
6	16EI5DE1XX	Department Elective- I	3	0	0	0	03
		Total	**17**	**1**	**3**	**4**	**25**

Department Elective I

Course Code	Course Title	L:T:P:S	Credits	Hours	CIE	SEE	Total
16**EI5**DE1OI	Laser and Optical Fiber Instrumentation	3:0:0:0	3	3	50	50	100
16**EI5**DE1PE	Power Electronics	3:0:0:0	3	3	50	50	100
16**EI5**DE1CP	OOPs using C++	3:0:0:0	3	3	50	50	100
16**EI5**DE1HD	Fundamentals of HDL	3:0:0:0	3	3	50	50	100

SCHEME OFINSTRUCTION FOR SIXTH SEMESTER

SL no.	Code	Course Title	Credits				
			L	T	P	S	Total
1	Data Acquisition and	16EI6DCDVI	3	0	1	2	06

	Virtual Instrumentation						
2	Algorithms & System Design	16EI6DCASD	3	0	1	2	06
3	Signaling and Communication in Process Automation	16EI6DCSAC	3	1	0	0	04
4	Analytical Instrumentation	16EI6DCANI	3	0	0	0	03
5	Department Elective-II	16EI6DC2XX	3	0	0	0	03
6	Cluster Elective – I	16XX6GE1XX	3	0	0	0	03
		Total	**18**	**1**	**2**	**4**	**25**

Department Elective-II

Course Code	Course Title	L:T:P:S	Credits	Hours	CIE	SEE	Total
16EI6DE2DP	Digital Image Processing	3:0:0:0	3	3	50	50	100
16EI6DE2CC	Control System Components	3:0:0:0	3	3	50	50	100
16EI6DE2DD	Digital System Design using VHDL	3:0:0:0	3	3	50	50	100
16EI6DE2BM	Biomedical Instrumentation	3:0:0:0	3	3	50	50	100
16EI6DE2OS	Operating System	3:0:0:0	3	3	50	50	100

Electrical Science Cluster Elective Group-I:

Semester: VI

Course Code	Course Title	L:T:P:S	Credits	Hours	CIE	SEE	Total
16**TE6** GE 1ES	Displays for Embedded Systems	3-0-0-0-	3	3	50	50	100
16**TE6** GE 1CN	Cryptography and Network Security	3-0-0-0	3	3	50	50	100
16ML6GE1BM	Bio-Mems	3-0-0-0	3	3	50	50	100
16ML6GE1FL	Fiber Optics and Laser Medicine	3-0-0-0	3	3	50	50	100
16EC6GE1DA	Data Structures and algorithm	3-0-0-0	3	3	50	50	100
16EC6GE1ST	Sensor Technology	3-0-0-0	3	3	50	50	100
16EC6GE1VT	VLSI Testing and Design for Testability	3-0-0-0	3	3	50	50	100
16EC6GE1PD	Physical Design	3-0-0-0	3	3	50	50	100
16EC6GE1PR	Probability & Random process	3-0-0-0	3	3	50	50	100
16EC6GE1AM	Advanced Microcontrollers & Applications	3-0-0-0	3	3	50	50	100
16EC6GE1NE	Nano Electronics	3-0-0-0	3	3	50	50	100
16EE6GE1EM	Electrical & Electronic Engineering Materials	3-0-0-0	3	3	50	50	100
16EE6GE1MT	Modern Control Theory (Except EE)	3-0-0-0	3	3	50	50	100
16EE6GE1EC	Electromagnetic Compatibility *(*Except EC and IT*)*	3-0-0-0	3	3	50	50	100
16EI6GE1II	Industrial IOT	3-0-0-0	3	3	50	50	100
16EI6GE1RT	Robotics	3-0-0-0	3	3	50	50	100

SCHEME FOR SEVENTH SEMESTER

Code		Course Title	Credits				Total Credits	Marks		
			L	T	P	S		CIE	SEE	Total
Fundamentals of VLSI		16EI7DCFVI	3	0	1	0	04	50	50	100
Automation in Process Control		16EI7DCAPC	3	0	1	2	06	50	50	100
Modern Control Theory		16EI7DCMCT	2	1	0	0	03	50	50	100
Department Elective – III	Industrial Instrumentation	16EI7DE3II	3	0	0	0	03	50	50	100
	Aircraft Instrumentation	16EI7DE3AI								
	Remote Sensing and Telemetry	16EI7DE3RT								
Cluster Elective – II	Computer Vision	16EI7GE2CV	3	0	0	0	03	50	50	100
	MEMs & Sensors	16EI7GE2MS								
Institutional Elective – I		16XX7IE1XX	3	0	0	0	03	50	50	100
Project for Community Service		16EI7DCPCS	0	0	3	0	03	50	50	100
TOTAL							25	350	350	700

SCHEME FOR EIGHTH SEMESTER

Course Title	Course Code	Credits				Total Credits	Marks		
		L	T	P	S		CIE	SEE	Total
Micro-sensing Networks for Sustainable Cities.	16EI8DCMNS	2	0	0	1	3	50	50	100
Project Management and Finance	16HS8GCPMF	2	0	0	1	3	50	50	100
Major Project	16EI8DCMPJ	0	0	10	0	10	150	150	300
Seminar based on Internship/Industrial Training	16EI8DCSMR	0	0	2	0	2	50	50	100
IPR and Cyber Law	16HS8GCIPL	2	0	0	1	3	50	50	100
Institutional Elective II	16XX8IE2XX	3	0	0	0	3	50	50	100
NSS/NCC/YOGA/SPORTS/PERFORMING ARTS	16HS8GEXXX	0	0	1	0	1	50	50	100

TOTAL	25	450	450	900

Course Title	ADVANCED ENGINEERING MATHEMATICS (Common to EC, TE, EE, IT, ML)				
Course Code	15MA3GCADM	Credits	4	L-T-P-S	3:1:0:0
CIE	100 Marks (50% weightage)	SEE	100 Marks(50% weightage)		

Prerequisites: Trigonometric formulas, methods of differentiation, methods of integration, partial derivatives, matrices, Fourier Series, Fourier Transforms

UNIT-I		9 hours

MATRICES

Introduction: Elementary row transformations, Echelon form of a matrix, rank of a matrix by elementary row transformations. Consistency of system of linear equations and solution.

Solution of a system of non-homogenous linear algebraic equations: Gauss elimination method, LU decomposition method, Gauss-Seidel method. Eigenvalues and eigenvectors of matrices. Reduction of a matrix to diagonal form.

(7L+2T)

Suggested Reading: Inverse of a matrix using Gauss-Jordan method. Largest eigenvalue and corresponding eigenvector using Rayleigh power method.

UNIT-II		**10 hours**

NUMERICAL METHODS

Solution of algebraic and transcendental equations: Newton-Raphson method.

Finite Differences and interpolation: Forward differences, backward differences. Newton-Gregory forward interpolation formula, Newton-Gregory backward interpolation formula, Lagrange's interpolation formula, Lagrange's inverse interpolation. Numerical integration: Simpson's $1/3^{rd}$, $3/8^{th}$ rule, Weddle's rule. Numerical solution of ordinary differential equations: Euler's modified method, Runge-Kutta method of fourth order**(8L+2T)**

Suggested Reading: Milne's method to solve ordinary differential equations. Solution of simultaneous differential equations by Runge-Kutta fourth order method.

UNIT-III		**10 hours**

PARTIAL DIFFERENTIAL EQUATIONS

Formation of Partial differential equations-elimination of arbitrary constants, elimination of arbitrary functions. Equations of first order- Solution of the linear equation $P\,p + Q\,q = R$ **(**Lagrange's partial differential equation).

Applications: One-dimensional heat equation and wave equation (without proof), Transmission line-telegraph equations, various possible solutions of these by the method of separation of variables.

(7L+3T)

Suggested Reading: Direct integration method, method of separation of variables, D'Alembert's solution of wave equation.

UNIT-IV		**9 hours**

COMPLEX ANALYSIS 1

Function of a complex variable, limits, continuity and differentiability of a complex valued function. Analytic functions, properties of analytic functions, Cauchy-Riemann equations in Cartesian and polar form, construction of analytic functions by Milne-Thomson method. Conformal mapping-Transformations: $w = z^2$ and $w = z + \frac{a^2}{z}$ $(z \neq 0)$.Bilinear transformations.

(7L+2T)

Suggested Reading: Standard transformations $w = c + z$, $w = cz$, $w = 1/z$, properties of bilinear transformations.

UNIT-V		**9 hours**

COMPLEX ANALYSIS 2

Complex integration: Line integral, Problems on line integral, Cauchy's theorem, Cauchy's integral formula.

Complex series: Taylor's series, Maclaurin's series and Laurent's series (without proof).

Zeros, Poles and Residues: Residue theorem (without proof). Evaluation of real definite integrals using residues.

(7L+3T)

Suggested Reading: Power series, radius of convergence. Removable and essential singularities, improper real integrals with singular points on real axis.

Applications: Use of harmonic function to a heat transfer problem. Analysing AC circuits, Current in a field- effect transistor.

Mathematics Lab

- Solution of system of algebraic equations using Gauss Seidel method.
- LU decomposition of matrices.
- Eigenvalues and eigenvectors of matrices.
- Largest eigenvalue, smallest eigenvalue and corresponding eigenvectors of a matrix.
- Solution of algebraic and transcendental equations using Newton- Raphson method.
- Numerical integration.
- Numerical solution of ordinary differential equations

Text books:

1.	Higher Engineering Mathematics, B.S. Grewal, 43rd edition, 2014, Khanna Publishers
2.	Advanced Engineering Mathematics, 5th edition, 2011, by Dennis G. Zill and Cullen, Jonesand Bartlett India Pvt. Ltd.

Reference books:

1.	Higher Engineering Mathematics, B.V. Ramana, 2007, Tata Mc. Graw Hill.
2.	Advanced Engineering Mathematics, Erwin Kreyszig, 10th edition Vol.1 and Vol.2, 2014, Wiley-India.
3.	Numerical Methods for Scientific and Engineering Computation. M.K. Jain, S.R.K Iyengar, R.K. Jain, 6th edition, 2010, New Age International (P) Limited Publishers

E Books	
1.	Engineering Mathematics, K. A. Stroud, Dexter J. Booth, Industrial Press, 2001 http://books.google.co.in/books/about/Engineering_Mathematics.html?id=FZncL-xB8dEC&redir_esc=y.
2.	Advanced Engineering Mathematics, P. V. O'Neil, 5th Indian reprint, 2009, Cengage learning India Pvt. Ltd.
3.	http://ocw.mit.edu/courses/mathematics/ (online course material)
Moocs	
1.	http://nptel .ac.in/courses.php?disciplineId=111
2.	https://www.khanacademy.org/
3.	https://www.class-central.com/subject/math (MOOCS) (4)E-learning: www.vtu.ac.in
4.	E-learning: www.vtu.ac.in
Course outcomes At the end of the course ,the student will have the ability	
CO1: To Obtain numerical solution a system of algebraic equations, algebraic and transcendental equations and ordinary differential equations.	
CO2: To Formulate boundary value problems involving one dimensional heat and wave equation.	
CO3: To Solve partial differential equations with appropriate boundary conditions using the method of separation of variables**.**	
CO4: To Construct analytic functions and simple conformal mappings.	
CO5: To Evaluate real and complex integrals using the calculus of residues.	

Course Title	**LINEAR CIRCUIT ANALYSIS**				
Course Code	**15ES3GCLCA**	**Credits**	**4**	**L-T-P-S**	**3-1-0-0**
CIE	**100 Marks (50% weightage)**	**SEE**	**100 Marks(50% weightage)**		

Prerequisites: Elements of Electrical Engineering ,Laplace transform, Engineering Mathematics I &II		
UNIT-I		[5+4]hours hours
Basic Concepts: Practical sources, Source transformations, Network reduction using Star Delta transformation, Loop and node analysis with linearly dependent and independent sources for DC and AC networks, Concepts of super node and super mesh.		
UNIT-II		**[8+6] hours**
Network Topology: Graph of a network, Concept of tree and co-tree, incidence matrix, tie-set, tie-set & cut- set schedules, Formulation of equilibrium equations, Principle of duality.		

Resonant Circuits:

Series and parallel resonance, frequency response of series and Parallel circuits, Q factor, Bandwidth

UNIT-III		**[7+6]hours**

Network Theorems :

Superposition, Reciprocity, Millman's, Thevinin's and Norton's theorems; Maximum Power transfer theorem

UNIT-IV		**[10+6] hours**

Transient behavior and initial conditions:

Behavior of circuit elements under switching condition and their representation, evaluation of initial and final conditions in RL, RC and RLC circuits

Review of Laplace transforms, Laplace Transformation & Applications, waveform Synthesis, initial and final value theorems, step, ramp and impulse responses, convolution theorem, solution of simple R-L, R-C, R-L-C networks for AC and DC excitations using Laplace transforms.

UNIT-V		**[6+2] hours**

Two port network parameters and State Variable analysis:

Definition of z, y, h and transmission parameters, modeling with these parameters, relationship between parameters sets. Writing state equations and solution using Laplace transforms.

Text books:

1.	"Network Analysis", M. E. Van Valkenburg, PHI / Pearson Education, 3rd Edition. Reprint 2002.
2.	"Networks and systems", Roy Choudhury, 2nd edition, 2006 re-print, New Age International Publications
3.	Theory and Problems of Electric Circuits (Schaum Series), 2nd Edition McGraw Hill

Reference books:

1.	"Engineering Circuit Analysis", Hayt, Kemmerly and Durbin,TMH 6th 2002
2.	"Network analysis and Synthesis", Franklin F. Kuo, Wiley Edition
3.	"Analysis of Linear Systems", David K. Cheng, Narosa Publishing House, 11th reprint, 2002
4.	"Circuits", Bruce Carlson, Thomson Learning, 2000. Reprint 2002

E Books

1.	Nptel.ac.in/courses/108105065- Networks signals and systems by Prof T.K. Basu, IIT Kharagpur
2.	Nptel.ac.in/courses/108102042- Circuit Theory by Prof Dutta Roy S.C, IIT Delhi
3.	www.electrodiction.com/circuit-theory

Moocs

1.	http://elearning.vtu.ac.in/06ES34.html
2.	https://www.coursera.org/course/circuits

Course outcomes

At the end of the course ,the student will have the ability

CO1: To **understand, define and explain** the concepts of loop and node analysis, network topology and resonant circuits
CO2: To **apply** the knowledge of Network theorems, Laplace transformation and state -space analysis to two port networks to obtain desired parameters
CO3: To **analyze** two port networks
CO4: To listen and comprehend audio/video lectures related to the course

Course Title	**ANALOG MICRO ELECTRONICS**				
Course Code	**15ES3GCAME**	**Credits**	**6**	**L-T-P-S**	**3-0-1-2**
CIE	**100 Marks (50% weightage)**	**SEE**	**100 Marks(50% weightage)**		

Prerequisites: Elements of Electronics Engineering		
UNIT-I		7 hours
Diodes: - Introduction **Limiting and clamping circuits** --- Limiter circuits, The Clamped capacitor or DC restorer . **Bipolar Junction Transistor (BJTs**):- Introduction, **Single stage BJT amplifiers** --- The basic structure , characterizing BJT Amplifiers, The common emitter amplifier **Frequency Response of the CE amplifier**---The 3 frequency bands, The high frequency response , The low frequency response.		
UNIT-II		**8 hours**
MOSFETS:- INTRODUCTION ,**Device structure and physical operation** ---- Device structure, operation with no gate voltage, creating a channel for current flow, Applying a small VDs, Operation as		

VDs is increased, Derivation of the id – V_{DS} relationship, The P- Channel MOSFET, Complementary MOS or CMOS, operating the MOS transistor in the subthreshold region .

Current voltage Characteristics---Circuit symbol, id – V_{DS} characteristics, characteristics of the P-Channel MOSFET

MOSFET Circuits at DC

The MOSFET as an amplifier and as a switch --- Large – signal operation , Graphical derivation of the transfer characteristic, operation as a switch, operation as a linear amplifier.

Biasing in MOS amplifier circuits---Biasing by fixing V_{GS}, Biasing by fixing V_G and connecting a resistor in the source , Biasing using a drain to gate feedback resistor, biasing using a current source.

UNIT-III		**7 hours**

Small – signal operation and models of MOSFETs---The DC bias point, the signal current in the drain terminal ,the voltage gain, separating dc analysis and the signal analysis, small signal equivalent circuit models, the trans conductance g_m, the T equivalent circuit model.

Single stage MOS amplifiers---The basic structure, characterizing amplifiers, The CS amplifier, The CS amplifier with a source resistance.

IC Biasing :– **Current sources, current mirror and current steering circuits**---
The basic MOSFET current source, MOS current steering circuits

Current mirror circuit with improved performance --- The Wilson current mirror

UNIT-IV				**7 hours**

Feedback:-

Introduction ,the general feedback structure, S**ome properties of negative feedback**---Gain density, bandwidth extension, noise reduction, reduction in non linear distortion, **The four basic feedback topologies**--- Voltage amplifiers, current amplifiers, transconductance amplifiers , practical feedback circuits for current series and voltage series feedback

UNIT-V		**7 hours**

Power Amplifiers:-

Introduction, The classification of output stages .

C**lass A output stage** – transfer characteristic, signal w/Fs, power dissipation, power conversion efficiency, transformer coupled power amplifiers, class B transformer coupled amplifier

Class B output stage – Circuit operation , transfer characteristic, power conversion efficiency, power dissipation, reducing crossover distortion, single supply operation

Class AB output stage – Circuit operation, output resistance

Power BJTs – Junction te**mperatur**e, thermal resistance, power dissipation versus temperature, transistor case and heat sink

This course shall include an assessment based on the **QEEE Phase IV** on 'Fundamentals of Small Signal Analysis' taught by Prof.Shanthi Pavan, IIT Madras

Text books:

1.	Microelectronic Circuits-Theory and applications by Adel S. Sedra and Kenneth C.Smith, Fifth Edition , (Oxford International Student Edition)
2.	Electronic Devices and Circuit Theory-Robert L.Boylestad and Louis Nashelsky

	(Pearson Education)
Reference books:	
1.	Electronic Devices and Circuits- Millman and Halkias, TMH
2.	Electronic Devices and Circuits- David A Bell - PHI 4th edition
E Books	
1.	www.pyroelectro.com/edu/analog
2.	http://freevideolectures.com/Course/3020/Circuits-for-Analog-System-Design
Moocs	
1.	https://www.mooc-list.com/course/electronic-systems-and-digital-electronics-uninettuno?static=true
2.	http://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-012-microelectronic-devices-and-circuits-spring-2009/
3.	Introductory Analog Electronics Laboratory (Spring 2007) by MIT Open Courseware | Reviews and Ratings
Course outcomes At the end of the course ,the student will have the	
CO1: Ability to **define, understand and explain** the structure, V-I characteristics, working and applications of analog electronic devices like diodes, Bipolar Junction Transistors(BJTs) and MOSFETs	
CO2: Ability to **apply** the knowledge of KVL and KCL to obtain voltage /current/waveform at different points in analog electronic circuits such as diode clippers, clampers, amplifiers using BJTs and MOSFETs, current sources, current mirrors, power amplifiers, feedback amplifiers	
CO3: Ability to **analyze** analog electronic circuits such as diode clippers, clampers, amplifiers using BJTs and MOSFETs, current sources, current mirrors, power amplifiers, feedback amplifiers etc. to obtain voltage /current/waveform at different points for given specifications	
CO4: Ability to **design** analog electronic circuits such as diode clippers, clampers, amplifiers using BJTs and MOSFETs, current sources, current mirrors, power amplifiers, feedback amplifiers for given specifications.	
CO5: Ability to **conduct experiments** using analog electronic components and electronic instruments to function as switch, regulator, clippers, clampers, small signal amplifiers, oscillators, power amplifiers	
CO6: Ability to engage in **self-study/independent study** to formulate, design, implement, analyze and demonstrate an application using analog electronic components through an **open ended experiment**	
CO7: Ability to engage in **self-study/independent study** to submit a seminar report and make an effective presentation on topics related to the course (e-waste management, www.deity.gov.in, Comparative study of components, preparing the specifications of components, verifying the data sheets, applications of analog electronics)	

Laboratory Experiment List

Sl No	Title of Experiments
1	Diode and Transistor as a switch.
2	Zener diode characteristics and Zener as regulator.
3	Diode clipping circuits- Single/Double ended.
4	Diode clamping Circuits - positive clamping/negative clamping.
5	BJT as RC coupled amplifier.
6	BJT as RC phase shift oscillator.
7	Crystal Oscillator.
8	Power Amplifier.
9	Open ended experiments.

Course Title	**DIGITAL ELECTRONICS**				
Course Code	**15ES3GCDEC**	**Credits**	**6**	**L-T-P-S**	**3-0-1-2**
CIE	**100 Marks (50% weightage)**	**SEE**	**100 Marks(50% weightage)**		

Prerequisites: Elements of Electronics Engineering		
UNIT-I		**8 hours**
Introduction: Review of Boolean algebra, logic gates. **Simplification of Boolean functions :** Three Variable K – Maps, Four Variable K – Maps, The Tabulation Method, Determination of Prime Implicants, Selection of prime implicants **Combinational Logic Circuits:** Introduction, Carry Look Ahead Adder, Parallel Adder, Decim Adder Code conversion, , Magnitude Comparator, Decoders, Multiplexers, Read Only memori (ROM), Programmable Logic Arrays(PLAs).		
UNIT-II		**7 hours**
Flip-Flops: The Basic Flip-flop circuit, Clocked Flip-flops, Triggering of Flip-flops: Master Slave Flip-Flops, Edge Triggered Flip Flops, Characteristic Equations.		
UNIT-III		**8 hours**
Sequential Logic Circuits: Shift Registers, Ripple Counters, Design of Synchronous Counters		
UNIT-IV		**8 hours**

Sequential systems: Analysis of Clocked Sequential circuits, State Reduction and Assignment, Design Procedure, Desig with State Equations		
UNIT-V		**8 hours**
Logic Families: Characteristic of Digital ICs, Transistor – Transistor Logic,Complementary MOS (CMOS) Logic, Comparison of TTL and CMOS families		
This course shall include assessments based on the QEEE Phase IV lecture on 'Nitty Gritty of Log Gates to Processor Design' by Prof. Ashok Jhunjhunwala, IIT Madras (based on the topics Log Gates to Execution Unit Design, ALU design)		
Text books:		
1	Digital Logic and Computer Design- M. Morris Mano, Prentice Hall – Pearson Education	
2	Fundamental of Logic Design- Charles Roth Jr., Thomas Learning	
Reference books:		
1	Digital Principles and Design- Donald Givone, Tata Mc Graw Hill	
2	Digital Logic Applications and principles- John Yarbrough, Pearson Education	
E Books		
1.	http://www.free-engineering-books.com/2014/11/digital-fundamentals-by-thomas-l-floyd.html	
2.	https://books.google.co.in/books/about/Fundamentals_of_Digital_Circuits.html?id=BOVkrtiLUcEC	
Moocs		
1.	http://freevideolectures.com/blog/2010/11/130-nptel-iit-online-courses/	
2.	http://freevideolectures.com/Course/2319/Digital-Systems-Design#	
3.	www. Pyroelectrom.com/edu	
4.	Nptel.ac.in/courses/117106086	
5.	http://nptel.ac.in/courses/117105080	
6.	**Digital Circuits and Systems** Youtube - S. Srinivasan, IIT Madras	
7.	**Digital Integrated Circuits** Youtube - AmitavaDasgupta, IIT Madras	
Course outcomes At the end of the course ,the student will have the		
CO1: Ability to **understand, define and explain** the fundamental concepts of Digital circuits		
CO2: Ability to **apply** the knowledge of digital circuit concepts (Boolean Algebra, K-Maps and Quine-McClusky method) to optimize a digital circuit for the given parameter (number of gates, time delay, power consumption, cost)		
CO3: Ability to **analyze** digital circuits and arrive at suitable conclusions		
CO4: Ability to **design** a digital circuit for given specifications		
CO5: Ability to **conduct experiments** using digital ICs for a given application/problem statement		
CO6: Ability to engage in **self-study** to formulate, design, implement, analyze and demonstrate an application of digital electronic circuits through an **open ended experiment**		
CO7: Ability to engage in **self-study** to deliver a **seminar** on topics related to the course accompanied by a seminar report (www.deity.gov.in, Comparative study of components, preparing the specifications of components, verifying the data sheets, applications of digital ICs, the characteristics/specifications of different digital ICs, etc)		

Laboratory Experiment List

Sl.No	Title of the Experiments
1	Applications of IC 7483 (Adders, Subtractors and Comparators)
2	Multiplexers (using Gates and IC) and their applications
3	Decoders/DeMultiplexers (using Gates and IC) and their applications
4	BCD to Decimal decoder using 7-segment display
5	Verification of MSJK Flip-flop (using Gates and IC 7476)
6	Asynchronous counters (using ICs 7476,7490,7493)
7	Synchronous Counters (using ICs 7476, 74190/74192)
8	Shift registers and their applications (using ICs 7476, 7495)

Course Title	**MEASUREMENTS AND INSTRUMENTATION**				
Course Code	**15EI3DCMSI**	**Credits**	**04**	**L-T-P-S**	**3-0-1-0**
CIE	**100 Marks (50% weightage)**	**SEE**	**100 Marks(50% weightage)**		

Prerequisites: Elements of Electronics Engineering		
UNIT-I		6 hours
(a) **Performance Characteristics-** Static & Dynamic, Measurement Errors: Gross errors and systematic errors, Absolute and relative errors. (b) **Electrical Measuring Instruments:** Types of instruments, PMMC type, Dynamometer type Wattmeter, Induction type energy meter, Constructional features & Principle of operation, shunts and multipliers, universal shunt, Multi range voltmeter, Calibration of instruments, Construction and working of current and potential transformer.		
UNIT-II		**8 hours**
Electronic Instruments: AC voltmeter using Rectifiers – Half wave and full wave, Peak responding and True RMS voltmeters. Digital voltmeter - ramp type, integrating type, successive approximation type, Resolution and sensitivity, General specifications, Digital multimeter, Digital frequency meters, Digital measurement of time.		
UNIT-III		**7 hours**

a) **Resistance Measurement:** Wheatstone bridge, arrangement of ratio arms, sensitivity, limitations, errors, null type and deflection type, calibration adjustment, Kelvin bridge, Kelvin double bridge

b**) Inductance and Capacitance Measurement:** Maxwell's bridge: design and applications, Schering bridge: design and applications, sources and detectors, shielding of bridges.

UNIT-IV		**7 hours**

Inductive, capacitive, optical, Sensors and limit switches

Introduction to sensors and its classification. Inductive proximity sensors and its working principle. Different types like flush, non-flush, ring type. Various industry applications (like end travel sensing, metal sensing). Capacitive type proximity sensors and its working principle, various industry applications (like rice mill etc.,) Limit switches and its industry applications (like dead stop). Photo sensors (diffused beam, through beam, slotted sensor) working principle and industry application.

Laser, Ultrasonic, Radar type Sensors for distance and level measurement

Ultrasonic sensor for distance and level measurement (ON/OFF type, Analog type). Laser and Radar sensor for distance and level measurement with its industrial use application. Advantage and disadvantages. Conventional conductive sensor used in water tanks for level measurement. Light curtains for industrial safety.

UNIT-V		**8 hours**

Oscilloscopes: Introduction, Basic principles, CRT features, Block diagram and working of each block, Typical CRT connections, Dual beam and dual trace CROs, Measurement of voltage, frequency and phase, Digital storage oscilloscope, Power scopes

Signal analyzers: Wave analyzers, harmonic distortion analyzer, Basic spectrum analyzer. Introduction to Virtual Instrumentation.

Laboratory Experiments:

1. Testing of Current Transformer (CT) by Silsbee method.
2. To measure the unknown resistance using Wheatstone's Bridge and Kelvin's Bridge
3. To measure unknown Inductance and Capacitance using Maxwell's and Schering bridge.
4. Study the principle of operation of LVDT, plot the performance characteristic and its application in displacement of hydraulic cylinder
5. Study of Strain gauge and Load cell by plotting the performance characteristics, understand its operation and application in Industrial Weighing Belt (using Load cell)
6. Study of Ultrasonic sensor, its working principle through plotting of performance characteristics, to learn teach mode and to determine the dead band, range of a given sensor
7. To study the role of Laser sensor in the measurement of distance, plot its performance characteristics and its application in AC/ DC Motor speed control.
8. To study the working, principle of operation of Encoder (Counts vs Angle, Distance vs Count using Screw (given the pitch)) and its application in Industry Table Control using

DC motor and Impulse Counter (Eg: Bottle filling unit)

9. To explore the applications of various sensors. (For ex. Inductive Proximity in End limit of a Crane, Capacitive Proximity in Silo level using Rice/ wheat, Limit Switches, Diffused beam in Conveyers, Slotted Sensor in Measurement of an angle, Through beam Sensor in application of a counter etc.)

Text books:

1.	"Electronic Instrumentation", H. S. Kalsi, TMH, 2004
2.	"Electronics & Electrical Measurements", A K Sawhney, Dhanpat Rai & sons, 9th edition

Reference books:

1.	"Modern Electronic Instrumentation and Measuring Techniques", Cooper D & A D Helfric PHI, 1998.
2.	. "Electronic Instrumentation and Measurements", David A Bell, PHI / Pearson Education, 2006
3.	"Transducers and Instrumentation", D. V. S. Murthy, Prentice-Hall Of India Pvt. Limited, 2004

E Books

1.	http://www.nptel.ac.in/courses/Webcourse-contents/IIT%20Kharagpur/Basic%20Electrical%20Technology/pdf/L-42(GDR)(ET)%20((EE)NPTEL).pdf
2.	http://www.freeengineeringbooks.com/Instrumentation/Instrumentation-Engineering-Ebooks.php
3.	http://www.vitorrent.me/search/ak+sawhney+instrumentation+and+measurement+pdf

Moocs

1.	http://nptel.iitg.ernet.in/courses/Elec_Engg/IIT%20Madras/Electrical%20and%20Electronic%20Measurements%20(Video).htm
2.	http://freevideolectures.com/Course/2345/Industrial-Automation-and-Control/3

Course outcomes

At the end of the course ,the student will have the

CO1: Ability to define the performance characteristics and explain the concepts of electrical & electronic instruments used for measuring electrical quantity.

CO2: Ability to derive the balance equations of DC / AC bridges and apply the same to find unknown values of R, L, C.

CO3: To understand the classification of sensors and their applications.

CO4: To understand the functional operation of oscilloscopes, signal analyzers and its applications.

CO5: Identify, formulate and solve problems related to measurements.

Course Title	SIMULATION TECHNIQUES				
Course Code	15EI3DCLST	Credits	01	L-T-P-S	0-0-1-0
CIE	100 Marks (50% weightage)	SEE	100 Marks(50% weightage)		

EXPERIMENTS	
1.	Introduction: The MATLAB Environment, MATLAB as a calculator, Syntax and Semantics, Help, Plotting, Publishing. Introduction to matrices and operators, the colon operator, accessing parts of a matrix, combining matrices, Arithmetic operations, operator precedence.
2.	Introduction to functions, function I/O, definitions of functions, scope, advantages, scripts, File I/O, MAT files, excel files, text files, binary files.
3.	Solution of mesh current and node voltage equations using matrix operations.
4.	Solution of first order and second order differential equations. Obtain the transient response of first order and second order systems.
5.	Introduction: Simulink as a Tool box, steps involved in creating system models using the simulink Library, solver selection, creating model hierarchy.
6.	Introduction to PSpice, Basic DC Analysis, Transient Analysis Basics, Advanced Probe Functions, Frequency Analysis, Parametric Analysis.
7.	Obtain the transient response of first order and second order systems using PSpice.
8.	Solution of branch currents & voltages for a given circuit by applying KCL and KVL.
Course outcomes At the end of the course, the student will have the Ability to	
1.	**CO1:** Navigate the MATLAB user interface, enter commands, Create access, modify, perform calculations, and visualize matrix data and customize plots.
2.	**CO2:** Ability to import data from files, write and debug scripts and create functions.
3.	**CO3:** To explore the use of Simulink in design and analyzing models.
4.	**CO4:** Ability to identify, select and analyze electric circuits by performing simulations using PSpice.

Course Title	Discrete Mathematics And Probability	Course Code	15MA4GCDMP
Credits	04	L – T – P- S	3 – 1 – 0 – 0
Contact hours	48 hours (36L+12T)	ECE/EEE/IT/ML/TCE	

Prerequisites:
Basic concepts of set theory, relations and functions. Matrices. Basic concepts of probability, addition theorem, conditional probability, Bayes' theorem, discrete random variable, Binomial

distribution

UNIT-I		12 hours

SET THEORY AND RELATIONS

Introduction to sets and subsets, operations on sets, laws of set theory. Duality, Principle of duality for the equality of sets. Countable and uncountable sets. Addition Principle.

Introduction to Relations. Definition, Types of functions, operations on relations, matrix representation of relations, composition of relations, properties of relations, equivalence relations, partial orders, Hasse diagram. Posets- extremal elements on posets.

(9L+3T)

Suggested Reading: Some particular functions- Floor and ceiling functions, Projection, Unary and Binary operations.

UNIT-II		10 hours

ALGEBRAIC STRUCTURES- Groups, properties of groups. Some particular groups- The Klein 4-group, additive group of integers modulo *n*, multiplicative group of integers mod *p*, permutation groups. Subgroups, Cyclic groups, Coset decomposition of a group, homomorphism, isomorphism.

(7L+3T)

Suggested Reading: Lagrange's theorem and its consequences.

UNIT-III		9 hours

GRAPH THEORY

Basic concepts: Types of graphs, order and size of a graph, in-degree and out-degree, connected and disconnected graphs, Eulerian graph, Hamiltonain graphs, subgraphs, dual graphs, isomorphic graphs. Matrix representation of graphs: adjacency matrix, incidence matrix. Trees: spanning tree, breadth first search. Minimal spanning tree: Kruskal's algorithm, Prim's algorithm, shortest path-Dijkstra's algorithm.

(7L+2T)

Suggested Reading: Konigsberg bridge problem, Utility problem.

UNIT-IV		8 hours

PROBABILITY

Theoretical distributions: Poisson distribution, Normal distribution: Error function, Central limit theorem.

Two dimensional random variables: Discrete random variable, Mathematical expectation, Covariance and Correlation. **(6L+2T)**

Suggested Reading: Exponential distribution, Uniform distribution. Continuous two dimensional random variables.

UNIT-V		9 hours

MARKOV CHAIN AND QUEUING THEORY

Markov Chain, Probability vectors, stochastic matrices, fixed point vector, regular stochastic matrices. Higher transition probabilities, stationary distribution of regular Markov chains.

Queuing models: Concept of Queue, M/M/1 queuing systems.

(7L+2T)

Suggested Reading: Power supply model, Economic cost profit model.

Mathematics Lab

• Probability distributions

• Minimal spanning tree- Kruskal's algorithm, Prim's algorithm. • Shortest Path- Dijkstra's algorithm	
Text books:	
1.	Discrete Mathematical Structures, Dr. DSC, 4th edition, 2011-12, Prism Engineering Education Series.
2.	Higher Engineering Mathematics, B.S. Grewal, 43rd edition, 2013, Khanna Publishers.
3.	Discrete Mathematics, Seymour Lipschutz. M. Lipson, 2005, Tata Mc Graw Hill.
Reference books:	
1.	Higher Engineering Mathematics, B.V. Ramana, 2007, Tata Mc. Graw Hill.
2.	Discrete Mathematics, J K Sharma, 3rd edition, 2013, Macmillan India Ltd.
3.	Queuing Theory and Telecommunications, Networks and applications, Giovanni Giambene, 2005, Springer
4.	Data Networks, Dimitri Bertsekas, Robert Gallager, 2nd edition, 1992, Prentice India
5.	Schaum's Outline of Probability and Statistics, John J Schiller, Murray R Speigel, 4th edition, 2013, Schaum's Outlines
E Books	
1.	Discrete Mathematics for Computer Science, Gary Haggard, John Schlipf, Sue Whitesides, Thomson Brooks/Cole, 2006
2.	http://www.khanacademy.org/math/probability/random-variablestopic/random_variables_prob_dist/v/random-variables
3.	http://ocw.mit.edu/courses/mathematics/ (online course material)
Moocs	
1.	www.nptelvideos.in/2012/11/discrete-mathematical-structures.html
2.	www.cs.berkeley.edu/~daw/teaching/cs70-s05
3.	https://www.khanacademy.org/
Course outcomes At the end of the course ,the student will have the ability to	
CO1: Understand the notation of set theory, relations and functions.	
CO2: Construct a Hasse diagram for partial orderings, Use many terms associated with graphs and prove whether two graphs are isomorphic.	
CO3: Obtain the probability of an event using discrete and continuous distributions, including the n-step transition probability.	
CO4: Analyse and classify simple states (recurrent/transient)	
CO5: Understand, derive and apply the properties of the M/M/m queuing model (properties like stationary probability, average waiting and system time, expected number of customers in the queue)	

Alternate Assessment Tool: 20% of CIE marks for the lab.

Question Paper Pattern

1. Each unit consists of one full question.
2. Each full question consists of three or four subdivisions.
3. Five full questions to be answered.

4. Internal choice in unit 2 and unit 3.

Course Title	ANALOG INTEGRATED CIRCUITS				
Course Code	15ES4GCAIC	Credits	6	L-T-P-S	3-0-1-2
CIE	100 Marks (50% weightage)	SEE	100 Marks (50% weightage)		

Prerequisites: Elements of Electronics Engineering, Analog Microelectronics		
UNIT-I		**8 hours**
Operational Amplifier Characteristics: Introduction, DC Characteristics, AC Characteristics, Analysis of data sheets of an OP-AMP **Operational Amplifier Applications:** Review of basic Opamp applications, Instrumental Amplifier, V to I and I to V converter, Op-amp circuits using Diodes – Half wave rectifier, Full wave rectifier, Sample and hold circuit, Multiplier and Divider.		
UNIT-II		**7 hours**
Comparators and Waveform Generators: Introduction, comparator, Regenerative comparator (Schmitt Trigger), Square wave generator (Astable Multivibrator), Monostable Multivibrator, Triangular wave generator. (RC and wein bridge oscillators only)		
UNIT-III		**7 hours**
Voltage Regulators: Introduction, Series op-amp regulator, IC Voltage regulators, 723 General purpose Regulator, Switching Regulator. **Active Filters:** Introduction, RC Active Filters, First order low pass filter, second order active filter, Higher order low pass filter, High pass active filter, All pass filter-phase shift lead and lag circuit		
UNIT-IV		**7 hours**
Timers : Introduction to 555 timer, Description of Functional diagram, monostable operation, astable operation. **Phase locked loops** : Introduction, Basic principles, phase detector/comparator, voltage controlled oscillator (VCO)		
UNIT-V		**7 hours**
D-A and A-D Converters: Introduction, Basic DAC Techniques- Weighted Resistor DAC, R-2R Ladder DAC. A-D Converters: Direct type ADCs- The parallel Comparator (Flash) A/D converter, Successive Approximation Converter, DAC/ADC Specification, Sigma – delta ADC		

Text books:	
1.	Linear Integrated Circuits-D.Roy Choudhury & Shail B.Jain (New age Publication)
2.	Op-Amps and Linear Integrated Circuits- Ramakanth A.Gayakwad,4th ed,PHI
Reference books:	
1.	Linear Integrated Circuits-S.Salivahanan & V.S.Kanchana Bhaaskaran (Tata McGraw-Hill Publication)
2.	Opamps and Linear ICs-David A.Bell (Prentice-Hall Publications)

E Books	
1.	http://freevideolectures.com/Course/2321/Electronics-for-Analog-Signal-Processing-I
2.	http://freevideolectures.com/Course/2322/Electronics-for-Analog-Signal-Processing-I
Moocs	
1.	http://ocw.tudelft.nl/courses/microelectronics/analog-integrated-circuit-design/course-home/
2.	Introductory Analog Electronics Laboratory (Spring 2007) by MIT Open Courseware | Reviews and Ratings
3.	http://www.pannam.com/blog/free-resources-to-learn-electrical-engineering/

Course outcomes

At the end of the course ,the student will have the

CO1: Ability to **define**, **understand** and **explain** the DC and AC performance characteristics of Opamp, applications of Opamp, working of 555 timer and voltage regulators.

CO2: Ability to **apply** the knowledge of KVL and KCL to **obtain** voltage /current/waveform at different points in analog electronic circuits such as Opamp amplifiers, rectifiers, filters, waveform generators, PLL, data converters, regulators, comparators ,555 timers

CO3: Ability to **analyze** analog electronic circuits such as Opamp amplifiers, rectifiers, filters, waveform generators, PLL, data converters, regulators, comparators ,555 timers etc.to **obtain** voltage /current/waveform at different points that meet desired specifications .

CO4: Ability to **design** analog electronic circuits such as Opamp amplifiers, rectifiers, filters, waveform generators, PLL, data converters, regulators, comparators ,555 timers etc. that meet desired specifications

CO5: Ability to c**onduct experiments** using analog electronic components, electronic instruments to function as amplifiers, comparators, rectifiers, filters, astable and monostable circuits using 555 ,data converters

CO6: Ability to engage in **self-study/independent study** to formulate, design, implement, analyze and demonstrate an application using analog electronic components/ASLK/Multisim through a **mini-project** and submit the mini-project and make an oral presentation of the work

Laboratory Experiments List

Sl.No	Title of the Experiments
1	Inverting and non- inverting amplifier, voltage follower
2	Inverting and non- inverting summing Amplifier
3	Differentiator and integrator
4	Precision half wave and full wave rectifier
5	Zero crossing detector and Schmitt trigger

6	Weinbridge Oscillator
7	First order active low pass filter
8	First order active high pass filter
9	555 as astable multivibrator
10	555 as monostable multivibrator
11	IC 723 as low voltage and high voltage regulators
12	D to A convertor
13	A to D convertor
14	Clipping Circuits
15	Clamping Circuits

Course Title	MICROCONTROLLERS				
Course Code	15ES4GCMCS	Credits	6	L-T-P-S	3-0-1-2
CIE	100 Marks (50% weightage)	SEE	100 Marks (50% weightage)		

Prerequisites: Elements of Electronics Engineering, Digital Electronics		
UNIT-I		**7 hours**
INTRODUCTION TO MICROCOMPUTER AND MICROCONTROLLER: Introduction to Microprocessors, Internal organization of computer- Bus Structures, Harvard & Von-Neumann CPU architecture, **The 8051 Architecture:** Introduction, 8051 Microcontroller Hardware, Input / Output Pins, External Memory Interface.		
UNIT-II		**8 hours**
MICROCONTROLLER PROGRAMMING Instruction set architecture-RISC & CISC CPU Architectures, Pipelining, Execution of an instruction, Addressing Modes and Instruction set. Example Demonstration using 8051 instruction set, Data transfer instructions, Arithmetic instructions, Logical instructions, Branching and Subroutines, Example programs.		
UNIT-III		**8 hours**
CONCEPTS OF EMBEDDED 'C' PROGRAMMING: Data types, examples in 8051 C, program structures, logical operations, Memory and I/O access, Programming peripherals (Examples: Timer / Counter), Programming serial communication (serial data input/output) - example programs using 8051		
UNIT-IV		**7 hours**
INTERRUPTS AND INTERRUPT PROGRAMMING: Concept of Interrupts, Interrupts in 8051. Programming Timer Interrupts, Programming External Hardware Interrupts, Programming Serial Communication Interrupts		
UNIT-V		**6 hours**
INTERFACING AND APPLICATIONS: Interfacing 8051 to LCD, DAC, ADC Stepper motor interfacing. Applications of microcontrollers		

List of laboratory experiments

Part A: Data Transfer, Logical-Byte/Bit manipulations, Jump and Subroutine Calls using Assembly language, counters and delay generation using timers, Embedded C programs
Part B: Interfacing: LCD Display, Stepper motor control, logical interface, 7 segment interface, DAC and keyboard.

Text books:

1.	"The 8051 Microcontroller Architecture, Programming & Applications", Kenneth J. Ayala 2e, Thomson Learning 2005
2.	"The 8051 Microcontroller and Embedded Systems – using assembly and C", Muhammad Ali Mazidi and Janice Gillespie Mazidi and Rollin D. McKinlay; PHI, 2006

Reference books:

1.	'Computer Organization and Architecture', Carl Hamacher, McGrawHill, 5th Edition
2.	http://cnx.org/contents/dadb4fd5-8390-4323-a056-f6381587e89a@1/Microcontroller%288051%29-Lab

E Books	
1.	nptel.ac.in/courses/Webcourse-contents/IIT.../microcontrollers
2.	http://freevideolectures.com/Course/3018/Microprocessors-and-Microcontrollers
Moocs	
1.	**Embedded Systems - Shape The World**-https://www.edx.org/course/embedded-systems-shape-world-utaustinx-ut-6-02x
2.	**Electronic Interfaces: Bridging the Physical and Digital Worlds**-https://www.edx.org/course/electronic-interfaces-bridging-physical-uc-berkeleyx-ee40lx-0
Course outcomes At the end of the course ,the student will have the	
CO1: Ability to **understand** and **explain** computer based and memory based architecture, microcontroller, pipelining, addressing modes, data types in Embedded C, basics of serial communication, timer configuration and interrupt handling	
CO2: Ability to **calculate** instruction execution time, delay, baud rate, and **write** assembly and C Code**, identify** the timer mode, serial communication mode and interrupt priorities	
CO3: Ability to **debug**/ **analyze** the code in assembly as well as Embedded C	
CO4: Ability to identify the IDE to **conduct experiments by** simulating, debugging and executing the assembly and Embedded C code	
CO5: Ability to engage in **independent study/ self-study** by preparing a 5 min video on 'Applications of Microcontrollers for health, safety, environment and society'	
CO6: Ability to work as an individual and as a team-member to design, formulate and implement experiments using microcontroller through conduction of an **Open-Ended experiments**	

Course Title	**CONTROL SYSTEMS**				
Course Code	**15ES4GCCST**	**Credits**	**4**	**L-T-P-S**	**3-1-0-0**
CIE	**100 Marks (50% weightage)**	**SEE**	**100 Marks (50% weightage)**		

Prerequisites: Linear Circuit Analysis, Engineering Mathematics I & II, Advanced Mathematics		
UNIT-I		[9+3] hours
Introduction: Examples of Control Systems, open loop vs Closed loop Systems, Mathematical Modeling of Linear Systems: Transfer functions, Mechanical Systems, Analogous Systems, Block diagram, Signal Flow graph, Compensators: Lag, Lead(obtaining transfer functions only).		
UNIT-II		**[6+3] hours**
Controllers & Time response analysis: Step response of first order, second order systems, response specification, steady state error and error constants. Example of effect of P-I controllers on the time response		
UNIT-III		**[9+2] hours**

Stability Analysis: Concept of stability, RH criterion, applications of RH criterion with limitations, Nyquist plot, Polar plots, Stability Analysis using Nyquist criterion		
UNIT-IV		**[6+2] hours**
Root locus technique: Introduction to root locus concepts, Construction rules, Analysis of stability by root locus plot		
UNIT-V		**[6+2] hours**
Frequency response Analysis: Bode plots, Relative stability, and Frequency domain specification.		

Text books:	
1.	Control Engineering by Nagrath & Gopal, New Age International Publishers
2.	Engineering control systems – Norman S. Nise, John WILEY & sons , fifth Edition
Reference books:	
1.	Modern control Engineering- Ogata, Prentice Hall
2.	Automatic Control Systems- B.C Kuo, John Wiley and Sons
E Books	
1.	http://en.wikibooks.org/wiki/Control_Systems
2.	http://www.electrical4u.com/control-system-closed-loop-open-loop-control-system/#practical-examples-of-open-loop-control-system
3.	http://www.facstaff.bucknell.edu/mastascu/eControlHTML/CourseIndex.html
Moocs	
1.	www.nptel.com/IITK
2.	https://www.edx.org/course/
3.	http://nptel.ac.in/courses/108103007/1
Course outcomes At the end of the course ,the student will have the ability to	
1.	**CO1:** Understand the various methods of representing a system and obtaining its transfer function.
2.	**CO2:** To study the need and effect of using compensators and controllers.
3.	**CO3:** To study, analyze and formulate time response of a linear system.
4.	**CO4:** To identify, formulate and analyze the stability of a system.

Course Title	**SIGNALS AND SYSTEMS**				
Course Code	**15ES4GCSAS**	**Credits**	**4**	**L-T-P-S**	**3-1-0-0**
CIE	**100 Marks (50% weightage)**	**SEE**	**100 Marks (50% weightage)**		

Prerequisites: Linear Circuit Analysis, Engineering Mathematics I & II, Advanced Mathematics		
UNIT-I		**10 hours**

INTRODUCTION: Definitions of a signal and a system, classification of signals, basic operations on signals, elementary signals, Systems viewed as Interconnections of operations, properties of systems.		
UNIT-II		**10 hours**
TIME-DOMAIN REPRESENTATIONS FOR LTI SYSTEMS: Convolution, impulse response representation, Convolution Sum and Convolution Integral, Properties of impulse response representation, Differential and difference equation Representations, Block diagram representations.		
UNIT-III		**8 hours**
FOURIER SERIES: Introduction, Discrete time and continuous time Fourier series (derivation of trigonometric Fourier series representation are excluded), Properties of Fourier series (No proof), Applications of Fourier series. Sampling Theorem and Reconstruction		
UNIT-IV		**10 hours**
FOURIER TRANSFORM: Discrete and continuous Fourier transforms & their properties (With proof). Fourier transform representation of periodic signals, Applications of Fourier transform, Frequency response of LTI systems. Laplace Transform and its Applications.		
UNIT-V		**10 hours**
Z-TRANSFORMS: Introduction, Z – transform, properties of ROC & Z – transforms Inverse Z–transforms, unilateral Z- Transform, analysis of LTI Systems and application to solve Difference equations.		
Text books:		
1.	Simon Haykin and Barry Van Veen "Signals and Systems", John Wiley & Sons, 2001.Reprint 2002	
2.	Alan V Oppenheim, Alan S, Willsky and A Hamid Nawab, "Signals and Systems" Pearson Education Asia / PHI, 2nd edition, 1997. Indian Reprint 2002	
Reference books:		
1.	H. P Hsu, R. Ranjan, "Signals and Systems", Scham's outlines, TMH, 2006	
2.	B. P. Lathi, "Linear Systems and Signals", Oxford University Press, 2005	
3.	Ganesh Rao and SatishTunga, "Signals and Systems", Sanguine Technical Publishers, 2004	
E Books		
1.	NPTEL lecture Video on Signals and Systems by Prof. S.C.Dutta Roy, http://www.satishkashyap.com/2012/04/iit-video-lectures-on-signals-and.html	
2.	NPTEL lecture Video on Signals and Systems by Prof. T.K. Basu, IIT Kharagpur. http://www.nptel.ac.in/courses/108105065/	
3.	NPTEL on line Course Modules–IIT Bombay –Signals and Systems http://www.cdeep.iitb.ac.in/nptel/Electrical%20&%20Comm%20Engg/Signals%20and%20System/TOC-M1.html	
Moocs		
1.	https://www.edx.org/course/signals-systems-part-1-iitbombayx-ee210-1x-0	
2.	https://www.edx.org/course/signals-systems-part-2-iitbombayx-ee210-2x-0	
Course outcomes At the end of the course ,the student will have the ability		
CO1: To apply the knowledge of mathematics and engineering to analyze signals and obtain the response of continuous and discrete time systems.		
CO2: Analyze Continuous Time and Discrete Time signals and systems in Frequency domain using Fourier analysis tools like CTFS, CTFT, DTFS and DTFT.		
CO3: Analyze Discrete Time systems using Z-transforms.		

Course Title	**PCB Design**				
Course Code	**15EI4DCPCB**	**Credits**	**1**	**L-T-P-S**	**0-0-1-0**

CIE	100 Marks (50% weightage)	SEE	100 Marks (50% weightage)

List of Experiments	
PART - A	
1.	Modeling and Validation of a Practical Battery Source
2.	Design and Simulation of an Electronic Battery Characterization System
3.	Design of a Linear Regulated DC Power Supply
4.	Design of Switching Regulated Power Supply for LED Drive
5.	Design and Simulation of a PV Smart LED Driver System
6.	Design and Simulation of a of an Electronic Testing Prototype for Characterizing a Capacitor/ Inductor
7.	PCB Design for the Smart LED Driver System of Experiment 5 above
PART - B	
1.	Advanced Analysis such as Sensitivity Analysis, Design Optimization, Smoke Test and Monte Carlo (Statistical) Analysis of the Smart LED Driver System
2.	Detailed Floor Plan and PCB Design of the Smart LED Driver System
3.	Signal Integrity and Power Integrity Analysis of the Smart LED Driver PCB and Design Sign off
4.	Reliability Analysis of the Designed PCB for Thermal Fatigue Analysis of Solder Joints, Virtual Shock, PTH Fatigue, FEM Analysis of Vias using FEM software
5.	Mechanical and Thermal Analysis: Structural, Vibration and Fatigue Analysis using FEM Software for the PCB Designed
6.	PCB Fabrication, Component Mounting, Preliminary Testing and Final In Application Testing/ Characterization of the Smart LED Driver System
Course outcomes At the end of the course, the student will have the Ability to	
1.	**CO1:** Model, design, analyze and simulate electronic circuit using circuit simulation tools, for the given system specification.
2.	**CO2:** Transfer the circuit from circuit simulation tool to PCB design tool
3.	**CO3:** Design and develop PCB layout using PCB design tool
4.	**CO4:** Develop skills such as component selection, soldering, etc required for designing printed circuit boards
5.	**CO5:** To convert an idea into a successful project and to build a prototype as an industrial product

Course Title	PROCESS CONTROL				
Course Code	16EI5DCPCS	Credits	6	L-T-P-S	3:0:1:2
CIE	100 Marks (50% weightage)	SEE	100 Marks(50% weightage)		

Prerequisites: Analog Microelectronics, Digital Electronics, Analog Integrated Circuits, Basic Electronics, Control Systems.

UNIT-I		8 Hours

INTRODUCTION TO PROCESS CONTROL:

Introduction, control systems, Process control principles, classifications, Block diagram, control systems evaluation, analog and digital processor, sensor time response, problems.

FINAL CONTROL OPERATIONS: Objectives, Elements of final control operation, Electric actuators, pneumatic actuators, hydraulic actuators, control elements, mechanical control element, electrical control element, fluid valves, principles, control valve types, control valve sizing, and Basic instrumentation P&ID symbols.

UNIT-II		7 Hours

CONTROLLER PRINCIPLES: Process characteristics, control system parameters, discontinuous controller modes, continuous controller modes, composite controller modes.

INCENTIVES FOR CHEMICAL PROCESS CONTROL & MODELING: Suppress the influence of external disturbances; ensure the stability of a process, Optimize the performance of chemical process.

UNIT-III		8 Hours

ANALOG CONTROLLERS: General features, Electronic controllers**,** Error detector, Single mode, composite controller modes, Pneumatic controllers, Design considerations.

DIGITAL CONTROLLERS: Digital electronic methods, Simple alarms Two position control, Multivariable alarms, Data loggers, Direct digital and Supervisory control.

UNIT-IV		8 Hours

CONTROL-LOOP CHARACTERISTICS

Control system quality, Process loop tuning, Open - loop transient response method, Ziegler _ Nichols method.

PARADIGM OF PROCESS CONTROL: Cascade control systems, Selective control systems, Split- range control systems.

UNIT-V		**7 Hours**

INTRODUCTION TO PROCESS SAFETY:

Introduction to process control safety systems. Need for power to energize in a safety process inputs. Concept of high availability Vs high reliability systems. The different between control system vs emergency shutdown system. Classification of safety hazard. Dual redundant and triple redundant shut down systems, their architecture and working principle.

Text books:

3.	**Process Control Instrumentation Technology by C.D .Johnson,** 7th Edition, Pearson Education Private Limited, New Delhi 2002.
4.	**Chemical Process Control** – George Stephanopoulos, 4th Indian reprint, PHI Ltd., 1997.

Reference books:

3.	**Process/ Industrial Instruments and Control Handbook**, 4th Edition by D.M. Considine, McGraw Hill International Edition, 1993.
4.	**Computer Based Industrial Control** by Krishna Kant, PHI, New Delhi 1997.
3.	**Process dynamics and control** by S.S.Bhagade and G.D.Nageshwar PHI publications New Delhi, 2011.
4.	**Lessons in Industrial Instrumentation** by Tony R. Kuphaldt, Creative Commons Attribution License (open source textbook), Sept. 2008.

E Books

1.	**http://www.learnerstv.com/Free-engineering-Video-lectures-ltv689-Page1.htm**
2.	**http://nptel.ac.in/courses/103105064/**

Moocs

1.	**https://www.mooc-list.com/tags/process-management**

Course outcomes

At the end of the course ,the student will have the ability

CO1: Understand the need of process control, basic principles of various manufacturing

processes and apply engineering knowledge to do problem analysis in process control.
CO2: Select the proper controller and apply the tuning rules to achieve optimum performance
CO3: Select advanced control strategy to enhance the performance
CO4:practice safety rules in the measurement and control of industrial processes
CO5: Understand , interpret and implement tuning of the controllers using various methods and study about digital controllers and data loggers
CO6: Design requirements of optimization in chemical process control system which leads to team work and project management in a chemical process industry addressing the safety and environmental aspects.
ProcessControl Lab Time response for a I order and II order system for standard input signals, Calibration Design to display the temperature using RTD with suitable signal conditioning circuit. Design and display the temperature using Thermocouple with suitable signal conditioning circuit, Design and test the circuit to display the temperature using AD590 with suitable signal conditioning circuit. Design and test the circuit to display the load using load cell with suitable signal conditioning circuits, P, PI and PID controllers to obtain the optimum response of the given temperature controller, P, PI and PID controllers to obtain the optimum response of the given flow/Level controller.

Course Title	**SENSORS AND TRANSDUCERS**				
Course Code	**16EI5DCSET**	**Credits**	**6**	**L-T-P-S**	**3:0:1:2**
CIE	**100 Marks (50% weightage)**	**SEE**	**100 Marks(50% weightage)**		
Prerequisites: Measurements and Instrumentation, Basic Electronics , Basic electronics					
UNIT-I			8 Hours		
Sensor Technologies Sensors, Signals, and Systems , Sensor Classification , Potentiometric Sensors ,Capacitive Sensors, Inductive and Magnetic Sensors, LVDT and RVDT, Eddy Current Sensors, Hall Effect					

Sensors, Optical Sensors, Proximity Detector with Polarized Light, Fiber-Optic Sensors, thickness and level sensors, Ultrasonic Sensors, Thin Film Sensors, Liquid Level Sensors.

UNIT-II		**8 Hours**

Flow: Purpose of measuring Flow, Definitions & Terminologies, Drawing symbols, Principles of flow measurement, Types of flow – Continuity equation – Bernoulli's theorem, Restriction flow meters with primary devices and DP transmitters - variable head type flow meters – Orifice plate and its parameters, orifice application and device selection, Venturi tube , Flow nozzle , Pitot tube.Variable area meter- Rota meter – Performance, installation and application.
Applications of Magnetic flow meters- Measuring principle, sensor, construction, Installation
Turbine flow meter -Analyze the application of turbine flow meters, Construction, sizing and selection, typical industry installations, performance.
Applications of Ultrasonic flow meters- Principle of operation, Doppler effect (Frequency shift) flow meters, transit time, installation and performance.

UNIT-III		**8 Hours**

Temperature measurement:- Temperature Measurements and Measuring units, Definitions and standards – Calibration of thermometers - Bimetallic thermometers -Different types of filled in system thermometer , Thermistors, Thermocouples – Law of thermocouple – Fabrication of industrial thermocouples– common types of thermocouples, References junction Considerations – Commercial circuits for cold junction compensation. Electrical methods of temperature measurement – Signal conditioning of industrial RTDs and their characteristics –Resistance thermometer bridge circuits -3 lead and 4 lead RTDs. Comparison of thermocouples & RTD, Analog and smart temperature transmitters.

UNIT-IV		**8 Hours**

Pressure measurement: - Units of pressure –pressure transducers and its working, Manometers – Different types – Elastic type pressure gauges – Bourdon type- Bellows , capsules, diaphragms – Measurement of vacuum – McLeod gauge
Performance and installation criteria of pressure transmitter, Comparison of different types of pressure transmitters – Design of pressure transmitters, Smart pressure transmitters and their calibration- typical calibration procedures, Dead weight tester.

UNIT-V		**7 Hours**

Force, Load and Weight Sensors: Introduction ,Quartz Sensors –Technology fundamentals, Sensor types, High impedance, piezo electric force sensors, Construction, selection and specifying, Strain Gage Sensors-types.

LAB EXPERIMENTS

1. ***Temperature Sensors***
   - a.. Characteristics of Platinum RTD.
   - b. Characteristics of NTC Thermistor
   - c.. Characteristic of K type thermocouple
   - d.. Temperature measurement using AD590 Semiconductor temperature sensor
   - e. Bimetallic relay as a temperature dependent control device. -**AAT**
   - f. Temperature controlled alarm system (INTC) -**AAT**
   - g. Temperature controlled alarm system (Bridge NTC) -**AAT**
   - h. Characteristics of IC Temperature Sensor -**AAT**
2. ***Displacement measurement by Capacitive Transducers****:*
   - a. Linear displacement measurement using capacitance.
   - b. Angular displacement measurement using capacitance

3. Displacement measurement by Linear Variable Displacement Transducers (LVDT).

   - a. Study of Input Output characteristics of LVDT.

b. To determine linear Range of operation of LVDT.
c. To determine Sensitivity of LVDT.

4. ***ULTRASONIC SENSOR***

a. Distance measurement using ultrasonic sensor.
b. Sound sensitive switch -**AAT**

5. STRAIN / PRESSURE SENSOR / PIEZO ELECTRIC SENSOR

a. Strain gauge as displacement sensor.
b. Strain measurement and gauge factor determination.
c. To determine linear range of operations of strain measurement
d. Study of strain measurement using strain gauges and cantilever assembly.
e. Test piezo electric transducer

6. MEASUREMENT OF SPEED USING MAGNETIC PICK-UP PROXIMITY SENSOR.

Text books:

1.	K Padma raju, Y J Reddy, Instrumentation and control systems, Tata McGraw Hill Publishing Ltd .
2.	Jacob Fraden, Handbook of Modern sensors, physics design and applications, Springer , Fourth edition.
3.	Jon S. Wilson, Sensor Technologies, Elsevier & Newnes, Chapter 11.
4.	Ernest O. Doebelin, Measurement systems Application and Design, International Student Edition, IV Edition, McGraw Hill Book Company, 1998.
5.	R. K. Jain, Mechanical and Industrial Measurements, Khanna Publishers, New Delhi, 1999.

Reference books:

1.	D.Patranabis, Principles of Industrial Instrumentation, Tata McGraw Hill Publishing Ltd., New Delhi, 1999.
2.	A.K.Sawhney, A course in Electrical and Electronic Measurement and Instrumentation–Dhanpat Rai and Sons, New Delhi, 1999.
3.	P.Holman, Experimental Methods for Engineers International Student Edition, McGraw Hill Book Company, 1971. 4. B.C.Nakra and K.K.Chaudary, Instrumentation Measurement and Analysis, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1985.
4.	Murthy D. V. S, "Transducers and Instrumentation", Prentice Hall, New Delhi, 1995
5.	Neubert H.K.P, "Instrument Transducers - An Introduction to their Performance and Design", 2nd Edition, Oxford University Press, Cambridge, 1999.
6.	Patranabis, "Sensors and Transducers", 2nd Edition, Prentice Hall India Pvt. Ltd., 2003.

E Books

1.	http://nptel.ac.in/courses/112103174/3

2.	https://www.youtube.com/watch?v=1uPTyjxZzyo
3.	http://www.nptelvideos.in/2012/11/industrial-instrumentation.html
4.	http://nptel.iitg.ernet.in/courses/Elec_Engg/IIT%20Bombay/Electrical%20and%20Electronic%20Measurements.htm
5.	http://onlinevideolecture.com/?course_id=385&lecture_no=32
6.	http://nptel.ac.in/courses/112103174/pdf/mod2.pdf

Suggested List of Experiments for Alternate Assessment Tools

OPTICAL FIBER SENSORS

a. Characteristic of optical fibers
b. Humidity Sensor
c. Force Sensor
d. Flow Sensor

SPEED MEASUREMENT SENSOR

a. Using magnetic pick up for motor speed sensor.
b. Photo reflector for speed measurement.
c. Photo interrupter method for speed measurement.

STROBOSCOPIC METHOD FOR SPEED MEASUREMENT.

a. Inductance used for speed measurement.
b. Hall effect used for speed measurement.

Course outcomes

At the end of the course ,the student will have the ability

CO1: Understand the fundamental characteristics, terminologies, sensing and transduction principles of various types of transducer /sensors.
CO2: Understand fundamentals of fluid flow and their applications to flow through pipes and hydraulic machines.
CO3: Understand various techniques used for measuring parameters of temperature measurement in Industries.
CO4: Understand the principles of industrial processes & process in pressure measurement
CO5: Understand the different types of force & level measurements adopted in industrial
CO6: Understand the fundamental characteristics, terminologies, sensing and transduction principles of various types of transducer /sensors.

Course Title	**DIGITAL SIGNAL PROCESSING**				
Course Code	**16EI5DCDSP**	**Credits**	**4**	**L-T-P-S**	**3:0:1:0**
CIE	**100 Marks (50% weightage)**	**SEE**	**100 Marks(50% weightage)**		
Prerequisites: Signals and systems					

UNIT-I		9 Hours
Introduction to DSP, Sampling and reconstruction of a discrete time signal in the frequency domain. Definition of Discrete Fourier Transform (DFT). Useful properties of DFT : linearity, circular shift, Multiplication by a complex exponential sequence, Properties of even and odd parts of x[n], Multiplication, Parseval's relation, Circular convolution in the time domain ,use of tabular arrays and circular arrays		
UNIT-II		**8 Hours**
Use of DFT in linear filtering, linear convolution of two finite duration sequences, overlap add and save methods. Relation between DFT and other transforms. Direct computation of DFT. Necessity for efficient computation of DFT. Radix 2 Fast Fourier Transform (FFT) algorithm for DFT computation. Decimation in time algorithm, decimation in frequency algorithms. Radix 2 FFT algorithm for computation of Inverse Discrete Fourier Transform. (IDFT).		
UNIT-III		**8 Hours**
Introduction to realization of digital systems, block diagrams representation, Realization of Infinite Impulse Response (IIR) systems: direct form, parallel form, cascade form. Introduction to IIR filters, Impulse invariant & Bilinear Transformations, Design of analog Butterworth and Chebyshev filters, Design of Digital Butterworth and Chebyshev filters.		
UNIT-IV		**8 Hours**
Realization of Finite Impulse Response (FIR) systems: Direct Form, Linear Phase Form. Introduction to FIR filters, Frequency response of ideal digital low pass filter, high pass filter, Frequency sampling technique of designing FIR filters, Windowing design of FIR filters using Rectangular, Kaiser and Hamming window.		
UNIT-V		**6 Hours**
Introduction to Multirate Digital Signal Processing: Introduction, Decimation by a factor D, Interpolation by a factor I, Sampling conversion by a Rational factor I/D, Filter Design and implementation for sampling rate conversion. Direct form FIR Filter structure, Polyphase filter structures, Time Variant filter structures. Signal Averaging: Basics of signal averaging, Typical Signal Averager, Signal averaging as a Digital Filter.		
LAB EXPERIMENTS: Display of basic elementary signals, sampling theorem, basic operations on sequences (shifting, folding, time scaling and multiplication), linear and circular convolution, cross and auto correlation, linear convolution and correlation using		

FFT algorithm, FFT of Sequence, FIR Filter design-LP,HP, BP and Notch filter, FIR filter design using Hamming and Kaiser window for the given order and cut-off frequency, Design of IIR FILTER-LP,HP.	
Text books:	
1.	Digital Signal Processing, A computer based approach, Sanjit K Mitra, Tata McGrawHill, Third Edition.
2.	Digital Signal Processing, Principles, Algorithms and Applications, John G. Proakis, Dimitris K Manolakis, Pearson education/PHI, (4th Edition)
Reference books:	
1.	Fundamentals of Digital Signal Processing, Lonnie Ludeman, John Wiley & Sons; Wiley International 1st Edition, 1988.
2.	Discrete-Time Signal Processing, Alan V. Oppenheim, Ronald W. Schafer, John R. Buck, Prentice-Hall Signal Processing Series, 2nd Edition, 1999
3.	Understanding Digital Signal Processing, Richard G. Lyons Prentice Hall, March 25, 2nd Edition 2004
4.	Digital Signal Processing: Fundamentals and Applications, Li Tan, Academic Press, 1st edition 2007
5.	Schaum's Outline of Digital Signal Processing, Monson Hayes, McGraw- Hill, 1st edition, 1998
Course outcomes At the end of the course ,the student will have the ability	
CO1: To apply knowledge of Mathematics and Engineering to understand Sampling and Reconstruction of signals from the given samples.	
CO2: An ability to identify and analyze a problem and formulate the computing requirements to determine the DFT of the given signals.	
CO3: An ability to implement the processes of FFT to reduce the computational complexity and to increase the speed.	
CO4: An ability to understand and formulate algorithms using the Multirate signal processing for sampling rate conversion in speech signal analysis.	
CO5: An ability to use current techniques and modern tools to improve the Medical data analysis**.**	

Course Title	ELECTRO MAGNETIC FIELD THEORY				
Course Code	16EI5DCMFT	Credits	3	L-T-P-S	2:1:0:0
CIE	100 Marks (50% weightage)	SEE	100 Marks(50% weightage)		

Prerequisites: Engineering Mathematics, Engineering Physics.

UNIT-I		6 + 2 Hours

INTRODUCTION

Sources and effects of electromagnetic fields – Vector fields – Different co-ordinate systems- vector calculus – Gradient, Divergence and Curl - Divergence theorem – Stoke's theorem. Coulomb's Law – Electric field intensity – Field due to point and continuous charges – Gauss's law and application

UNIT-II		10 + 2 Hours

ELECTROSTATICS

Electric potential – Electric field and equipotential plots – Electric field in free space, conductors, dielectric -Dielectric polarization - Dielectric strength - Electric field in multiple dielectrics – Boundary conditions, Poisson's and Laplace's equations – Capacitance- Energy density.

UNIT-III		7 + 2 Hours

MAGNETOSTATICS

Lorentz Law of force, magnetic field intensity – Biot–savart Law - Ampere's Law – Magnetic field due to straight conductors, circular loop, infinite sheet of current – Magnetic flux density (B) – B in free space, conductor, magnetic materials – Magnetization – Magnetic field in multiple media – Boundary conditions – Scalar and vector potential – Magnetic force – Torque – Inductance – Energy density – Magnetic circuits.

UNIT-IV		4 + 1 Hours

ELECTRODYNAMIC FIELDS

Faraday's laws, induced emf – Transformer and motional EMF – Forces - Maxwell's equations (differential and integral forms) – Displacement current – Relation between field theory and circuit theory.

UNIT-V		4 + 2 Hours

Effects of Electromagnetic Fields

Electromagnetic Interference and Compatibility (EMI/EMC), EMI

Sources, Effects of EMI, Methods to eliminate EMI, EMC Standards, Advantages of EMC standards, Biological effects of EMI/EMR (Electromagnetic Interference, Electromagnetic radiation)	
Text books:	
1.	Mathew N. O. SADIKU, 'Elements of Electromagnetics', Oxford University press Inc. First India edition, 2007.
2.	Ashutosh Pramanik, 'Electromagnetism – Theory and Applications', Prentice-Hall of India Private Limited, New Delhi, 2006.
Reference books:	
1.	Joseph. A.Edminister, 'Theory and Problems of Electromagnetics', Second edition, Schaum Series, Tata McGraw Hill, 1993.
2.	William .H.Hayt, 'Engineering Electromagnetics', Tata McGraw Hill edition, 2001.
3.	Kraus and Fleish, 'Electromagnetics with Applications', McGraw Hill International Editions, Fifth Edition, 1999. GE 2211 ENVIRONMENTAL SCIENCE AND ENG
4.	Clayton R Paul, ' Introduction to Electro Magnetic compatibility', 2nd edition, Wiley India Pvt Ltd.,
E Books	
1.	NPTEL Video Lecture On Electromagnetic Theory By Dr. Harishankar Ramachandran, IIT Madras. http://www.nptel.ac.in/courses/108106073/
2.	Phillips P., Engineering Dielectrics Volume IIA Electrical Properties of Solid Insulating Materials: MolecularStructure and Electrical Behavior., http://www.astm.org/DIGITAL_LIBRARY/STP/SOURCE_PAGES/STP783.htm
Course outcomes At the end of the course ,the student will have the ability to	
CO1: Apply the fundamental knowledge of electrostatics.	
CO2: Apply the fundamental knowledge of Magneto-statics.	
CO3: Analyzing the effect of EMI and EMC on various devices.	

Course Title	**COMMUNICATION SYSTEMS**				
Course Code	**16EI5DCCST**	**Credits**	**3**	**L-T-P-S**	**3:0:0:0**
CIE	**100 Marks** **(50% weightage)**	**SEE**	**100 Marks(50% weightage)**		
Prerequisites: Advanced Engineering Mathematics					

UNIT-I		8 Hours
AMPLITUDE MODULATION: Time-Domain Description, Frequency domain description, Generation of AM waves, Detection of AM waves, AM/DSB, Time-Domain Description, Frequency domain description Generation of DSBSC waves, Coherent Detection of DSBSC Modulated waves. Costas loop, Quadrature Carrier multiplexing, Comparison of amplitude modulation techniques, frequency translation, FDM.		
UNIT-II		8 Hours
ANGLE MODULATION: Basic Concepts, Frequency Modulation, Spectrum Analysis Of sinusoidal FM wave, NBFM, WBFM, Constant Average power, Transmission bandwidth of FM waves, Generation of FM waves, Direct FM, demodulation of FM waves, frequency discriminator, ZCD, phase locked loop (1st order) comparison of AM and FM		
UNIT-III		7 Hours
NOISE IN ANALOG MODULATION SYSTEMS: Signal-to-noise ratios, AM receiver model, DSBSC receiver, noise in AM receivers using envelope detection, threshold effect, FM receiver model, noise in FM reception, FM threshold effect, pre-emphasis and de-emphasis in FM systems		
UNIT-IV		8 Hours
PULSE MODULATION: Sampling theorem for low-pass and band-pass signal, statement and proof, PAM, Channel Bandwidth for a PAM signal, natural sampling, flat-top sampling, signal recovery though holding, quantization of signals, quantization error, PCM, electrical representations of binary digits, PCM systems, DPCM , delta Modulation, Adaptive delta modulation.		
UNIT-V		8 Hours
DIGITAL MODULATION: Introduction, Binary Shift Keying, DPSK, QPSK, QPSK transmitter, QPSK receiver, signal-space representation, BFSK, spectrum, receiver for BFSK, line codes, TDM. Application of analog/digital communication in Instrumentation and Automation.		
Simulation experiments: **1.** AM modulator and Demodulator. 2. DSB-SC modulator and Demodulator. 3. FM		

modulator and Demodulator. 4. PAM modulator and Demodulator. 5. TDM Multiplexer and Demultiplexer. 6. AM Modulation using Matlab 7. FM Modulation using Matlab.	
Text books:	
1.	**"Analog and Digital communication ",**Simon Haykin, John Willey.
2.	**"Principles of communication systems",**Taub and Schilling, Tata McGrawHill.
3.	"**Process Control: Instrument Engineers' Handbook** " Béla G. Lipták
Reference books:	
1.	**"Electronic Communication Systems", 2nd**Edition,Blake, Thomson publishers.
2.	**"Electronic Communication Systems",**GeorgeKennedy.
E Books	
1.	**http://nptel.ac.in/courses/117102059/**
2.	**http://nptel.ac.in/courses/117101051/**
Course outcomes At the end of the course ,the student will have the ability	
CO1: To define, understand and explain the concept of modulation, demodulation, figure of merit ,sampling, quantization, multiplexing	
CO2: To apply the knowledge of basic systems to articulate the building blocks of the given analog/digital communication system and derive figure of merit for the system.	
CO3: To analyze interaction among various blocks of a given analog/digital communication system to obtain waveform at different points for given specifications and obtain noise performance parameters.	
CO4: To design and decide the modulators, demodulators, sampling rate, type of encoding for given specifications of analog/digital communication system	
CO5: To simulate the modulator-demodulator for the given analog/digital communication system using modern tools	

Course Title	**LASER AND OPTICAL FIBER INSTRUMENTATION**

	(Department Elective-I)				
Course Code	**16EI5DE1OI**	**Credits**	**3**	**L-T-P-S**	**3:0:0:0**
CIE	**100 Marks (50% weightage)**	**SEE**	**100 Marks(50% weightage)**		

Prerequisites: Basic Electronics

UNIT-I		10 Hours

FUNDAMENTALS OF LASER, TYPES AND CHARACTERISTICS

Laser characteristics, Einstein's coefficients- its significance, population inversion, three levels, four level laser, Principles, classification, construction of Ruby, He-Ne, Nd-YAG, semiconductor, Argon and Carbon dioxide lasers. Characteristics of stabilization, Q-switching and mode locking, frequency stabilization, line shape function.

UNIT-II		7 Hours

LASER INSTRUMENTATION:

Measurement of distance - Interferometric methods, beam modulation telemetry, pulse echo techniques. Laser Doppler velocimetry- Holography-principle, applications of holography, holographic computer memories, laser welding, laser machining, laser printing and laser spectroscopy

UNIT-III		8 Hours

OPTICAL FIBERS AND THEIR PROPERTIES:

Introduction to Optical Fibers - principles of light propagation through a fiber – Different types of fibers and their properties –Transmission characteristics of optical fiber –Absorption losses – Scattering losses – Dispersion- advantages and disadvantages of optical fibers.

Light sources for fiber optics: photo detectors, source coupling, splicing and connectors. light Modulation schemes, optical fibers, intermodal dispersion, graded index fiber, low dispersive fibers Fiber losses, fiber materials.

UNIT-IV		7 Hours

OPTICAL FIBER SENSORS:

Multimode passive and active fiber sensors, phase modulated sensors, optical fiber flow sensors, optical displacement sensors microbend optical fiber sensors, intrinsic fiber sensors measurement, current measurement by single-mode optical fiber sensors, fluro-optic temperature sensors, photo elastic pressure sensors, polarization fiber sensors, rotation sensors, integrated optics

UNIT-V		7 Hours

OPTICAL FIBER INSTRUMENTATION:

Fiber optic Instrumentation system - Interferometric method of measurement of length - Moire fringes – Measurement of pressure, temperature, current, voltage, liquid level and strain. Fiber optic gyroscope – polarization maintaining fibers – applications

Text books:	
1.	"Optoelectronics", Wilson & Hawkes, Prentice Hall of India.
2.	Optoelectronics and Fiber Optics Communication – C.K.Sarkar and D.C. Sarkar, New Age Int. Pub., 2004
3.	"Laser principles and applications", Wilson and Hawkes, Prentice Hall of India

Reference books:	
1.	John and Harry, Industrial Lasers and their Applications, McGraw Hill, 1974.
2.	Senior J.M., Optical Fiber Communication Principles and Practice, Prentice Hall, 1985.
3.	Keiser G., Optical Fiber Communication, McGraw Hill, 1991

Course outcomes

At the end of the course ,the student will have the ability to

CO1: Understand the principles, characteristics and construction of various types of Lasers

CO2: Understand the basic instrumentation principle using different type of Laser

CO3: Recognize and classify the structures of Optical fiber and types.

CO4: Discuss the channel impairments like losses and dispersion.

CO5: Select the type of optic fiber sensor for a given optical application

CO6: Understand the basic instrumentation principle using Optic fiber

Course Title	POWER ELECTRONICS (Department Elective-I)				
Course Code	16EI5DE1PE	Credits	3	L-T-P-S	3:0:0:0
CIE	100 Marks (50% weightage)	SEE	100 Marks(50% weightage)		

Prerequisites: Basic Electronics and Basic Electrical Engineering

UNIT-I		8 Hours

Introduction: Applications of Power Electronics, Power Semiconductor Devices**,** Control Characteristics of Power Devices, Types of Power Electronic Circuits, Peripheral Effects. **Power Transistors:** Power BJTs: Steady state characteristics (Qualitative analysis only). Power MOSFETs: Device operation, switching characteristics, IGBTs: Device operation,

output and transfer characteristics, di/dt and dv/dt limitations. **Gate drive circuits:** MOSFET gate drive, Isolation of gate and base drives.		
UNIT-II		8 Hours
DC-DC Converters: Introduction, Principle of step-down operation and it's analysis with RL load (only CCM mode of operation), and Principle of step-up chopper with R load, Performance parameters, Chopper/Converter classification (Quadrant classification).		
UNIT-III		7 Hours
Thyristors : Introduction, Thyristor characteristics, Two transistor model, Turn on and Turn off, di/dt and dv/dt protection. Steady state characteristics of TRIAC, GTO, MCT and IGCT. Thyristor firing circuits, Commutation techniques: Introduction, Natural commutation, Forced commutation: self commutation (Class A and Class B) (Qualitative analysis only)		
UNIT-IV		8 Hours
Controlled rectifiers: Introduction, Principle of phase controlled converter operation, Single phase fully controlled converters, Single phase semi-converters, Three phase fully controlled converters (RL load, Continuous current conduction operation only)		
UNIT-V		8 Hours
Inverters: Introduction, Principle of operation, Performance parameters, Single phase bridge inverters, Three phase inverters, Voltage control of single phase inverters- single pulse width, multiple pulse width.		
Text books:		
1.	"Power Electronics – Circuits, Devices and Applications", Muhammad H Rashid, Third Edition, Prentice – Hall India	
2.	"Power Electronics", M.D.Singh, K B Khanchandani, Second edition, TMH	
3.	Power Electronics – Converters, Applications and Design", Ned Mohan, Tore M. Undeland and William P Robbins, 3rd Edition, John Wiley & sons	
Reference books:		
1.	"Power Electronics – Principles andApplications", Joseph Vithayathil, TATA McGraw-hill Edition.	
E Books		
1.	.http://nptel.ac.in/courses/108105066/	
2.	http://nptel.ac.in/courses/108101038/#	

Course outcomes At the end of the course ,the student will have the ability to
CO1: Identify the need for efficient conversion and control of electrical energy to match the load requirements
CO2: Comprehend the characteristics of practically available Power Electronics devices.
CO3: Analyze different types of converters such as AC to DC, DC to AC, DC to DC and comprehend their steady state behavior.

Course Title	**OOPS USING C++** **(Department Elective-I)**				
Course Code	**16EI5DE1CP**	**Credits**	**3**	**L-T-P-S**	**3:0:0:0**
CIE	**100 Marks** **(50% weightage)**	**SEE**	**100 Marks(50% weightage)**		

Prerequisites: Basics of C, programming skills.		
UNIT-I		**7 Hours**
Principles of Object oriented programming: OOP - Definition, Concepts, Benefits and applications, structure of C++ program, preprocessor directives, header files and library files, compiling and linking. **Tokens Expressions and control structures:** Tokens, keywords, identifiers and constants, data types, storage classes, symbolic constants, variables, operators, manipulators, control statements and loops.		
UNIT-II		**7 Hours**
Functions in C++: Function prototype, argument passing, call & return by reference, recursion, inline functions, function overloading, friend and virtual functions. **Classes and objects:** Class definition and declaration, member functions, static data members and member functions, arrays of objects, functions returning objects.		
UNIT-III		**9 Hours**

Constructors and destructors: Constructors, parameterized constructors, multiple constructors in a class, copy constructor, dynamic constructors and destructors.

Operator overloading: Overloading unary and binary operators, overloading binary operators using friends, rules for overloading.

UNIT-IV		**9 Hours**

Inheritance: Types, public, private and protected inheritance, derived class constructors, virtual base class.

Pointers, virtual functions and polymorphism: Pointers to objects, this pointer, pointers to derived classes, virtual functions, pure virtual functions.

Templates: Class templates, function templates, overloading template functions, member function templates and non type template arguments.

UNIT-V		**7 Hours**

Managing console I/O operations: C++ streams, C++ stream classes, I/O operations, managing O/P with manipulators.

Working with files: Introduction, Classes for the stream operators, opening and closing files, detecting end-of-file, more about open( ); file modes.

Exception handling: Basics, throwing and catching mechanisms, rethrowing an exception, specifying exceptions.

Text books:

1.	**Object Oriented Programming with C++,** -E Balagurusamy (TMH Publications, 4thedn)
2.	**Object oriented Programming in turbo C++,** Robert Lafore (GALGOTIA Publications)

Reference books:

1.	**Let Us C++** Yashavanth P. Kanetkar (BPB Publications)
2.	**Programming With C++** Schaum's series (TMH Publications)

E Books

1.	http://nptel.ac.in/video.php?subjectId=108102043
2.	http://nptel.ac.in/courses/108101037/41

Course outcomes

At the end of the course ,the student will have the ability

CO1: To differentiate between Procedure Oriented and Object Oriented Programming, benefits, understand the fundamental concepts, develop programming skills.

CO2: To develop programs using OOP concepts to provide solutions to an engineering problem.

CO3: To understand and explain the benefits of operator overloading, inheritance and pointers in program development.
CO4: To explain the use of templates, stream and stream classes to implement input-output operations.
CO5: To understand and discuss storing, retrieving data from files, file and exception handling.

Course Title	**FUNDAMENTALS OF HDL (Department Elective-I)**				
Course Code	**16EI5DE1HD**	**Credits**	**3**	**L-T-P-S**	**3:0:0:0**
CIE	**100 Marks (50% weightage)**	**SEE**	**100 Marks(50% weightage)**		
Prerequisites: Digital Electronics.					
UNIT-I					7 Hours
Introduction: Why HDL? , A Brief History of HDL, Structure of HDL Module, Operators, Data types, Types of Descriptions, simulation and synthesis, Brief comparison of VHDL and Verilog					
UNIT-II					8 Hours
Data-Flow Descriptions: Highlights of Data-Flow Descriptions, Structure of Data-Flow Description, Data Type – Vectors. Behavioral Descriptions: Behavioral Description highlights, structure of HDL behavioral Description, The VHDL variable –Assignment Statement, sequential statements.					
UNIT-III					8 Hours
Structural Descriptions: Highlights of structural Description, Organization of the structural Descriptions, Binding, state Machines, Generate, Generic, and Parameter statements.					
UNIT-IV					8 Hours
Procedures and Functions: Procedures, Tasks, and Functions: Highlights of Procedures, tasks, and Functions, Procedures and tasks, Functions. Advanced HDL Descriptions: File Processing, Examples of File Processing.					
UNIT-V					8 Hours
Synthesis Basics: Highlights of Synthesis, Synthesis information from Entity and Module,					

Mapping Process and Always in the Hardware Domain.	
Text books:	
1.	**HDL Programming (VHDL and Verilog)-** Nazeih M.Botros- Dreamtech Press (Available through John Wiley – India and Thomson Learning), 2006 Edition
Reference books:	
1.	**Verilog HDL –**Samir Palnitkar, Pearson Education
2.	**VHDL –**Douglas Perry, TMH
3.	**Fundamentals of Digital Logic with Verilog Design-**Stephen Brown, TMH
4.	C**ircuit Design with VHDL-**Volnei A.Pedroni, PHI
Course outcomes At the end of the course ,the student will have the ability	
CO1: To learn the role of HDL in digital system design using latest tools like VHDL and Verilog.	
CO2: To Describe and test digital logic circuits in data flow description, structural description, behavioral description and advanced constructs (procedures, tasks, functions) using both VHDL and Verilog.	
CO3: To Apply the overall knowledge of digital circuit design using HDL for gate level synthesis targeted for FPGA /CPLD as preparation for project work.	

Course Title	**DATA ACQUISITION AND VIRTUAL INSTRUMENTATION**

Course Code	16EI6DCDVI	Credits	6	L-T-P-S	3:0:1:2
CIE	100 Marks (50% weightage)	SEE	100 Marks(50% weightage)		

Prerequisites: Analog Micro Electronics, Analog Integrated Circuits, Basic Electronics

UNIT-I		7 Hours

GRAPHICAL PROGRAMMING ENVIRONMENT

Introduction, History of Virtual Instrumentation, Lab View and VI, Conventional and Graphical Programming, Future Perspective. Introduction, Components of LabView, Owned and Free Labels, Tools and Other Palettes, Arranging Objects, Pop-up menus, Color Coding, Code Debugging, Context Sensitive Help, Types of VI's, Creating Sub-VIs. Concepts of graphical programming Lab-view software.

UNIT-II		8 Hours

FUNDAMENTALSOFVIRTUALINSTRUMENTATION PROGRAMMING:

Modular programming, Controlling Program execution with structures, composite data-arrays and clusters, visual displays types- graphs and charts-analog and digital, shift registers and feedback nodes, local and Global variables, Exploring string and File input and output operations.

UNIT-III		8 Hours

DATA ACQUISITION WITH LABVIEW:

Concept of Virtual Instrumentation-PC based data acquisition-Typical on board DAQ card-Resolution and sampling frequency-Multiplexing of analog inputs-Single-ended and differential inputs-Different strategies for sampling of multi-channel analog inputs. Concept of universal DAQ card - Use of timer- counter and analog outputs on the universal DAQ card- NI-DAQ mx Tasks

UNIT-IV		8 Hours

CLUSTER OF INSTRUMENTS IN SYSTEM: Interfacing of external instruments to a PC RS232C, RS-422, RS485 and USB standards-IEEE488standard-ISO-OSImodel for series bus-introduction to bus protocols of MODbus and CANbus.

UNIT-V		8 Hours

ANALYSIS TOOLS AND SIMPLE APPLICATION IN VI:

Signal Processing and manipulation -Anti-aliasing Filter, Frequency-Domain Signal analysis (DFT and FFT), Power Spectrum, Windowing, Practical Hints for Frequency

Domain Analysis, Signal Processing Functions, Time Domain Analysis, Frequency Domain Analysis, Filters.

Control design and simulation-Simulation of a simple second order system.

Report generation- Generation of HTML page.

VIRTUAL INSTRUMENTATION LAB:

1. Development of basic algorithms in labVIEW
2. Development of Sub VI-
   a) Half adder design and designing full adder using Half adder Sub-VI.
   b) Design 8:1 mux using 2:1 mux Sub-VI.
3. Generation of Fibonacci series using formula node and shift registers.
4. To build a VI to find whether a given number is prime number or not using flat sequence structure/stacked sequence structure**.**
5. Development of algorithms using Arrays and clusters function pallets
   a) Create a 1-D numeric array and check whether the array elements are odd or even and in the output display 0 and 1respectively.

b) To find the sum of positive and negative numbers in a given array.

C) Build a Vi that generates 1-D array and sort array in ascending and descending order.Also find the maximum and minimum number, size of array.

d) Create a 2-D array and find the sum of rows and columns separately and display

e) Build a VI that matches the input of containers consisting of two numeric input array, clusters and display sine-wave if match is found else display a DC wave.

6. String and File Input and output operations using labVIEW
   a) Build a VI which finds the number of occurrence of particular string in an array of strings.
   b) Build a VI to find whether the i/p string is a palindrome or not.

c) Build a VI to split numbers and words available in a string and display the split numbers and words in separate array.

d) Create a table of Username and Password.Input a username and password,if match is found display ACCESS GIVEN else ACCESS DENIED.

e) To open/create a file and perform read/write operations on a given file.

7. Amplitude Modulated wave generation and demodulate on.
8. Data Acquisition from various sensors using DAQ Cards- Finite and continuous buffered acquisition mode.
9. Building a VI to simulate and study the performance of First order and second order systems.
10. Generation of HTML report using LabVIEW.
11. Acquire, analyze and present an ECG signal using Virtual Instrumentation and also implementing an algorithm to calculate its heart rate.

Text books:

1.	**"Virtual Instrumentation using LabVIEW"** Jovitha Jerome, PHI publication

2.	**"LabVIEW for Everyone"** JEFFREY TRAVIS JIM KRING, 3rd Edition, Pearson education.
3.	**"PC Interfacing for Data Acquisition and Process Control",**S.Gupta andJPGupta InstrumentSocietyofAmerica,1994
4.	**"Understanding Serial Communication",** Peter W Gofton, Sybes International, 2000

Reference books:

1.	**"Learning with Lab-View"** Robert H. Bishop, PreticeeHall,2009
2.	**"Virtual Instrumentation, LABVIEW",** Sanjay Gupta, TMH,NewDelhi,2003
3.	**"Measurement Systems-Application and Design",** Ernest O. Doeblin and Dhanesh N Manik, 5thEdn, TMH, 2007.

Course outcomes

At the end of the course ,the student will have the ability to

CO1: Apply structured programming concepts in developing VI programs and employ various debugging techniques.

CO2: apply the knowledge of LabVIEW programming for simulating and analyzing the data.

CO3: Create applications that uses plug in DAQ boards and built in analysis functions to process the data.

CO4: Build applications that use general purpose interface bus and Serial communication Interface.

CO5: design and analyze various applications using signal Processing tool kit

CO6: design and analyze various applications using control and simulation tool kit.

CO7: Able to generate the report using built in LabVIEW functions.

CO8: Engage in designing, implementing, analyzing and demonstrating an application using tools in available in LabVIEW through an open ended experiment.

Course Title	**ALGORITHMS AND SYSTEM DESIGN**				
Course Code	**16EI6DCASD**	**Credits**	**6**	**L-T-P-S**	**3:0:1:2**
CIE	**100 Marks (50% weightage)**	**SEE**	**100 Marks (50% weightage)**		

Prerequisites: Signals and systems, Digital Signal Processing.

UNIT-I		8 Hours

Architecture of signal processors: CPU, Memory Architecture, DSP Peripherals, Instruction set, JTAG emulation, Addressing modes, Memory organization , Basic

Elements of Real Time DSP Systems, Input and O/P Channels, A/D Conversion, Sampling, Quantization and Encoding, D/A conversion, I/O Devices		
UNIT-II		8 Hours
Fundamentals of DSP programming: Program management, central arithmetic logic unit, multiplier, method of enhancing programming, pipelining, numerical calculations in DSP Processor Hardware options, Fixed and Floating point processors, Real time constraints		
UNIT-III		8 Hours
Algorithm Development: Selection of DSP Chips, Software development, High level software development tools, Introduction to DSP development tools, C compiler, Assembler, Linker, other development tools		
UNIT-IV		8 Hours
VLIW architecture and 6713 processor: Internal structure and core architecture 6713, CPU registers and blocks, arithmetic units, instruction set to multiply , logical , data transfer operations, program branching, Increased computing power, data path cross, Interrupt sources and their management		
UNIT-V		7 Hours
DSP based system design: Design and implementation of FIR ,IIR filters, Interpolation , decimation, Noise cancellation, Adaptive filtering, Speech signal processing and echo cancellation, Harmonic detection, Fundamental frequency extraction, Signal Enhancement techniques		
LAB **EXPREMENTS** The laboratory experiments are implemented using **Code Composer Studio and DSK Boards** FIR, IIR , Interpolation, Decimation, Adaptive filtering, Audio processing, Noise cancellation, Spectral analysis, Signal Enhancement, Harmonic detection		
Text books:		
1.	Real Time Digital Signal Processing, Sen M. Kuo, Bob S.Lee, John Wiley & Sons, 2001	
2.	Digital Signal Processing and Applications with C6713 and C6416 DSK ,	

	Rulph Chassaing, John Wiley & Sons, INC. 2004
Reference books:	
1.	Texas Instruments Reference manual
2.	Architectures for Digital Signal Processing-PeterPirschJohn, Weily and Sons 2007.
Course outcomes At the end of the course ,the student will have the ability to	
CO1: Design and develop solutions using computational power of DSP processor to solve real time problems.	
CO2: Develop algorithms for DSP applications by choosing appropriate techniques to meet specific needs of the design	
CO3: Apply reasoning, interpret and analyze the solutions for simple and moderately complex realtime problems.	
CO4: Optimize the code based on loop time, speed, code size for different system designs	
CO5: Apply modern technique of modelling and simulation for the designs understanding their limitations	

Course Title	**SIGNALING AND COMMUNICATION IN PROCESS AUTOMATION**				
Course Code	**16EI6DCSAC**	**Credits**	**4**	**L-T-P-S**	**3:1:0:0**
CIE	**100 Marks (50% weightage)**	**SEE**	**100 Marks(50% weightage)**		
Prerequisites: Control System, Process control.					
UNIT I			8 Hours		
DATA NETWORK FUNDAMENTALS					

Network hierarchy and switching – Open System Interconnection model of ISO– Data link control protocol: - HDLC – Media access protocol – Command/response – Token passing – CSMA/CD,
TCP/IP.

UNIT II		8 Hours

INTER NETWORKING

Bridges – Routers – Gateways –Standard ETHERNET and ARCNET configuration- special requirement for networks used for control.

UNIT III		8 Hours

HART AND FIELDBUS

Introduction- Evolution of signal standard – HART communication protocol – Communication modes– HART networks – HART commands – HART applications.
Fieldbus: – Introduction – General Fieldbus architecture – Basic requirements of Field bus standard – Fieldbus topology – Interoperability – Interchangeability – Introduction to OLE for
process control (OPC).

UNIT IV		8 Hours

MODBUS AND PROFIBUS PA/DP/FMS AND FF

MODBUS protocol structure – function codes – troubleshooting
Profibus : Introduction – profibus protocol stack – profibus communication model – communication objects – system operation – troubleshooting – review of foundation field bus.

UNIT V		7 Hours

INDUSTRIAL ETHERNET AND WIRELESS COMMUNICATION

Industrial Ethernet: Introduction – 10Mbps Ethernet, 100Mbps Ethernet.
Radio and wireless communication: Introduction – components of radio link – the radio spectrum and frequency allocation – radio modems.

Text books:

1.	Steve Mackay, Edwin Wrijut, Deon Reynders, John Park, 'Practical Industrial Data networks Design, Installation and Troubleshooting', Newnes publication,

	Elsevier First edition, 2004.
2.	William Buchanan 'Computer Busses', CRC Press, 2000.

Reference books:

1.	Andrew S. Tanenbaum, Modern Operating Systems, Prentice Hall of India Pvt. LTD, 2003

Course outcomes

At the end of the course ,the student will have the ability

CO1: To understand basic data networks

CO2: To learn the basic of inter-networking

CO3: To have adequate knowledge in various communication protocol.

CO4: To study industrial data communication.

Course Title	**ANALYTICAL INSTRUMENTATION**				
Course Code	**16EI6DCANI**	**Credits**	**3**	**L-T-P-S**	**3:0:0:0D**
CIE	**100 Marks (50% weightage)**	**SEE**	**100 Marks(50% weightage)**		

Prerequisites: Basic electronics, laser and optical instrumentation

UNIT-I		10 Hours

INTRODUCTION:

Types of instrumental methods for analysis, electromagnetic spectrum, properties of electromagnetic radiation and its interaction with matter, emission of radiation.

MOLECULAR SPECTROSCOPY: Measurement of transmittance and absorbance, Beer Lambert's law, instrumentation, single and double beam spectrometers, application of UV- Visible spectroscopy for qualitative and quantitative analysis. IR

absorption spectrometry, IR instruments, application for quantitative analysis.

UNIT-II		8 Hours

ATOMICABSORPTION AND EMISSIONSPECTROSCOPY:

Principles, sample atomization techniques, atomic absorption instrumentation, interferences In atomic spectroscopy, standard addition and internal standard methods of evaluation. Principles, arc, spark and plasma sources, emission based on plasma sources, emission Spectroscopy based on arc and spark sources

UNIT-III		7 Hours

X-RAYSPECTROSCOPY:

Fundamentals, instrumentation, X-ray absorption methods, X-ray fluorescence methods, X-ray diffraction, applications.

UNIT-IV		7 Hours

MASSSPECTROSCOPY

Features of mass spectroscopy, ion sources, sample inlet systems, mass analyzers – single beam, double beam and quadruple instruments, applications.

UNIT-V		7 Hours

CHROMATOGRAPHY:

Classification of chromatographic Methods, Gas Chromatographs, Gas Chromatographic Columns, Liquid Phases and Column Selection, Detectors for Gas chromatography Gas-solid

Chromatography.

Text books:

1.	"Principles of Instrumental Analysis-6th Edition", Douglas A. Skoog, James Holler, Stanley R. Crounch. Thomson Learning
2.	"Instrumental Methods of Analysis", Willard H.W Merritt, L.L Dean J A Settie FA, 7thEdition,CBSPublishers

Reference books:

1.	"Analytical Instrumentation" by R.S. Khanpur
2.	"Fundamentals of Analytical Chemistry" ,Douglas A Skoog, Donald M West Holler Thomson Learning
3.	"Instrumental Methods of Chemical Analysis", Galen W. Ewing, McGrawHill

Course outcomes
At the end of the course ,the student will have the ability to
Co1: understand and identify the interaction of the matter with electromagnetic radiation and various phenomenon related to it.
Co2: understand the concepts of various analytical methods used for instrumental techniques used for physical, chemical, quantitative and qualitative analysis
Co3: identify and understand the working of various transducers and instrument design in various spectroscopic methods

Course Title	**DIGITAL IMAGE PROCESSING (Department Elective-II)**				
Course Code	**16EI6DE2DP**	**Credits**	**3**	**L-T-P-S**	**3:0:0:0**
CIE	**100 Marks (50% weightage)**	**SEE**	**100 Marks(50% weightage)**		

Prerequisites: Mathematics, Digital Electronics, Signals And Systems, Digital Signal processing

UNIT-I		**8 Hours**

FUNDAMENTALS: Introduction, Fundamental steps in digital image processing (DIP), components of DIP system, A simple image formation model, Image sampling and quantization, Basic relationship between pixels, color images and color models.

Programs in Matlab

UNIT-II		**8 Hours**

IMAGE ENHANCEMENT IN SPATIAL DOMAIN: Background, Point processing – Image negatives, Log transformations, Power law transformations, Contrast stretching, Gray level slicing, Bit plane slicing, Histogram processing – Histogram equalization, Local enhancement, Arithmetic/Logic operations – Image subtraction, Image averaging, Basics of spatial filtering, Smoothing spatial filters – Smoothing linear filters, order statistics filters, Sharpening spatial filters – Foundation, Laplacian and gradient. Programs in Matlab

UNIT-III		**8 Hours**

IMAGE ENHANCEMENT IN FREQUENCY DOMAIN: Background, Basic properties of the frequency domain, Basic filtering in the frequency domain, Basic filters and their properties, Smoothing frequency domain filters – Ideal low-pass filters, Butterworth low-pass filters, Gaussian lowpass filters, Sharpening frequency domain filters – Ideal high-pass filters, Butterworth high-pass filters, Gaussian high-pass filters, Homo morphic filtering. Programs in Matlab		
UNIT-IV		**7 Hours**
IMAGE RESTORATION: Image degradation and restoration models, noise models, restoration using spatial filtering – mean filter, geometric mean filter, harmonic mean filter, median filter, max & min filters, midpoint filter. Programs in Matlab		
UNIT-V		**8 Hours**
IMAGE SEGMENTATION: Introduction, thresholding: threshold detection methods, optimal thresholding, multi-spectral thresholding, edge based segmentation: edge image thresholding, border tracing, Hough transform, region-based segmentation: region merging, region splitting, splitting & merging. Matching: matching criteria.		

Text books:	
1.	**Digital Image Processing** - Rafael C. Gonzalez & Richard E. Woods, Second Edition. Pearson Education Inc.
2.	**Digital Image Processing, analysis and computer Vision**- First edition, Milan Sonka, Cenage Learning, 2008.

Reference books:	
1.	**Fundamentals of Digital Image Processing**- Anil K. Jain, 2nd Edition, Prentice Hall of India.
2.	**Digital image processing, First edition, S**.Jayaraman, S.Esakkirajan, J.Veerakumar, TMH-2008.

E Books	
1.	http://nptel.ac.in/courses/117105079/
2.	https://www.cs.nmt.edu/~ip/lectures.html

Course outcomes

At the end of the course ,the student will have the ability
CO1: Ability to define, explain and understand pixels, enhancement, restoration, segmentation, thresholding, identify steps ,components of Image processing system, relation between pixels
CO2: Ability to **d**iscuss algorithms used for image enhancement in spatial and frequency domain, restoration, segmentation, thresholding.
CO3: Ability to **d**iscuss performance of algorithms for image enhancement in spatial and frequency domain, restoration, segmentation, thresholding
CO4: Ability to design and implement masks, algorithms for the given image processing application
CO5: Ability to simulate the algorithms used in image processing using modern tools

Course Title	**CONTROL SYSTEM COMPONENTS (Department Elective-II)**				
Course Code	**16EI6DE2CC**	**Credits**	**3**	**L-T-P-S**	**3:0:0:0**
CIE	**100 Marks (50% weightage)**	**SEE**	**100 Marks(50% weightage)**		

Prerequisites: control systems, process control, signaling and communication in process automation

UNIT-I		10 Hours

INTRODUCTION:

Introduction to control system parameters, components of control system, overview of pneumatic transmitter, electronic transmitter and smart transmitter.

DC and AC servo motors, stepper motor:DC servo motor: field controlled DC servomotor, armature controlled DC servomotor, AC servomotor: introduction, construction, characteristics, theory of operation, transfer function, steeper motor : introduction, permanent magnet stepper motor, variable reluctance type stepper motor, application of stepper motor

TACHOMETER AND TACHOGENERATOR: AC and DC tachogenerator, contactless tachometer and various other types of tachometers

UNIT-II		7 Hours
SYNCHROS AND GYROS: Introduction, theory of operation, synchro construction, types, synchro as a differential generator, error detector, theory of operation of gyroscope, horizontal & vertical Gyroscope, construction, measurement of pitch, roll, yaw, angular to electrical conversion, equation of motion, transfer function of gyroscope.		
UNIT-III		7 Hours
ACTUATORS AND RELAYS: Selection of actuators, spring diaphragm actuator, piston actuators, rotary valve actuator, pneumatic hydraulic actuator, rotary pneumatic, electro pneumatic actuators, force balance and motion balance petitioners, pneumatic relays, electro-mechanical relays, reed relays , characteristics of relays		
UNIT-IV		8 Hours
GEAR AND CAM FOLLOWERS: Classification of gears, types of gears, working, peculiarities, terminology used in gears, backlash in gear, speed-torque, teeth ratio, types of cams & followers, 2D-3D cams, cams and followers including mechanical function generator.		
UNIT-V		7 Hours
HYDRAULIC SYSTEM: advantages and disadvantages of hydraulic systems, components of hydraulic system, classification of hydraulic system and its application, gear pump, vane pump, ball pump, spool type pilot valve, centrifugal pump.		
Text books:		
1.	‘Control system components’, Dr. M.D. Desai, PHI learning private limited,2008	
2.	W. G. Andrew & H. B. William, Applied Instrumentation In The Process Industries, Gulf Professional Publishing	
Reference books:		
1.	Bela. G. Liptak, Instrument Engineers’ Handbook, CRC Press.	
Course outcomes At the end of the course ,the student will have the ability to		
Co1: identify and utilize the various components used in the process control Loops		
Co2: understand the fundamental principles of working of various		

Components used in Process loops
Co3:design profiles for gears and cams based on control application
Co4: differentiate between various components application, its usage, Advantages and disadvantages

Course Title	**DIGITAL SYSTEM DESIGN USING VHDL(Department Elective-II)**				
Course Code	**16EI6DE2DD**	**Credits**	**3**	**L-T-P-S**	**3:0:0:0**
CIE	**100 Marks (50% weightage)**	**SEE**	**100 Marks(50% weightage)**		
Prerequisites: fundamentals of HDL, Digital Electronics					
UNIT-I					10 Hours
Introduction: VHDL description of combinational networks, Modelling flip-flops using VHDL, VHDL models for a multiplexer, Compilation and simulation of VHDL code, Modelling a sequential machine, Variables, Signals and constants, Arrays, VHDL operators, VHDL functions, VHDL procedures, Packages and libraries, VHDL model for a counter. **Additional Topics in VHDL:** Attributes, Transport and Inertial delays, Operator overloading, Multi-valued logic and signal resolution, IEEE-1164 standard logic, Generics, Generate statements, Synthesis of VHDL code, Synthesis examples, Files and Text IO.					
UNIT-II					**8** Hours
Designing With Programmable Logic Devices: Read-only memories, Programmable logic arrays (PLAs), Programmable array logic (PLAs), Other sequential programmable logic devices (PLDs), Design of a keypad scanner.					
UNIT-III					**6** Hours
Designing With Programmable Gate Arrays And Complex Programmable Logic Devices: Xlinx 3000 series FPGAs, Designing with FPGAs, Xlinx 4000 series FPGAs, using a one-hot state assignment, Altera complex programmable logic devices (CPLDs), Altera FELX 10Kseries CPLDs.					
UNIT-IV					**8** Hours
Design Of Networks For Arithmetic Operations: Design of a serial adder with accumulator, State graphs for control networks, Design of a binary multiplier, Multiplication of signed binary numbers, Design of a binary divider.					

UNIT-V		7 Hours
Digital Design with SM Charts: State machine charts, Derivation of SM charts, Realization of SM charts. Implementation of the dice game, Alternative realization for SM charts using microprogramming, Linked state machines		
Text books:		
1.	Charles H. Roth. Jr:, Digital Systems Design using VHDL, Thomson Learning, Inc, 9th reprint, 2006.	
Reference books:		
1.	Stephen Brown & ZvonkoVranesic, Fundamentals of Digital Logic Design with VHDL,Tata McGrw-Hill, New Delhi, 2nd Ed., 2007	
2.	Mark Zwolinski, Digital System Design with VHDL, 2 Ed, Pearson Education., 2004	
3.	Volnei A Pedroni, Digital electronics and Design with VHDL. Elsevier	
Course outcomes At the end of the course ,the student will have the ability to		
CO1: Use of advanced programming concepts of VHDL and develop VHDL code to model and simulate basic combinational networks and sequential machines.		
CO2: Design combinational networks and sequential machines for PLA, PAL, FPGAs and CPLD variants using SM chart based representation.		
CO3: Design of functional blocks for arithmetic operations (adders, multipliers and dividers) using the knowledge of combinational networks and sequential machines.		
CO4: Develop VHDL models for functional representation of memory element, memory interfaces, communication bus and floating point operations.		
CO5: Use of advanced programming concepts of VHDL and develop VHDL code to model and simulate basic combinational networks and sequential machines.		

Course Title	**BIOMEDICAL INSTRUMENTATION (Department Elective-II)**				
Course Code	**16EI6DE2BM**	**Credits**	**3**	**L-T-P-S**	**3:0:0:0**
CIE	**100 Marks (50% weightage)**	**SEE**	**100 Marks(50% weightage)**		
Prerequisites: Measurements and instrumentation , sensors and transducers					
UNIT-I					8 Hours

FUNDAMENTAL CONCEPTS:

Sources of biomedical signals, Basic medical instrumentation system, performance requirements of medical instrumentation systems, PC based medical instruments, General constraints in design of medical instrumentation systems. Bioelectric Signals and Electrodes: Electrocardiogram (ECG), Electroencephalogram (EEG), Electromyogram (EMG), Electro oculogram (EOG), Electro retinogram (ERG) and Electrodes for ECG, EEG, EMG.

UNIT-II		**8** Hours

RECORDERS:

ELECTRO CARDIOGRAM: Review of Heart Structure & Function, Conduction System the heart, Electrical activity of the heart, Genesis & characteristics of Electrocardiogra (ECG), Electrocardiogram (ECG), Characteristics of the normal ECG, Cardiac arrhythmias a their electrocardiographic interpretation- Abnormal sinus rhythms, Premature contractio description of an Electrocardiograph, ECG lead system, ECG recorder.

ELECTROENCEPHALOGRAPH: Genesis of Electroencephalogram (EEG), Block diagra description of an Electroencephalograph, 10-20 electrode systems, and computerized analy of EEG.

UNIT-III		**8** Hours

BLOOD FLOW AND CARDIAC OUTPUT MEASUREMENT: Measurement of blood pressure Direct & Indirect method measurement of systolic, diastolic blood pressure, Detection of Kortokoff sounds, Laser Doppler flow meters. Cardiac output measurement: Indicator dilution method, Dye dilution method.

UNIT-IV		**8** Hours

CARDIAC PACEMAKERS AND DEFIBRILLATORS: Need for cardiac pacemaker, External pacemaker, Implantable pacemaker, Ventricular synchronous demand pacemaker, Programmable pacemaker, Rate-responsive pacemakers, Packaging, Power sources, Leads & electrodes and their problems.

Defibrillators- Need, DC defibrillator, Electrodes, DC defibrillator with synchronizer, Automatic external defibrillator, Implantable defibrillator, Defibrillator analyzer.

UNIT-V		**7** Hours

BIO TELEMETRY: Biomedical Telemetry & Telemedicine: Wireless telemetry, single channel telemetry, multi-patient telemetry, implantable telemetry and telemedicine.

Text books:	
1.	"Hand book of Biomedical Instrumentation", by R. S. Khandpur, 2nd Edition, Tata McGraw Hill, 2003.
2.	"Biomedical Instrumentation and Measurement", by Leslie Cromwell, Fred J Weibell and Erich A. Pfeiffer, 2nd Edition, Prentice-Hall India Pvt. Ltd., 2004.
Reference books:	
1.	"Medical Instrumentation Application & Design", John G. Webster, 3rd Edition, John Wiley & Sons/Wiley Student Edition, 2001.
2.	"Principals of applied Biomedical instrumentation", LESLEY CROMWELL & OTHERS, John Wiley and sons, 2nd edition.
3.	"Introduction to Biomedical equipment technology", JOSEPH J CARR, JOHN BROWN, Prentice hall of India, 4th Edition.

Course Title	**OPERATING SYSTEM (Department Elective-II)**				
Course Code	**16EI6DE2OS**	**Credits**	**3**	**L-T-P-S**	**3:0:0:0**
CIE	**100 Marks (50% weightage)**	**SEE**	**100 Marks(50% weightage)**		

UNIT-I		7 Hours

INTRODUCTION TO OPERATING SYSTEMS AND CLASSIFICATION: What is an operating system? Abstract views of an Operating system, Goals of an O.S, Operation of an O.S, Efficiency, system performance and user convenience, Classes of operating systems: O.S and the computer system, Batch processing system, Multi programming systems, Time sharing systems, Real time operating systems, distributed operating systems. Operating system structure, system components, virtual machines.

UNIT-II		**7** Hours

PROCESSES AND THREADS: Processes and programs, Programmer and OS view of processes, threads.

SCHEDULING: Preliminaries, Non-preemptive Scheduling Policies, Preemptive Scheduling Policies, Scheduling in practice, Real Time Scheduling, Scheduling in Unix.

UNIT-III		**9** Hours

MEMORY MANAGEMENT: Static and Dynamic memory allocation, Memory allocation to a process, Reuse of memory, Contiguous memory allocation, Noncontiguous memory allocation, Paging, Segmentation, Segmentation with paging. Virtual memory – Background, Demand paging, Process creation, Page replacement algorithms, Allocation of frames, Thrashing.

VIRTUAL MEMORY: Virtual memory basics, Demand paging : overview of paging, demand paging preliminaries, page replacement, Page replacement policies, Memory allocation to process.

UNIT-IV		**9** Hours

FILE SYSTEMS: File system and IOCS, Files and File Operations, Fundamental of File Organizations, Directory Structures, Allocation of disk space, Implementing file access, UNIX file system.

Deadlocks: Definition of deadlock, Deadlock in resource allocation, Handling deadlocks, Deadlock detection and resolution, Deadlock prevention, Deadlock avoidance.

UNIT-V		**7** Hours

Message Passing: Overview of message passing, Implementing message passing, Mailboxes, Message passing in Unix

SECURITY AND PROTECTION: Overview, goals, security attacks, Formal and practical aspects of security.

STRUCTURE OF THE OPERATING SYSTEMS: Operation of an O.S, Structure of an operating system, Operating system with monolithic structure, layered design of operating system.

Text books:

1.	Operating Systems concepts based approach, D. M. Dhamdhere, Tata McGraw Hill, 2002
2.	Operating System Concepts – by Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, 6th edition, John Wiley & Sons, 2003.

Reference books:

1.	Operating system concepts and design – Milan Milankovic 2nd Edition, McGraw Hill, 1992.
2.	Operating systems – Harvey M Deital Addison Wesley, 1990.

E Books

1.	http://nptel.ac.in/courses/106108101/
2.	http://www.satishkashyap.com/2013/02/video-lectures-on-operating-systems-by.html

Course outcomes

At the end of the course ,the student will have the ability to
CO1: understand types of OS, fundamental concepts, techniques used in the execution of programs.
CO2: understand and explain the different techniques being employed in scheduling and memory allocation.
CO3: understand and discuss page replacement policies and the way computers stores files on disk
CO4: explain message passing, deadlock detection, resolution and prevention.
CO5: understand and discuss the protection system for computer system resources.

DISPLAYS FOR EMBEDDED SYSTEM 16TE6 GE1ES (L:T:P:S :: 3:0:0:0)	
Course Outcomes	
At the end of the course, the student will have the	
CO1: Ability to **understand** the working principle behind various display devices for embedded systems.	--
CO2: Ability to **apply** c programming concepts toprogram LED and LCDs for embedded displays	PO1-H
CO3: Ability to **analyse** and **investigate** working of GLCDs for both graphic displays and Touch interfaces	PO2-H
CO4: Ability to work as an individualand thereby **conduct experiments** using UTLP for a given application/problem statement.	PO5 – M PO9 – M
CO5: Develop, test, analyze and demonstrate applications of telecommunication using UTLP	PSO3-M

Prerequisites: C Programming

UNIT I	**[7 hours]**
Introduction: Introduction to display devices, Types of display devices, CRT, vector displays, raster displays, character based frame buffer, LED, LCD, GLCD, Touch screen, plasma display panels, FEDs.	
UNIT II	**[7 hours]**
Driving LEDs Programming LEDs with iterative loops: for, while, do-while, Branching with if, break, continue, switch statements, usage of pointers and arrays in LED programming, Number arrays for LEDs, LED class definition, Macros, Dynamic memory allocation, exception handling, Example programs to turn on/off LED on board, Controlling brightness of LED by changing the parameters of PWM signal.	
UNIT III	**[7 hours]**
Programming with CLCD Comparison of CRT and LCD, Reflective and backlit LCDs, Active matrix LCDs, Programming with character LCD to display one line, printing values on different lines of CLCD, display a string keep changing the message with delay, shifting the characters right and left on CLCD, example application program on display system for railways on CLCD.	
UNIT IV	**[07 hours]**
Programming with GLCD and Touch screen Introduction to GLCD, Introduction to touch screen technology, components of touch screen, Types of touch screen technology, resistive, capacitive, saw and infrared touch screen. Loading images of different formats onto GLCD, display an image with four quadrants of different color, program to set the GLCD as touch panel and display the coordinates of touch panel on screen.	
UNIT V	**[8 hours]**

OS mode and DSP for Embedded system Comparison of non OS mode and OS mode of embedded system, Linux architecture, DSP and C6Accel, Q format data representation ,Using 7 segment LED and LCD in OS mode, Frame buffers, Touch interfaces in OS mode, File system API, Debugging.	
TEXT BOOKS: Interfacing with c++, jayanthakatupitiya and kim Bentley ,springer publications (unit2)	
1.	http://www.slideshare.net/abhishekpal1991/pal-17140724 (unit 1)
2.	http://www.vrarchitect.net/anu/cg/Display/printCG.en.html (unit1)
3.	UTLP practitioner workshop & UTLP Expert workshop training materials from Mission 10x, Wipro Technology. (unit3,unit4,unit5) (http://www.mission10x.com/m10x/technology/learning

CRYPTOGRAPHY AND NETWORK SECURITY **16TE6 GE1CN (L:T:P:S :: 3:0:0:0)**	
UNIT I	**[8 hours]**
Introduction, Services, mechanisms and attacks, The OSI security Architecture, A model for network security, A model for network security, Symmetric Ciphers: Symmetric Cipher model, Symmetric Ciphers: Symmetric Cipher model, Substitution techniques Transposition technique,	
UNIT II	**[8 hours]**
Simplified DES, Block Cipher Principles, Data encryption Standard, The strength of DES, , Differential and Linear Cryptanalysis, Block Cipher Design Principles, Block Cipher modes of Operation, Advanced Encryption Standar, Triple DES, Blow fish	
UNIT III	**8 hours]**
Fermat's and Euler's theorem Chinese Remainder Theorem , Discrete Logarithm, Principles of public key cryptosystems, The RSA algorithm, Diffe-Hellman key exchange, Elliptic Curve Arithmetic, Elliptic Curve cryptography	
UNIT IV	**[8 hours]**
Message Authentication and Hash Functions: Authentication requirements, Authentication functions, Message authentication codes, Hash functions, Security of hash functions and MAC. Digital Signatures, Digital Signature standard, Electronic Mail Security : Pretty Good Privacy,	
UNIT V	**[7 hours]**
Intruders, Intruder detection, Password management, Viruses and related threats, Viruses and related threats, Firewalls design principles	
TEXT BOOK: Cryptography and Network Security- Principles and Practice: William Stallings, Third Edition	

BIO-MEMS

16ML8DE1BM (L:T:P:S :: 3:0:0:0)

Course Outcomes

CO1: Ability to apply knowledge of mathematics, science and engineering to understand the working principle of MEMS and sensors, Microfluidic Systems, Bio-Mems

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CO2: Ability to identify, analyse and formulate the computing requirement using MOEMS technology, Microfabrication techniques

CO3: An ability to understand the environmental impact & safety issues of biomems with reference to medical standards and ethics.

CO4: Ability to function, engage in implementing, communicating the concepts and principles learnt in course using softtool

UNIT I	**[7 hours]**
MEMS and Microsystems: Working principle of Microsystems, materials for MEMS and Microsystems, micromachining, System modelling and properties of materials. **Micro sensors and Acuators**: Mechanical sensors and actuators – beam and cantilever, Piezoelectric materials, thermal sensors and actuators- micro machined thermocouple probe, Peltier effect heat pumps, thermal flow sensors	
UNIT II	**[9 hours]**
Micro Opto Electro Mechanical Systems: Fundamental principle of MOEMS technology, light modulators, beam splitter, microlens, digital micromirror devices, light detectors, optical switch. **Microfluidic Systems:** Microscale fluid, expression for liquid flow in a channel, fluid actuation methods, electrophoresis, microfluid dispenser, microneedle, micropumps continuous flow system.	
UNIT III	**7 hours]**
Scaling laws in miniaturization: Introduction to scaling, scaling in geometry, scaling in rigid body dynamics. **Microfabrication techniques:** Introduction, photolithography, electron beam lithography, and soft lithography, chemical vapour deposition, Impurity doping, Etching, micromachining.	
UNIT IV	**[9 hours]**
Introduction to Bio-MEMS: what are biosensors? , the driving force behind biomedical applications, biocompatibility, reliability considerations, regulatory considerations, Emerging BioMEMs Technology: minimally invasive surgery, point care clinical diagnosis, pressure and flow measurement in cardiovascular system, diabetes, endoscopy, neurosciences, oncology, ophthalmology.	
UNIT V	**[7 hours]**
Chemical and biomedical micro systems: Introduction, sensing mechanism , primary sensing principle, membrane transducer materials, Chem-lab-on-a-chip(CLOC), chemoresistors, chemocapacitors,chemotransistors, E-Nose, Mass sensitive chemo sensors, fluorescence detection, SAW sensors.	

TEXT Books:

NitaigourPremchandMahalik, " MEMS", Tata McGraw Hill Publishing Company, New Delhi, 2007

Steven S. Saliterman, "Fundameantals of BioMEMS and Medical Microdevices", WileyInterscience.

Reference Books:

Tai-Ran-Hsu, "MEMS and Microsystems design and manufacture" Tata McGraw Hill Publishing Company, NewDelhi, 2002

Vijay K Varadan, K J Vinoy, S Gopakrishnan, " Smart material systems and MEMS design and development methodologies", WILEY, India, 2006

FIBER OPTICS AND LASERS IN MEDICINE
16TE6 GE1FL (L:T:P:S :: 3:0:0:0)

CourseOutcomes

CO1: Ability to apply the knowledge of mathematics science and engineering fundamentals to understand the mechanisms describing the interaction of laser radiation with bodily tissue.

CO2: Ability to analyze the properties of lasers and light delivery systems relevant to applications in medicine.

CO3: Ability to discuss selected applications of lasers and optical techniques which are presently important in medicine

UNIT I	**[7 hours]**

Medical Lasers: Introduction, Laser physics-fundamentals, principles, Medical Laser Systems-solid state laser, gas laser, dye laser, semiconductor laser, Laser safety.

UNIT II	**[7 hours]**

Laser interaction with tissue- photocoagulation, photo thermal ablation, photochemical ablation photo disruption

UNIT III	**8 hours]**

Laser Applications in Medical Therapy- application in dermatology, ophthalmology, general surgery, cardiovascular surgery, tumor surgery, gynecology

UNIT IV	**[10 hours]**

Optical Fibers: Elements of optical fiber transmission link 1Basic Optical Laws and Definations, optical fiber mode and configurations, Fiber materials, Fiber fabrication, signal degradation in optical fibers connectors ,splices and couplers, Optical Fiber Bundles: Introduction, non-ordered fiber optic bundles for light guides-fundamentals & principles, ordered fiberoptic bundles for imaging devices- fundamentals & principles, fiberscopes

UNIT V	**[8 hours]**

Intruders, Intruder detection, Password management, Viruses and related threats, Viruses and related thrEndoscopy: Introduction, fundamentals, principles, types of endoscopes, Clinical Applications of Fiber Optic Laser Systems: in gastroenterology, neurosurgery, oncology, ophthalmology/ orthopedics 1 otolaryngology (ENT), urologyeats, Firewalls design principles

TEXT BOOK:

1. Lasers and Optical Fibers in Medicine by Abraham Katzir, Academic Press, 1998.
2. Handbook of Biomedical Instrumentation, by R.S.Khandpur, 2nd edition,
3. Optical Fiber communications/ by Gerd Keiser1 3rd editionMcGraw-Hill International Editions

REFERENCE BOOKS:

1. Therapeutic Lasers - Theory and practice by G.DavidBaxterr Churchill Livingstone

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DATA STRUCTURES AND ALGORITHMS 16EC6GE1DA (L:T:P:S :: 3:0:0:0)	
UNIT I	**[7 hours]**
Linear Structures: Abstract Data Types (ADT) – List ADT – array-based implementation – linked list implementation –cursor-based linked lists – doubly-linked lists – applications of lists – Stack ADT – Queue ADT circular queue implementation – Applications of stacks and queues	
UNIT II	**[7 hours]**
Tree Structures: Need for non-linear structures – Tree ADT – tree traversals – left child right sibling data structures for general trees – Binary Tree ADT – expression trees – applications of trees – binary search tree ADT	
UNIT III	**7 hours]**
Balanced Search Trees And Indexing :AVL trees – Binary Heaps – B-Tree – Hashing – Separate chaining – open addressing – Linear probing	
UNIT IV	**[9 hours]**
Graphs :Definitions – Topological sort – breadth-first traversal - shortest-path algorithms – minimum spanning tree – Prim's and Kruskal's algorithms – Depth-first traversal – biconnectivity – euler circuits – applications of graphs.	
UNIT V	**[8 hours]**
Chemical and biomedical micro systems: Algorithm Design And Analysis: Greedy algorithms – Divide and conquer – Dynamic programming – backtracking – branch and bound – Randomized algorithms – algorithm analysis – asymptotic notations – recurrences – NP complete problems	
Text Books M. A. Weiss, “Data Structures and Algorithm Analysis in C”, Pearson Education Asia, 2002. 2. ISRD Group, “Data Structures using C”, Tata McGraw-Hill Publishing Company Ltd., 2006. **References:** A. V. Aho, J. E. Hopcroft, and J. D. Ullman, “Data Structures and Algorithms”, Pearson Education, 1983. R. F. Gilberg, B. A. Forouzan, “Data Structures: A Pseudocode approach with C”, Second Edition, Thomson India Edition, 2005. Sara Baase and A. Van Gelder, “Computer Algorithms”, Third Edition, Pearson Education, 2000. T. H. Cormen, C. E. Leiserson, R. L. Rivest, and C. Stein, "Introduction to algorithms", Second Edition, Prentice Hall of India Ltd, 2001.	

SENSOR TECHNOLOGY 16EC6GE1ST (L:T:P:S :: 3:0:0:0)	
UNIT I	**[6 hours]**
Sensor Characteristics: Transfer function, span, accuracy, calibration, hysteresis, non linearity, saturation, dead band, resolution, special properties, output impedance, excitation, dynamic characteristics, environmental factors, reliability, application characteristics, and uncertainty	
UNIT II	**[8 hours]**
Physical principles of sensing: Electric charges, fields and potentials, capacitance, magnetism, induction, resistance, piezoelectric effect, pyro-electric effect, hall effect, Peltier effect and seebeck effect, sound waves, temp and thermal props of mats, heat transfer, light, dynamic models of sensor elements	
UNIT III	**8 hours]**
Sensors for embedded systems application_1: Photoelectric sensors, detection methods, proximity sensors: Inductive and capacitive, limit switches, LED, microwave sensors, laser sensors, bar code identification systems, OCRs, position sensors	
UNIT IV	**[8 hours]**
Sensors for embedded systems application_2: Displacement and level sensors, velocity and acceleration sensors, force, strain and tactile sensors, pressure sensors	
UNIT V	**[6 hours]**
Digital transducers and applications : Adv of digit ran, shaft encoders, optical encoders, digital tachometer, Hall effect sensors, linear encoders, Moire Fringe displacement sensors, binary transducers	
Text Books: T1: Handbook of modern sensors: Physics, designs, applications by JACOB FRADEN, 3rd edition, Springer. T2: Sensors Handbook by SabrieSoloman, 2nd edition, Mc Graw Hill. T3: Sensors and Actuators control systems Instrumentation by Clarence W de Silva, CRC Press.	

VLSI TESTING AND DESIGN FOR TESTABILITY 16EC6GE1VD (L:T:P:S :: 3:0:0:0)	
UNIT I	**[4 hours]**
Introduction: Testing Philosophy, Role of testing, Digital and Analog VLSI Testing. How to Test chips- types of Testing, Automatic Test equipment (ATE), Electrical parametric testing, Yield, Defects, Errors and Faults.	
UNIT II	**[10 hours]**
Fundamentals of VLSI testing: Fault models, Fault equivalence, Fault collapsing, Automatic test pattern generation: Path sensitization technique, Boolean difference, D-algorithm, PODEM algorithm, Iddq testing, Delay fault testing. Example problems. CAD tool usage for ATPG	
UNIT III	**8 hours]**
Design for testability**:** Controllability and observability, Scan design and scan based testing, Level sensitive scan Design (LSSD), Test interface and boundary scan	
UNIT IV	**[6 hours]**
Memory testing : Memory fault models, Test algorithms for RAMs, Detection of pattern sensitive faults Example problems	

UNIT V	[8 hours]
Built in self-test (BIST): BIST process, BIST implementation, BIST pattern generation methods, output response analysis	
Reference Books: 1. M. L. Bushnell and V.D. Agrawal, Essentials of Electronic Testing for Digital Memory and Mixed Signal VLSI Circuits, Springer, 2005 2. Parag.K.Lala, Digital Circuit Testing and Testability, Academic press 3. Neil Weste and K. Eshragian, "Principles of CMOS VLSI Design: A System Perspective", Third Edition, Pearson Education (Asia) Pvt. Ltd, 2006.	

PHYSICAL DESIGN 16EC6GE1PD (L:T:P:S :: 3:0:0:0)	
UNIT I	**[8 hours]**
Libraries Standard cells, Transistor sizing, input-output pads, ESD and its sources, Library characterization, Timing models: Delay model, NLDM, Polynomial Delay model, Current source model.	
UNIT II	**[8 hours]**
Partitioning and Floor planning Approximation of Hyper Graphs with Graphs, Kernighan-Lin Heuristic Ratio cut partition, Fiduccia &Mattheyses, Technology File, Circuit Description Design Constraints, Design planning, Pad placement, power planning, Macro placement, Clock planning	
UNIT III	**8 hours]**
Placement Global Placement, detail placement, clock tree synthesis, power analysis	
UNIT IV	**[6 hours]**
Routing (clock, power/ground, signal nets): Special routing, Global routing, Detailed routing, Extraction	
UNIT V	**[8 hours]**
Verification Functional Verification, Timing verification (STA), Physical Verification, SI analysis, Power Analysis	
Text Book: KhosrowGolshan,"Physical Design Essentials-An ASIC Design Implementation Perspective", 2007 Springer Science+Business, Media. **Reference books:** F. Nekoogar. Timing Verification of Application-Specific Integrated Circuits (ASICs).Prentice Hall PTR, 1999. Sarafzadeh, C.K. Wong, "An Introduction to VLSI Physical Design", McGraw Hill International Edition 1995. Preas M. Lorenzatti, " Physical Design and Automation of VLSI systems", The Benjamin Cummins Publishers, 1998.	

PROBABILITY AND RANDOM PROCESS 16EC6GE1PR (L:T:P:S :: 3:0:0:0)	
UNIT I	**[8 hours]**
Introduction to Probability theory: Experiments and Sample space, Events, Probability definition and Axioms, Joint and conditional probabilities, Baye's theorem- Independent events, Bernoulli Trials	
UNIT II	**[7 hours]**
Random variables, Distribution functions, Density functions: CDF, PDF, Gaussian random variable, Binomial, Poisson, Uniform, Exponential and Rayleigh types of random variable, Probability Mass Function	
UNIT III	**7 hours]**
Operation on a single random variable: Expectation, EV of random variables, EV of functions of random variables, Moments, Central moments, Conditional expected values	
UNIT IV	**[7 hours]**
Random processes. Stationarity and ergodicity. Strict sense and wide sense stationary processes. Mean, Correlation and Covariance functions	
UNIT V	**[7 hours]**
Spectral properties of random processes – power spectral density and its properties, relation with autocorrelation, cross PSD and cross correlation	
Text Books: Peyton Z. Peebles, "Probability, Random variables and random signal principles", TMH, 4th edition, 2015. S.Haykins, An Introduction to Analog and Digial Communications, Wiley, 2003 http://nptel.ac.in/courses/117105085	

ADVANCED MICROCONTROLLERS & APPLICATIONS 16EC6GE1AM (L:T:P:S :: 3:0:0:0)	
UNIT I	**[7 hours]**
Migration from 8051 to 32bit cores, RISC design and ARM Design Approach, Advantages of ARM, ARM Organization, Registers, Pipeline, Exceptions & Interrupts, Introduction to Cortex M3 Processor & its applications.	
UNIT II	**[10 hours]**
Cortex M3 Registers, Operation Modes, Thumb2 Technology & Instruction Set Architecture, Exceptions & Nested Vector Interrupt Controller, Memory Systems	
UNIT III	**10 hours]**
Cortex M3 Programming: A typical development flow, Using C, CMSIS, Using Assembly, Exception Programming.	
UNIT IV	**[6 hours]**
Introduction to Firmware, Boot-loader and Embedded Operating Systems, MPU & MMU, Working With I2C, SPI, CAN & USB protocols	
UNIT V	**[6 hours]**
Applications of ARM Cortex M3: Robotics & Motion Control, WSN, IoT, ARM Cortex for DSP applications	

TEXT BOOKS:

The Definitive Guide to ARM Cortex M3, 2nd Edition by Joseph Yiu.

ARM System Developer's Guide By Andrew N Sloss, Dominic Symes, Chris Wright

REFERENCE TEXT BOOKS:

ARM System-On-Chip Architecture By Steve Furber, Addison Wesley, Pearson Education, 2nd edition

Jagger (Ed) ARM architectural reference manual, Prentice Hall

NANO ELECTRONICS
16EC6GE1NE (L:T:P:S :: 3:0:0:0)

UNIT I	**[7 hours]**

INTRODUCTION: Overview of nanoscience and engineering, Moore's law and continued miniaturization, Classification of Nano structures, Electronic properties of atoms and solids: isolated atom, bonding between atoms Giant molecular solids, Free electron models and energy bands, crystalline solids, periodicity of crystal lattices, electronic conduction effects of nanometre length scale, Fabrication methods : top down process methods for templating the growth of nanomaterials, ordering of nanosystems.

UNIT II	**[7 hours]**

CHARACTERIZATION: Classification, Microscopic techniques, Field ion microscopy, scanning probe techniques diffraction techniques: bulk, surface spectroscopy techniques: photon, radiofrequency, electron, surface analysis and dept profiling: electron, mass, Ion beam, Reflectrometry, Techniques for property measurement; mechanical electron magnetic, thermal properties

UNIT III	**7 hours]**

INORGANIC SEMICONDUCTOR NANO STRUCTURES: Overview of semiconductor physics, quantum confinement in semiconductor nanostructures: quantum wells, quantum wires, quantum dots, super lattices, band offsets, electronic density of states.

UNIT IV	**[7 hours]**

PHYSICAL PROCESS: Modulation doping ,quantum hall effect, resonant tunnelling, charging effects, ballistic carrier transport, Inter band absorption, intra band absorption, Light emission processes, phonon bottleneck, quantum confined strark effect, nonlinear effects, coherence and dephasing, characterisation of semiconductor nanostructures: optical electrical structural.

UNIT V	**[8 hours]**

METHODS OF MEASURING PROPERTIES STRUCTURE: Atomic, crystallography, microscopy, spectroscopy, Properties of nano particles: metal nanoclusters, semiconductor nanoparticles, Rare gases and molecular clusters, Carbon nanostructures and its application (field emission and shielding computers, fuel cells, sensors, catalysis). Self-assembling nanostructured molecular materials and devices: building blocks, principles of self-assembly, methods to prepare and pattern nano particles, template nanostructures, liquid crystal mesophases.

SELF LEARNING: FABRICATION TECHNIQUES

Requirements of ideal semiconductor, epitaxial growth of quantum wells, lithography and etching ,cleaved edge growth, growth of vicinal substrates, strain induced dots and wires, electrostatically induced dots and wires, Quantum well width fluctuations , thermally annealed quantum wells, semiconductor nanocrystals, colloidal quantum dots, self-assembly techniques.

REFFERENCES

Ed Robert Kelsall, Ian Hamley, Mark Geoghegan, "Nanoscale science and technology"

Charles P Poole,Jr Frank J owens "Introduction to nanotechnology"

ED William A Goddard, Donald W Brenner, Sergy Edward Lysheveski, Gerald J Lafrate, "Hand Book of Nanoscience engineering and technology"

Course Title	Electrical & Electronics Engineering Materials (Group Elective)				
Course Code	16EE6GE 1EM	Credits	3	L-T-P-S	3-0-0-0
CIE	50 Marks(100% weightage)	SEE	100 Marks(50% weightage)		

Prerequisites:
Basics of Physics & Chemistry

Course Description:
This course will enable students to
Know about the basics of kinetics, chemical bonding and structure of materials.
Analyze the facts of conductors, resistors and dielectric materials.
Study different types and properties of semiconductors.
Know about the concept of magnetic materials and their properties.
Measure different electrical and magnetic properties of materials.

UNIT-1		7 hours

Introduction, Equilibrium, kinetics and crystal geometry - Materials science & Engineering: Classification of engineering materials, level of structure, structure-property relationship in materials. Crystal geometry: The space lattice, space lattice and crystal structure, crystal direction and planes.

UNIT-2		9 hours

Atomic structure, chemical bonding and structure of solid - Atomic structure: Quantum states, ionization potential, electron affinity and electro-negativity. Chemical bonding: bond energy, bond type and bond length, ionic bonding, covalent bonding, metallic bonding, variation of bonding character and properties. Structure of solids: crystalline and non-crystalline states, covalent solids, metal and alloys, ionic solids, the structure of silica and the silicates.

UNIT-3		7 hours

Conductors, Resistors and Dielectric materials - Conductors and resistors: The resistivity range, the free electron theory, conduction by free electrons, conductor and resistor materials, super conducting materials.
Dielectric materials: Polarization and dielectric constant, temperature and frequency effects, electric breakdown, ferroelectric materials, piezoelectricity, dielectric losses

UNIT-4		8 hours

Semiconductors - Classifying materials as semiconductor, the chemical bond in Si and Ge, the density of carriers in intrinsic semiconductor; the energy gap, the conductivity of intrinsic semiconductors, extrinsic semiconductors, carrier density in n-type semiconductors, p-type semiconductors, Hall effect and carrier density, photoconductivity, fabrication of integrated circuits

UNIT-5		8 hours

Magnetic Materials, Measurement of Electrical and Magnetic properties -
Classification of magnetic materials, diamagnetism, the origin of permanent magnetic dipoles in matter, soft magnetic materials, hard magnetic materials, some properties of ferromagnetic materials, antiferromagnetic materials,
Measurement of Electrical and Magnetic properties: Conductivity measurements, dielectric measurements, magnetic measurements, measurements of semiconductor parameters

Text book

1	Materials Science and Engineering, V. Raghavan,PHI Learning Private

	Limited, Fifth Edition. 42nd reprint2013.
2	Electrical Engineering Materials, A.J. Dekker, Prentice Hall of India Private Limited, 13threprint1988.
Reference books:	
1	An Introduction to Electrical Engineering Materials,C.S. Indulkar and S. Thiruvengadam, S. Chand & Company Ltd. 3rd Edition, reprint 1985.
2	Electronic Engineering Materials and Devices, John Allison,Tata McGraw-Hill Publishing Company Ltd. 9th reprint 1990.
Course outcomes At the end of the course ,the student will have the ability to	
CO1: Understand the physics of equilibrium and kinetics and crystal geometry of engineering materials.	
CO2: Understand the concept of atomic structure, chemical bonding, and structure of solid.	
CO3: Apply the principle of physics and mathematics to understand about the properties of conductors, semiconductors, dielectric and magnetic materials.	
CO4: Apply the concept of conductor, semiconductor, dielectric and magnetic materials to measure properties of these materials	

Course Title	**ELECTROMAGNETIC COMPATIBILITY (Cluster Elective I – Except EC & IT)**				
Course Code	**16EE6GE 1EC**	**Credits**	**3**	**L-T-P-S**	**3-0-0-0**
CIE	**50 Marks(100% weightage)**	**SEE**	**100 Marks(50% weightage)**		

Prerequisites:
Analog Electronic, Digital electronics, Power electronics.

Course Description:
The course covers topics on introduction to EMI/EMC, Cabling, balancing and filtering, grounding, and shielding, Electro static discharge.

UNIT-I		8 **hours**

Introduction - Designing of electromagnetic compatibility, EMC regulation, typical noise path, and Use of network theory, method of noise coupling, miscellaneous noise sources, and method of eliminating Interference.

UNIT-II		**8 hours**

Cabling - Capacitive coupling, effect of shield on magnetic coupling, mutual inductance calculations, magnetic coupling between shield and inner conductor, shielding to prevent magnetic radiation, shielding a receptor against magnetic fields, shield transfer impedance, experimental data, example of selective Shielding, co-axial cable versus shielded twisted pair braided shields.

UNIT-III		**7 hours**

Balancing and filtering - Balancing, power supply decoupling, decoupling filters, amplifier Decoupling driving capacitive loads, high frequency filtering, system bandwidth, and modulation and Coding. Introduction to Grounding - Safety grounds, signal grounds, single point ground systems, hybrid grounds, multipoint ground systems, functional ground layout, practical low frequency grounding, hardware grounds

UNIT-IV		**8hours**

Shielding - Near field and far fields, characteristic and wave impedance's shielding effectiveness, absorption loss, reflection loss, composite absorption and reflection loss, summary of shielding equation, Shielding with magnetic material, experimental data, apertures, wave guide below cut off, conductive gaskets, conductive windows, conductive coatings, cavity resonance, brooding of shields.

UNIT-V		**8 hours**

Electrostatic discharge - State generation, human body model, static discharge, and ESD Protection in equipment design, software and ESD protection, ESD versus EMC.

Text books:

1	Noise reduction techniques in electronic systems, Henry W. Ott, John Wiley, 2nd edition, 1988
2	Engineering Electromagnetic Compatibility: Principles, Measurements & Technologies, V. Prasad Kodali, S. Chand & Co. Ltd. Delhi, 2000

Reference books:

1	Electromagnetics Explained – A Hand Book For Wireless/Rf, Emc And High Speed Electronics

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

CO1: Analyze the fundamentals and reason for noise in Analog electronics, Power electronics and Digital electronics circuit**.**

CO2 : Design and development of filters for Analog electronics, Power electronics and Digital circuits for reduction of noise.

CO3 : Design the various types of grounding systems and get familiarised with handling electro static discharge systems

CO4 :Acquire knowledge about testing standards and Regulations.

Course Title	**Modern Control Theory (Cluster Elective I –Except EE)**				
Course Code	**16EE6DCMCT**	**Credits**	**03**	**L-T-P-S**	**2-1-0-0**
CIE	**50 Marks(100% weightage)**	**SEE**	**100 Marks(50% weightage)**		

Prerequisites:
Control Systems

Course Description:
This course intends to create state models using physical variables, phase variables and canonical variables that are used to solve state equations. It also deals with the various techniques used to analyse the controllability and observability of a system. Basics about nonlinear systems are also dealt with.

UNIT-I		**8 hours**

State variable analysis and design:
Introduction, concept of state, state variables and state model, state modeling of linear systems,

linearization of state equations. State space representation using physical variables & canonical variables		
UNIT-II		**8 hours**
Derivation of transfer function from state model, Eigen values, Eigen vectors, generalized Eigen vectors. Solution of state equation ,state transition matrix and its properties, computation using Laplace transformation, power series method, Cayley -Hamilton method		
UNIT-III		**7 hours**
Concept of controllability & observability, methods of determining the same, Effect of Pole-Zero cancellation. Duality.		
UNIT-IV		**8 hours**
Pole placement techniques - Stability improvements by state feedback, necessary & sufficient conditions for arbitrary pole placement, state regulator design, and design of state observer.		
UNIT-V		**8 hours**
Non-Linear systems - Introduction, behavior of non-linear system, common physical non linearity –saturation, friction, backlash, dead zone, relay, multivariable non-linearity. Phase plane method, singular points, stability of nonlinear system, limit cycles, construction of phase trajectories.		

Text books:	
1	Digital control & state variable methods- M.Gopal,THM Hill, 2nd edition, 2003
2	Control system Engineering- I.J .Nagarath&M.Gopal, New Age International (P)Ltd, 3rd edition.
Reference books:	
1	State space Analysis of Control Systems- Katsuhiko Ogata- Prentice Hall Inc
2	Automatic Control Systems- Benjamin C. Kuo&FaridGolnaraghi , John Wiley & Sons, 8th edition, 2003
3	Modern Control Engineering- Katsuhiko Ogata-PHI 2003
4	Modern control systems-Dorf& Bishop- pearson education,1998

Course outcomes

At the end of the course ,the student will have the ability to

CO1: Create state models using physical variables ,mathematical variables and to solve the state equation

CO2: Identify appropriate techniques to analyze the system for its controllability and Observability

CO3: Apply relevant concepts to design systems with state feedback to meet the specifications, Comprehend mathematical representation of nonlinear systems and analysis of a few simple models.

INDUSTRIAL INTERNET OF THINGS

16EI6GE1II(3-0-0-0)

Course Description :

With technological advances in computing power, connectivity and machine learning, the world of

manufacturing is expected to undergo a major transformation. Manufacturing will use these advancements and have interconnected smart learning machines improving the productivity and margin to a large extent. This fourth industrial revolution will convert existing manufacturing facilities into smart factories having cyber physical systems communicating with each other and humans in real time taking decentralized and faster decisions. This course is a preamble to the revolution taking you through the Industrial Internet of Things that forms the back bone of cyber physical systems. The various building blocks of IIoT such as Big data, analytics, cloud will be discussed along with case studies of integrating all these together.

UNIT I	**[7 hours]**
Course Overview : Introduction to IIoT Building Blocks Sensors & Wireless communication Big data & Cloud Analytics Mobility.	
UNIT II	**[10 hours]**
Architectures & Patterns for IIoT	
UNIT III	**10 hours]**
Challenges with IIoT.	
UNIT IV	**[6 hours]**
Case Study 1 : IIoT for Plant Operations	
UNIT V	**[6 hours]**
Case Study 2 : IIoT for Smart City	

Learning Material provided from YOKOGAWA
Duration : Theory (20-25 hours) , Practical (5-7 hrs), Assignments (20 hours offline effort), Assessments (2-4 hours). Optional Project Implementation

ROBOTICS
16EI6GE1RT(3-0-0-0)

UNIT I	**[5 hours]**

Introduction
Objectives, Classification of robots, Major components of robot, definitions: Kinematics, Controls, and actuators. Robot history, types and applications current and future with examples. Fixed and flexible automation

UNIT II	**[9 hours]**

Robot Arm Kinematics
Introduction, The direct kinematics problem, Rotation Matrices, Composite rotation Matrix, Rotation matrix about arbitrary axis, Rotation matrix with Euler angle representation, Geometric interpretation of rotation matrix, Homogenous coordinates and transformation matrix, Geometric interpretation of Homogenous transformation matrices, Composite homogenous transformation matrices, Links, Joints, and their parameters, The Denavit - Hartenberg representation, Kinematic equation for manipulator, Other specifications of the locations of the end effectors, Inverse kinematics problem.

UNIT III	**7 hours]**

Control of Actuators

Objective, Motivation, Closed loop control in position servo, Effect of friction and gravity, Adaptive control, Optimal control, Computed torque technique, Transfer function of single joint, Position control for single joint, Brief discussion on performance and stability criteria.

.

UNIT IV	**[9 hours]**

Vision and Processing :

Image acquisition, illumination Techniques, imaging geometry, some basic transformations, perspective transformations.

Camera model, camera calibration, stereo imaging, Higher-Level Vision: Segmentation, Edge Linking and Boundary detection, Thresholding. Region-oriented segmentation, Use of motion,

UNIT V	**[9 hours]**

Description, Boundary descriptors, Regional descriptors.

Mini project:

Discussion on DC motors with gears, Stepper motor, Servo motor ,Mini projects using Basic sensors, 555 timers, Motors (DC motors with gears, Stepper motor, Servo motor)

A batch of TWO students are required to undertake a mini project to showcase the knowledge acquired during the course of this study.

Example topics :

1. Line follower robot
2. Obstacle avoiding robot
3. Face reorganization algorithm
4. MATLAB simulation or Use of robosim
5. PCB design workshop (Using PCB design software)

Note: Carrying out small models / prototypes of projects are mandated which will carry a 20 percent weight in CIE

Project report has to be submitted with following chapters followed by a presentation

1. Abstract
2. Introduction
3. Block diagram
4. Materials used with detailed specification
5. Design and Design issues in detail
6. Model testing

Course Title	Fundamentals of VLSI				
Course Code	16EI7DCFVI	Credits	4	L-T-P-S	3-0-1-0
CIE	50 Marks(100%weightage)	SEE	100 Marks(50% weightage)		

Prerequisites: Digital Electronics

UNIT-I				10 hours

INTRODUCTION TO MOS TECHNOLOGY: Moore's law, speed power performance, Nmos fabrication, CMOS fabrication: n-well, p-well processes, BiCMOS, Comparison of bipolar and CMOS.

BASIC ELECTRICAL PROPERTIES OF MOS AND BiCMOS CIRCUITS : Drain to source current versus voltage characteristics, threshold voltage, trans conductance, nMOS inverter, Determination of pull up to pull down ratio, nMOS inverter driven through one or more pass transistors, alternative forms of pull up, CMOS inverter, MOS transistor circuit model, BiCMOS inverters, latch up.

UNIT-II				7 hours

MOS AND BICMOS CIRCUIT DESIGN PROCESSES: MOS layers, stick diagrams, nMOS design style,CMOS design style, design rules and layout, λ - based design, scaling of MOS circuits, scaling factors for device parameters, and limitations of scaling.

UNIT-III				7 hours

SUBSYSTEM DESIGN AND LAYOUT -1 : Switch logic pass transistor, Gate logic inverter, NAND gates, NOR gates, pseudo nMOS, Dynamic CMOS, example of structured design, Parity generator, Bus arbitration, multiplexers, logic function block, code converter.

UNIT-IV				7 hours

SUBSYSTEM DESIGN AND LAYOUT -2 : Clocked sequential circuits, dynamic shift registers, bus lines, subsystem design processes, General considerations, 4-bit arithmetic processes, 4-bit shifter.

UNIT-V				8 hours

MEMORY, REGISTER AND ASPECTS OF TIMING: Three Transistor Dynamic RAM cell, Dynamic memory cell, Pseudo- Static RAM, JK Flip-flop, D Flip-flop circuits, RAM arrays, practical aspects and testability: Some thoughts of performance, optimization and CAD tools for design and simulation.

Text books:

5.	**Basic VLSI Design** -3rd Edition Douglas A Pucknell, Kamaran Eshraghian, Prentice Hall of India publication, 2005.

Reference books:

5.	**CMOS Digital Integrated Circuits, Analysis And Design**, 3rd Edition, Sung – Mo (Steve) Kang,YusufLeblbici, Tata McGraw Hill, 2002.
6.	**VLSI Technology** - S.M. Sze, 2nd edition Tata McGraw Hill, 2003.

E Books

1.	http://nptel.ac.in/downloads/117101058/
2.	http://vlsi.cs.ucf.edu/books/intro-nmos-cmos.pdf

Course outcomes

CO-1: Describe the fabrication process and analyze the basic electrical properties of MOS circuits**.**

CO-2: Analyze the CMOS layout levels, how the design layers are used in the process sequence, and resulting device structures (i.e. cross-sectional views).

CO-3: Discuss the different types of inverters also Design and implement CMOS circuits in silicon also to Implement digital logic designs of various types (i.e. combinational logic, multiplexers).

CO-4: Illustrate circuit diagrams, stick diagrams and layouts for nMOS, CMOS and BiCMOS circuits. Explain design rules. Compare different technologies.

CO-5: Analyze and design subsystems using structured approach for MOS technologies and implementation of computational elements memories & register circuits.

Laboratory Experiment List FVI

Experiments
PART A: DIGITAL DESIGN: Write the Verilog code for the following circuits and observe the Waveforms and synthesize the code with technological library with given constrains- An Inverter and Buffer, Transmission Gate, Basic/Universal Gates, Flip flops, Counters, Registers, Adders **PART B**: ANALOG DESIGN: Design an inverter circuit by drawing the schematic and verify The following: i) Transient Analysis ii) DC Analysis, Design the following circuits with given Specification, draw the schematic and verify the following i) Transient Analysis ii) DC Analysis iii) AC Analysis, Common Source Amplifier, Common Drain Amplifier, Differential Amplifier

Course Title	**AUTOMATION IN PROCESS CONTROL**				
Course Code	**16EI7DCAPC**	**Credits**	**06**	**L-T-P-S**	**3-0-1-2**
CIE	**50 Marks(100%weightage)**	**SEE**	**100 Marks(50% weightage)**		

Prerequisites:				
UNIT-I				**6 hours**
Components of automation in process control Data loggers – Data Acquisition Systems (DAS), Introduction to Direct Digital Control (DDC), Distributed Control System, Introduction and importance of PLC, Types of PLC.				
UNIT-II				**7 hours**
Programmable Logic Controller (PLC) Basics Basic architecture of PLC, PLC operation, I/O Modules: Discrete, Analog, Special types, I/O Specifications, CPU, Processor memory organization, Program scan, Introduction to programming standards of PLC.				
UNIT-III				**9 hours**
PLC Programming Instruction: basic relay, branch, Modes of Operation, Developing fundamental PLC wiring diagrams and ladder logic programs. Manually operated switches, Mechanically operated switches, Sensors, Output Control Devices, Latching Relays, Related programming and practice examples, Programming timers, Applications.				
UNIT-IV				**9 hours**
Programming using counters, Control and Data Manipulation Instructions				

PLC intermediate functions: Arithmetic functions - comparison functions, logic functions, Data handling instructions. PLC sequencer and shift register instructions, Applications.
Transforms.

UNIT-V				**8 hours**

Distributed Control Systems (DCS): Definition – merits and demerits, Local Control Unit (LCU) architecture – hierarchical system structure functional level, database organization, field stations, intermediate stations, central computer station, monitoring and command facilities.

SCADA

Introduction to SCADA, Various SCADA architectures, advantages and disadvantages of each system - single unified standard architecture -IEC 61850, Evolution of SCADA, Communication technologies, Monitoring and supervisory functions, SCADA applications in Utility Automation, Industries.

Laboratory:

1. Introduction to AC500 PLC, CDsoft and input and input and output devices.
2. Problems on Relay based instruction.
3. Implementation of AND, OR, NOT, NAND, NOR, EX-OR gate using ladder programming
4. Implementation of multiplexer and De-multiplexer, de-Morgan's theorem using ladder logic
5. Implementation of arithmetic instruction set of PLC.
6. Implementation of timer instructions of PLC
7. Implementation of counter instruction of PLC
8. Implementation of data manipulation instructions of PLC
9. Case study of bottle filling plant using PLC.
10. Case study of elevator system using PLC.
11. Case study of water filling tank using PLC.
12. Case study of sorting based on weight, height of objects.
13. Case study of star to delta converter.
14. Case study of stepper motor control.
15. Case study of DC motor control.

Text books:

1.	Frank D. Petruzella, "Programmable Logic Controllers", McGraw Hill, New York, 2004**.**
2.	John.W. Webb, Ronald A Reis, "Programmable Logic Controllers - Principles and Applications", Prentice Hall Inc., New Jersey, 2003.
3.	Gary Dunning "introduction to Programmable logic controllers" 3rd edition, CENGAGE learning
4.	DobrivojiePopovic, Vijay P. Bhatkar, "Distributed Computer Control Systems in Industrial Automation", Volume 66 of Electrical and Computer Engineering, CRC Press, 1990.

Reference books:

1.	B.G. Liptak, "Process software and digital networks," CRC press, Florida-2003.
2.	W. Bolton, "Programmable Logic Controllers", Fourth Edition, Elsevier Newnes, 2006.
3.	Krishna Kant, "Computer-Based Industrial Control," PHI, New Delhi, 2004

4.	B.G. Liptak, "Instrument Engineers Hand, Process control and Optimization", CRC press- Radnor, Pennsylvania, 2006.

Course outcomes

CO1: Able to gain knowledge about the working of Data Loggers, DDC, SCADA, DCS, PLC and its uses in solving engineering problems.
CO2: Able to apply the concepts of automation for various processes.
CO3: Able to analyze and formulate the requirements of appropriate ladder programs to provide solutions using PLCs.
CO4: Able to design and apply program control, arithmetic, relay, data handling, sequencer, timer and counter instructions in development of solutions
CO5: Able to select, design, apply, simulate and experiment appropriate techniques to develop solutions for practical applications using modern tools.
CO6: Ability to pursue selfstudy to formulate, design, and select appropriate programming techniques using PLC to automate a given process.
CO7: Ability to communicate with effective presentations and submit reports

Course Title	**Modern Control Theory**				
Course Code	**16EI7DCMCT**	**Credits**	**3**	**L-T-P-S**	**2-1-0-0**
CIE	**50 Marks(100%weightage)**	**SEE**	**100 Marks(50% weightage)**		

Prerequisites:				
UNIT-I				**5+2 hours**
Nonlinear Control Systems: Analysis and design Techniques, Types of Nonlinear Systems, Describing Function analysis, Stability – examples. Concepts of Phase Plane analysis, fundamental types of phase portraits.				
UNIT-II				**6+3 hours**
State Space Analysis of Continuous – time Control Systems: State Space Representation- Physical Variables, Phase Variables, Canonical Variables, Cascade Programming, state variables of a dynamic system, block diagram and signal-flow graph state models, conversion of state equations to transfer functions and vice versa. Solution of state equations-homogenous and non-homogenous equations, state transition matrix- Laplace transform method, Cayley Hamilton method, Similarity Transform method.				
UNIT-III				**5+3 hours**
Discrete time Control Systems: Basic digital control system, Pulse Transfer functions, Examples, Stability analysis in the Z-plane-Jurys stability and Bilinear Transformation Problems. Controllability and Observability (Continuous time): Concepts, Kalmans and Gilberts Test, examples.				
UNIT-IV				**4+2 hours**
Compensator design using bode plot: Lead, Lag Networks problems.				

UNIT-V				4+2 hours
Compensator design using root locus technique: Lead, Lag Networks problems.				
Text books:				
1.	Digital Control and State Variables methods – M. Gopal, 2nd edition, PHI, 1997.			
2.	Modern Control Engineering - K. Ogatta, 3rd edition, PHI, 1996.			
3.	Discrete Time Control Systems - K. Ogatta, 2nd edition, PHI, 1996.			
4.	Modelling, Simulation and Control of Non-Linear Dynamical Systems - Patricia Melin and Oscar Castillo, 2002, Taylor & Francis.			
Reference books:				
1.	Advanced control Theory - A Nagar Kani, 2nd edition, RBA .			
2.	Modern Control Theory – UdayBakshi and MayureshBakshi, Technical publications.			
E Books				
1.	http://nptel.ac.in/courses/108103007/			
2.	http://www.nptelvideos.in/2012/11/advanced-control-system-design_27.html			
Course outcomes				
CO1: Ability to identify, categorize different types of non linearities and analyze the behavior of nonlinear system using describing functions and phase plane techniques.				
CO2: Able to represent and analyse given continuous and discrete time systems in the state space form.				
CO3: Able to design control system using pole placement approach and understand the concept of intelligent control.				
CO4: Able to understand the concepts and determine observability and controllability of a given system.				
CO5: Ability to design and analyze the cascade compensators to meet the required specifications using bode plot and root locus techniques.				

Course Title	INDUSTRIAL INSTRUMENTATION				
Course Code	16EI7DE3II	Credits	6	L-T-P-S	3-0-0-0
CIE	50 Marks(100%weightage)	SEE	100 Marks(50% weightage)		

Prerequisites: Process control				
UNIT-I				**6 hours**
Introduction to Power Plant: Power plant terminologies and key terms, power plant classification: thermal, hydro, nuclear, co-generation, comparison of various power plants based on technology, usage, efficiency, and limitations.				
UNIT-II				**8 hours**

Turbine Instrumentation: Turbine instrumentation and control, start-up and shut-down, thermal stress control, turbine supervisory instrumentation, condition monitoring, generator, power distribution instrumentation.				
UNIT-III				**7 hours**
Nuclear Power Plant Instrumentation: Classification of nuclear reactors, nuclear reactor control loops, fuel cycle, control and safety instrumentation, reliability aspects and various modes of operations.				
UNIT-IV				**7 hours**
Thermal Power Plant- Method of power generation, layout and energy conversion process, Types of Boilers, Types of Turbines, Types of Generators, Types of pumps and Fans; Material handling system, study of all loops- water, steam, fuel etc.				
UNIT-V				**7 hours**
Non-conventional energy sources and Power Distribution Schemes: Wind power, solar power, tid power, diesel generator controls, substation automation and smart grid, energy harvesting				

Text books:	
1	Sam. G. Dukelow, ―The Control of Boilers‖, ISA Press, New York, 2 nd ed., 1991.
2	David Lindsley, ―Boiler Control Systems‖, McGraw Hill, New York, 1st ed., 1991.
3	Power Plant Engg.: Domkundwar
4	Process Control: Liptak
5	Pollution: M.N.Rao and H.V. Rao
Reference books:	
1	Reference Books: •Manoj Kumar Gupta, ―Power Plant Engineering‖, PHI Learning Private Limited, 1st ed., 2012.
2	G.S. Sawhney, ―Non-Conventional Energy Resources‖, PHI Learning Private Limited, 1st ed., 2012
3	Gill A.B, ―Power Plant Performance‖, Butterworth, London, 1st ed., 1984
E Books	
1	https://books.google.co.in/books/about/Industrial_Instrumentation.html?id=B4mBaB6e7rsC&redir_esc=y
2	https://books.google.co.in/books/about/Industrial_Instrumentation.html?id=dv8DN_yB3VMC&redir_esc=y
MOOCS	
1.	https://www.mooc-list.com/tags/petroleum-industry
2.	https://mooc.tu9.de/?page_id=1612
3.	https://www.class-central.com/mooc/5222/nptel-industrial-automation-and-control

Course outcomes

At the end of the course ,the student will have the

CO1: Study of Instrumentation and Control Systems used in various power plants
CO2: Understand various standards and protocols used in different power plants
CO3: Discuss state of art technologies used in power sector
CO4: An ability to select and use latest technology tools for various processes and systems.
CO5: Ability to understand of contemporary / emerging technology for various processes and systems.

Course Title	Aircraft instrumentation				
Course Code	16EI7DE3AI	Credits	3	L-T-P-S	3-0-0-0
CIE	50 Marks(100%weightage)	SEE	100 Marks(50% weightage)		

Prerequisites: Measurements and instrumentation, sensors and transducers, control systems

UNIT-I		7 hours

Introduction : Instrument displays, qualitative and quantitative display, director displays, Electronic display, instruments grouping, cockpit layout

Integrated display systems:

Head up display, flight detector system, integrated attitude heading reference system

UNIT-II		8 hours

Air data instruments:

Standard atmosphere, basic air data system, pitot static probe, heating circuit arrangement, air speed indicator, square law characteristics, Mach/airspeed indicator.

vertical Airspeed indicators:

vertical Airspeed indicator, Instantaneous vertical speed indicator, air temperature indicator, air data alerting system, Mach warning system, altitude alert system.

UNIT-III		7 hours

Gyroscopic Flight instruments: The Gyroscope and its properties, determining direction of precession, limitations of gyroscopes, operating gyroscopic flight instruments, gyro horizon, Erection systems for gyro horizons, errors due to acceleration and turning, Direction Indicator, Turn and bank indicator.

UNIT-IV				7 hours

Engine Instruments:

Pressure measurement, Indicating systems, Pressure switches, Temperature measurement, Indicating systems: variable resistance systems, sensor units, Wheatstone bridge systems.

Fuel quantity and Indicating systems:

Quantity indicative system, capacitance type system, basic indicating system, effects of fuel temperature changes, Measurement of fuel quantity by weight: compensated indicating systems, Densitometers, Construction of probes, location and connection of tank probes.

UNIT-V		**7 hours**

Engine Power and control instruments:

RPM Measurement, Generator and indicating system, Tacho probe and indicator system, torque monitoring, Exhaust gas temperature (EGT) indicator, Engine pressure ratio measurement (EPR), fuel flow measurement, Integrated flow meter system.

Text books:

1.	Aircraft instrumentation and Integrated systems, EHJ Pallet, Longman Scientific and Technical, 1992.
2.	Aircraft instrumentation, 2nd edition EHJ Pallet, Longman Scientific and Technical, 1992.

References:

1.	Aircraft instrumentation design , W H Courthard, Pitman and Sound 1981
2.	Aircraft instrumentation C A Willams, Golgatia publishions, New Delhi

E Books

1.	http://www.freeengineeringbooks.com/AeroSpace/Aircraft-Design-Books.php
2.	https://www.abebooks.com/servlet/BookDetailsPL?bi=965050996&searchurl=tn%3Daircraft%2Binstruments%26sortby%3D17

Course outcomes

CO1: : Ability to **define, Understand** qualitative and quantitative display as per the basic T grouping and by giving importance to the aesthetics view of the front panel of an aircraft.

CO2: Ability to **Apply the knowledge** of aircraft instrumentation concepts and analyze the complexity and high functionality of air data instruments.

CO3: Ability to **analyze and Design** a match warning system, Altitude alerts systems, Airspeed warning systems.

CO4: Ability to **Describe and understand** the operation of flight instruments incorporating gyroscopes, basic flight indicators, sensors and its operating principles and types of displays.

CO5: Ability to engage in **effective written and Oral communication** through the report/poster by taking a case study/ literature paper review/ videos in aircraft instrumentation.

Course Title	**REMOTE SENSING&TELEMETRY**				
Course Code	**16EI7DE3RT**	**Credits**	**03**	**L-T-P-S**	**3-0-0-0**
CIE	**50 Marks(100%weightage)**	**SEE**	**100 Marks(50% weightage)**		

Prerequisites: Students has to have a prior understanding of Communication System and Image Processing.

UNIT-I				**8 hours**
TELEMETRY SYSTEMS Telemetry – basic telemetry systems – PCM telemetry system- fundamentals of data acquisition – microprocessor based DAS - block diagram analog data reduction documentation equipment -data recorders used in telemetry- ultra violet and magnetic recorders. Basics of satellite telemetry – TDMA – FDMA - CDMA				
UNIT-II				**8 hours**
SPACE TELEMETRY AND REMOTE SENSING PRINCIPLES Space systems -TTC system of satellite Telemetry & remote controlling -TTC system of INSAT – block diagram.Introduction to remote sensing – need for RS, Imaging systems – Salient feature of IRS satellites - Electromagnetic radiation, EM spectrum –Absorption and scattering				
UNIT-III				**8 hours**
INTERPRETATION AND IMAGING Visual interpretation - Types of data products – Interpretation techniques – Definition, recognition and identification, analysis, classification, deduction, idealization – elements of image interpretation. Tone or colour, pattern, texture, size, shape, shadow, location, Association, resolution- Equipment for interpretation of Ions, light table, stereoscopes, sketch master, Diazo printer, image analyzer. Digital handling of images – software & hardware options.				
UNIT-IV				**8 hours**
IMAGE PROCESSING Radiometric corrections- Line drop correction, geometric distortions- scan, skew-space craft velocity – mirror velocity –Enhancement techniques (basic idea only – no mathematical analysis) need of spatial filtering- basic idea of band combination– Pattern recognition-GIS hardware-remote sensing and GIS – application of remote sensing based GIS				
UNIT-V				**7 hours**
APPLICATION TRENDS IN REMOTE SENSING Agriculture – land use / land cover, crop production,forecasting, crop acreage, hydrology: approach and methodology for ground water exploration, soil moisture: passive microwave remote sensing for soil moisture estimation,other applications.				

Text books:	
1.	Digital Remote sensing concept - Prithvish Nag & M. Kudrat
2.	Hand book of telemetry & remote control - Elliot L Frunberg
3.	Telemetry Principles - D Patranabis, Tata McGrawhill
Reference books:	
1.	Aerospace Telemetry – Vol & II - Stiltz Harry L
2.	Satellite Communication - Agarwal
3.	Electronic Instruments & measurements - A. K. Sawhney
E Books	
1.	http://nptel.ac.in/courses/105107121/6

2.	http://www.northeastern.edu/online/degrees/graduate-certificate-remote-sensing/curriculum.php

Course outcomes

CO1: Understand the basic of telemetry system.

CO2: Discuss the principles of remote sensing and its applications.

CO3: Analyse the various processing done for proper interpretation

Course Title	COMPUTER VISION				
Course Code	16EI7GE2CV	Credits	03	L-T-P-S	3-0-0-0
CIE	50 Marks(100%weightage)	SEE	100 Marks(50% weightage)		

Prerequisites: A prior understanding of Digital Image Processing

UNIT-I				7 hours

Digital Image Formation and low-level processing

Overview and State-of-the-art, Fundamentals of Image Formation, Transformation: Orthogonal, Euclidean, Affine, Projective, etc; Fourier Transform, Convolution and Filtering, Image Enhancement, Restoration, Histogram Processing.

UNIT-II				8 hours

Feature Extraction

Edges - Canny, LOG, DOG; Line detectors (Hough Transform), Corners - Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, GLOH, Scale-Space Analysis- Image Pyramids and Gaussian derivative filters, Gabor Filters and DWT.

UNIT-III				8 hours

Image Segmentation

Region Growing, Edge Based approaches to segmentation, Graph-Cut, Mean-Shift, MRFs, Texture Segmentation; Object detection.

Pattern Analysis

Clustering: K-Means, K-Medoids, Mixture of Gaussians, Classification: Discriminant Function, Supervised, Un-supervised, Semi-supervised; Classifiers: Bayes, KNN, ANN models; Dimensionality Reduction: PCA, LDA, ICA; Non-parametric methods.

UNIT-IV				8 hours

Motion Analysis

Background Subtraction and Modeling, Optical Flow, KLT, Spatio-Temporal Analysis, Dynamic Stereo; Motion parameter estimation.

UNIT-V				8 hours

Applications: CBIR, CBVR, Activity Recognition, computational photography, Biometrics,

stitching and document processing; Modern trends - super-resolution; GPU, Augmented Reality; cognitive models, fusion and SR&CS. The course will involve Laboratory experiments implemented using MATLAB/SCILAB and OpenCV.	
Text books:	
1.	Richard Szeliski, Computer Vision: Algorithms and Applications, Springer-Verlag London Limited 2011.
2.	Computer Vision: A Modern Approach, D. A. Forsyth, J. Ponce, Pearson Education, 2003.
Reference books:	
1.	Richard Hartley and Andrew Zisserman, Multiple View Geometry in Computer Vision, Second Edition, Cambridge University Press, March 2004.
2.	K. Fukunaga; Introduction to Statistical Pattern Recognition, Second Edition, Academic Press, Morgan Kaufmann, 1990.
3.	R.C. Gonzalez and R.E. Woods, Digital Image Processing, Addison- Wesley, 1992.
Journals	
1.	IEEE-T-PAMI (IEEE Transactions on Pattern Analysis and Machine Intelligence).
2.	IJCV (International Journal of Computer Vision) - Springer.
Course outcomes	
CO1: Understand the principles general practices followed in image formation	
CO2: Analysis and selection of techniques of Feature extraction applied to images	
CO3: Classification of images using Parametric and non-parametric methods	
CO4: Analyze and build prototypes of the motion dynamics using the modeling techniques	
CO5: Apply the image processing techniques for computational photography	

Course Title	**MEMS and Sensors**				
Course Code	**16EI7GE2MS**	**Credits**	**03**	**L-T-P-S**	**3-0-0-0**
CIE	**50 Marks(100%weightage)**	**SEE**	**100 Marks(50% weightage)**		

Prerequisites: Measurements and instrumentation, sensors and transducers, control systems		
UNIT-I		7 hours
OVER VIEW OF MEMS AND MICROSYSTEMS Overview of MEMS and Microsystems, Evolution, Microsystems and microelectronic, multidisciplinary nature of Microsystems, Applications of Microsystems in different industry. Engineering science for micro system design and fabrication, Ionization, diffusion Process, plasma physics, Electrochemistry, Quantum physics.		
UNIT-II		**8 hours**
MICRO SENSORS, ACTUATORS, SYSTEMS AND SMART MATERIALS Micro sensors- biosensors, biomedical sensors, optical sensors, chemical sensors, Piezo resistive Pressure Sensor, thermal sensors, Silicon Capacitive Accelerometer and portable blood analyzer. Micro actuation-principle, MEMS with micro actuators- Micro grippers, micro motors, mic valves, micro pumps, Micro accelerometer-Smart Materials and Systems		
UNIT-III		**7 hours**
MINIATURIZATION TECHNIQUES		

Introduction to scaling, scaling in rigid body dynamics, electrostatic forces, electromagnetic forces, electricity, heat transfer, heat convection.				
UNIT-IV				**7 hours**
MICRO FABRICATION TECHNIQUE Silicon as a Material for Micromachining, Thin-Film Deposition, Lithography, Etching, Silicon Micromachining Specialized Materials for Microsystems, Advanced Processes for Micro fabrication-LIGA process				
UNIT-V				**7 hours**
MICROSYSTEM PACKAGING CAD package for Microsystems, Microsystem for packaging-objective, special issues in packaging, types of packaging, packaging technologies, reliability and key failure Mechanisms				

Text books:	
1.	MEMS & Microsystem: Design & Manufacture by Tai ran Hsu, Tata McGraw Hill Publisher, 2002.
2.	Micro And Smart Systems by G.K. Ananthasuresh, K.J. Vinoy, S. Gopalakrishnan, K.N. Bhat, V.K. Aatre : Wiley, India (2010)
References:	
2	Chang Liu, "Foundations of MEMS", Pearson International Edition, 2006.
3.	Marc Madou , "Fundamentals of microfabrication",CRC Press, 1997.
4	M.H.Bao "Micromechanical transducers :Pressure sensors, accelerometers and gyroscopes", Elsevier, Newyork, 2000.
E Books	
1.	http://www.nptelvideos.in/2012/12/mems-microsystems.html
2.	http://nptel.ac.in/video.php?subjectId=117105082
3.	http://www.memscentral.com/mems_videos.htm
4	http://nptel.ac.in/courses/117105082/#

Course outcomes

CO1: To **Analyze** the theories and concepts of micro electro mechanical systems. **PO1, PO2**

CO2: To **comprehend** the basic principles ,working and **identify** type of materials used for various types of micro sensors and actuators **:PO1,PO2**

CO3: To **Illustrate** range of fabrication techniques used in microsystem design and **analytically** describe different deposition techniques and **identify** different effects occurring during depositions on various topographies. : **PO1,PO2**

CO4: To **apply** the basic engineering principles in understanding the scaling effects in different physical principles related to microsystems.: **PO2**

CO5: Able to **Comprehend** the state-of-the-art of micromachining and packaging technologies. **PO2**

CO6: To **Engage** in Independent learning in analyzing and demonstrating an applications of MEMS devices through Case Studies/Literature review in the form of report/poster. **PO10,PO11,PO12**

Course Title	Project for Community Service				
Course Code	16EI7DCPCS	Credits	03	L-T-P-S	0-0-0-0
CIE	50 Marks(100%weightage)	SEE	100 Marks(50% weightage)		

CO#	Course Outcome
CO1	Ability to engage in **independent study** to research literature in the identified domain
CO2	Ability to consolidate the literature search to **identify** the research work for Implementation
CO3	Ability to **engage in independent study** to identify the mathematical concepts, Science concepts, engineering concepts necessary to solve the identified research work
CO4	Ability to engage in **independent study** to arrive at an exhaustive list of available Engineering tools ,and select the tool for implementing the identified research work
CO5	Ability to **apply** the identified concepts and engineering tools to validate the results of the identified work
CO6	Ability to engage in **effective written communication** through the project report
CO7	Ability to engage in **effective oral communication** through presentation of the project work, demonstration of the project and preparation of the video about the project
CO8	Ability to perform in the team, contribute to the team and mentor/lead the team
CO9	Ability to abide by the norms of **professional ethics** and meet societal and environmental needs

Course Title	MICRO-SENSING NETWORKS FOR SUSTAINABLE CITIES				
Course Code	16EI8IEMNS	Credits	03	L-T-P-S	2-0-0-1
CIE	50 Marks(100%weightage)	SEE	100 Marks(50% weightage)		

UNIT-I				5Hours

Micro sensing Networks for sustainable cities: Pollution as a key factor

Introduction, urban mega cities , Smart cities, Air pollutants, air pollution sources, water pollutant, water pollutant sources, Air pollution monitoring, Water pollution monitoring, Air quality sensors, water quality sensors, the Internet of Things, Wireless sensing Energy harvesting.

Population growth in Developing countries and smart city fundamentals: Introduction, developing country growth statistics, developed country statistics.

UNIT-II				6 hours

Modelling of Air and Water Pollution Sources

Introduction, Indoor and Outdoor Air pollution, Pollutant Concentration Conversion, Concentration in Altitude Variations, Unsaturated and saturated Adiabatic lapse Rate, pollution dispersion-Screening model-Gaussian plume. Vertical Distribution, Momentum and Buoyancy, Wind Speed Variations, Water Pollution Modelling., Types of water pollution and water quality Treatment.

UNIT-III				4 hours

Harvesting Energy from Ambient Sources: Wind Energy, hydropower, Radiation and Mechanical Deformation

Introduction, Ambient Sources, Wind Energy, Hydropower, Photodiodes, Radiation Sources, Piezoelectric Energy, Micro-electromechanical Structures.

UNIT-IV				4 hours

Designing and Planning for Sustainable Urbanism with focus on Developing Countries

United Nations Millennium Development, Sustainable Resources, responsible Development, Impact Assessment, Social and Economic Metrics, Demographic Considerations, Urban Macro-Effects, Environment Impact Metrics.

UNIT-V				5Hours

Tools and Facilitators towards Successful Planning for Sustainable Cities

Population Growth, Smart Cities, Pollution, Ambient Sources and Energy Harvesting, GIS, Remote Sensing and Ubiquitous Computing, Environmental Impact of climate change

Case Study: Developing countries committed to an ecologically aware future:

Categories of sustainable Development, Indicators of Sustainable cities, Worldwide Smart City Initiatives- **South Africa-** Human Capital in ICT, Information Distribution and transport, **Italy-** Training Programs in theoretical Physics Aimed at Creating Environmentally Aware and therefore sustainable communities in Developing countries. **Sweden**-Best practice in mixed use of environmental adaptation in urban areas

Text books:

4. Micro sensing Networks for sustainable cities: 2016 First Editionby Springer International publishing- Smart Sensor, Measurement and instrumentation

E-books/reference:

2. Design for sustainability E-Learning Programme - https://www.gaiaeducation.org/index.php/en/online?gclid=CPCoq5Pk9dICFZaOaAodlE8OjQ

2	Sustainable Cities: https://courses.sdgacademy.org/learn/sustainable-cities-november-2016

Course Outcomes

CO-1: Understand the need for sustainable Engineering solutions for Environmental framework.

CO-2: Analyze the requirements of sustainable development for different Environmental context.

CO-3: Develop solution by applying social, economic, Environmental considerations

CO-4: Self-study on various cases and presentation of report and seminars

Course Title	**PROJECT MANAGEMENT AND FINANCE**				
Course Code	**16HS8DCPMF**	**Credits**		**L-T-P-S**	**2-0-0-1**
CIE	**50 Marks (100% weightage)**	**SEE**	**100 Marks(50% weightage)**		

Pre-requisites: Personality development course, soft skills

Course Description:

This course trains in the basic principles of project management, including concepts from the initiating, planning, executing, monitoring & controlling, and closing process groups. Introduces fundamentals from the project management knowledge areas such as integration, scope, time, cost, quality, human resources, communications, risk, procurement, and stakeholder management.

Provides students with the opportunity to apply project management principles to real- world situations with the use of simulations and case studies. Also, offers additional training in project management principles, tools, techniques, and outcomes.

This course offers a comprehensive approach to understand the importance of financial management in managing projects and programs.

UNIT-I	**5 hours**

Concepts of Project Management - Concepts of project , Categories of project , Project life cycle phases, Project management concepts, Tools and techniques for project management, The project manager, Basic education for a project manager, Roles and responsibilities of project manager ,Project manager as profession, Summary

UNIT-II	**5 hours**

Establishing the Project - Scope, Time , Cost and performance goals, Feasibility report, Financing Arrangements, Preparation of cost estimates, Finalization of project implementation schedule, Evaluation of the project profitability, Appointing a project manager, Fixing the Zero date, Summary

UNIT-III		5 hours
Organizing Human Resources and Contracting - Delegation , Project managers authority, Project organization , Accountability in Project Execution , Contracts , R's of contracting, Tendering and Selection of Contractors, Team building, Summary		
UNIT-IV		**5 hours**
Organizing Systems and Procedures for Project Implementation -Working of systems, Design of Systems, Project work system design , Work breakdown structure, Project execution plan, Project procedure manual, Project control system, Planning, Scheduling and Monitoring, Monitoring contracts, Project diary , Summary.		
UNIT-V		**6 hours**
Financing of Projects - Capital structure, Menu of financing , Internal accruals , Equity capital, Preference capital , Debentures (or bonds) , Methods of offering term loans , Working capital advances, Miscellaneous sources , Raising venture capital, Project financing structures, Financial closure , Financial institutions ,Summary.		
Text books:		
1	Project Management – S Choudary, Tata McGRAW Hill Publishing Company Limited	
2	Projects- Planning , Analysis , Selection, Financing ,Implementation and Review –Dr. Prasanna Chandra McGRAW Hill Publishing Company Limited	
Reference books:		
1	Project Management – David I Cleland – Mcgraw Hill International edition	
2	Project Management – Gopalakrishnan – Mcmillan India Ltd	
3	Project Management – harry – Maylor- Peason Publication	
E Books:		
1	Nptel lecture on Introduction to project management by prof. Arun Kanda https://www.youtube.com/watch?v=5pwc2DYlKQU	

Course outcomes At the end of the course, the student will have the ability to
CO1: Apply the Knowledge of project management principles and to implement project management methodologies required for successful project completion
CO2: Develop Ethical principles in project planning and execution as a team and documentation in project implementation.
CO3: Identify and Apply finance aspects for project implantation in time**.**
CO4: Use modern tools to simulate their respective projects and case studies and investigate the behaviour under various operating conditions.

Major Project
Course code: 16EI8DCMPJ

CO#	Course Outcomes	PO#
CO1	Demonstrate a sound technical knowledge of their selected project topic.	**PO 1**
CO2	Undertake problem identification, formulation and solution	**PO 2**

CO3	Design engineering solutions to complex problems utilizing a systems approach.	**PO 3**
CO4	Conduct an investigation in engineering project	**PO 4**
CO5	Interpret data to provide valid conclusion.	**PO 4**
CO6	select appropriate techniques and simulate using modern tools	**PO5**
CO7	apply reasoning relevant to engineering practice	**PO 6**
CO8	Understand impact of engineering solutions in societal and environmental context	**PO 7**
CO9	Demonstrate the knowledge, skills and attitudes of a professional Ethics and responsibilities applied relevant to engineering practice	**PO 8**
CO10	Effective functioning as individual and in a team	**PO 9**
CO11	Communicate with engineers and the community at large in written ,oral and social learning platforms	**PO10**
CO12	Apply and use management principles for their work, team work and managing the dependencies between tasks.	**PO11**
CO13	Exhibit ability to engage in lifelong learning in the perspective of technological requirements of the project	**PO12**

Project Evaluation Sheet

	Parameter	CO Mapped	Maximum Marks	Guide (>50%)	PEC (30%)	External (20%)	Total	Remark
Group Evaluation	Literature Review	**CO1**	**10**					
	Identify the research Work for implementation	**CO2**	**5**					
	Identification of Essential concepts	**CO3**	**5**					
	List of Tools, selection Of the Tool	**CO4**	**5**					
	Result validation and discussion	**CO5**	**25**					
	The Project Report	**CO6**	**20**					
	Abide by ethics	**CO9**	**5**					
In	Oral Presentation	**CO7**	**10**					

	Viva-Voce(Technical Knowledge)	**CO3**	**10**					
	Performance in the Team	**CO8**	**5**					

RUBRICS for Project Evaluation

Parameter	>70%	40 to70%	< 40%
Literature Survey	Referred to more than TEN articles; appropriately summarized; includes recent references	Referred to more than SIX articles; appropriately summarized; NO recent references	NO references included
Problem statement	statement is clear, can be implemented and tested	Problem statement clear, NOT feasible for implementation,	Problem statement NOT clear
Identification of essential concepts	Clear list, description and justification of MOST essential Mathematical, Science, Engineering Concepts included	SOME essential Mathematical, Science, Engineering and without necessary details/ justification	There is NO mention of any of the essential Concepts
Preparing the equipment/ component list/ Modern Tool	An Exhaustive list of possible Modern Tools/Components that may be used to implement the project is provided, together with a brief comparative study	A list of possible Modern Tools/Components that may be used to implement the project is provided, without the brief comparative study	Only list of modern tool(s) and components being used is provided
Implement, Analyze and discuss the results	Implemented minimum of TWO Graphs, and can be verified with change in parameters	Implemented ONE graph, and can be verified with change in parameters	NO result validation
The Project Report	Well organized, clear objectives and outcomes for every chapter	NOT well organized	NOT submitted by the deadline
Ethics	Suitable reference and acknowledgement for all sources used	Not all reference acknowledged	Used 'reproducible research'
Oral Presentation	Well organized, clear presentation, have equal participation	Slides are not well organized, presentation not clear	Poor Organization ,No equal role
Viva-Voce	Fair knowledge of MOST concepts related to the project	Demonstrates fair knowledge of SOME concepts	NO knowledge of any of the concepts

Performance in the Team	Contributes and cooperates in the team, and mentors/leads the team	cooperates but does NOT contribute to the team	Does NOT cooperate

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Course Title	**Intellectual Property Rights and Cyber law**				
Course Code	**16HS8GCIPL**	**Credits**		**L-T-P-S**	**2-0-0-1**
CIE	**50 Marks (100% weightage)**	**SEE**	**100 Marks(50% weightage)**		
Pre-requisites: Personality development course, soft skills					
UNIT-I					**4 hours**
Basic principles of IP laws & Patents: Introduction, Concept of property, Constitutional aspects of IP, Evolution of the patent system in UK, US and India, Basis for protection, Origin and meaning of the term patent, Objective of a patent law, principles underlying the patent law in India, the legislative provisions regulating patents, Non – patentable inventions.					
UNIT-II					**7 hours**
Provisional and complete specification: Definition of Specification, Kinds of specification, provisional specification, complete specification, Claims, Conditions for amendment. **Rights conferred on a patentee:** Patent rights, Exception and limitations, Duties of a Patentee. **Transfer of patent:** Forms of transfer of Patent rights, Assignment, kinds of assignment, License, kinds of license, Rights conferred on a licensee, Transmission of patent by operation of law. **Infringement of patents:** Construction of claims and infringement, patents held to be infringed, patents held to be not infringed. **Action for Infringement:** Where a suit is to be instituted, procedure followed in the suit, Onus of establishment infringement, Defence by the defendant, The Relief's, Injunction, Damages or account of profits, patent agents, patent drafting, database searching, and Case studies.					
UNIT-III					**6 hours**
Copy Right: Meaning and characteristics of copy right, Indian copy right law, requirement of copy right, Illustrations copy right in literary work, Musical work, Artistic work, work of architecture, Cinematograph film, sound recording. Author and Ownership of copy right: Ownership of copy right, Contract of service, Contract for					

service, rights conferred by copy right, terms of copy right, license of copy right.

Infringement of copy right: Acts which constitute infringement, general principle, direct and indirect evidence of copying, Acts not constituting infringements, Infringements in literary, dramatic and musical works, Remedies against infringement of copy right, Case studies

Trade Marks: Introduction, Statutory authorities, procedure of registration of trademarks, rights conferred by registration of trademarks, licensing in trade mark, infringement of trade mark and action against infringement

UNIT-IV		**4 hours**

Cyber Law: An introduction, Definition, why cyber law in India, Evolving cyber law practices-for corporates, privacy in Indian cyber space. Terrorism & Cyber Crime. Cyber theft and Indian telegraph act, Cyber Stalking

UNIT-V		**4 hours**

Indian Cyber law: Protecting Indian children online, Spam, contempt in cyber space, Indian consumers & cyber space, E-courts of India.

Text books:

1	Dr. T Ramakrishna," Basic principles and acquisition of Intellectual Property Rights", CIPRA, NSLIU-2005.
2.	Dr .B.L. Wadehhra, "Intellectual Property Law Handbook", Universal Law Publishing Co .Ltd., 2002.
3	Cyberlaw- The Indian perspective by Pavan Duggal, 2009 Edition.

Reference books:

1	Dr. T Ramakrishna," Ownership and Enforcement of Intellectual Property Rights",CIPRA,NSLIU-2005.
2	"Intellectual Property Law (Bare Actwith short comments)",Universal Law PublishingCo.Ltd.2007.
3	"The Trade marks Act 1999 (Bare Act with short comments)", Universal Law Publishing Co. Ltd., 2005.

SELF STUDY: Presentation and documentation on infringements and various Intellectual property and Cyber law related articles or case studies.