Kurukshetra University Kurukshetra

Syllabus of M.Sc Electronic Science (IIIrd and IVth Semester) under CBCS-LOCF w.e.f. 2021-22 (For UTD Only)

Course Code: EL31	**Course Name:** MOS Solid State Circuits	**L**	**T**	**P**	**C**
		4	**0**	**0**	**4**
Year and Semester	**2nd Year** **III[rd] Semester**	**Contact hours per week:** (4 Hrs) Exam: (3 Hrs)			
Pre-requisite of course	**NIL**	**Evaluation**			
		Sessional: 25	**Examination: 75**		

Course Objectives:

1	To explain the working principals of basic building blocks of digital systems
2	To learn the functioning of dynamic storage like DRAMs and binary adder circuits.
3	To understand various MOS capacitances and delays present in integrated circuits.
4	To learn various testing and simulation methods used in integrated circuits.

Course Outcomes: On completion of the course, student would be able to:

CO1	Describe the working principals of basic building blocks of digital systems
CO2	Explain the functioning of dynamic storage like DRAMs and binary adders circuits
CO3	Estimate the various MOS capacitances and delays present in the integrated circuits
CO4	Use various testing and simulation methods used in integrated circuits.

Mapping of Course Outcomes to Program Outcomes:

CO's	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3		1		2	3			--	--	2		
CO2	3	3		3		3	3			--	--	3		
CO3	3	3		3		3	3			--	--	3		
CO4	3	3		3		3	3			--	--	3		

CONTENTS	**Hrs**	**COs**
Unit-1 Basic digital building blocks, NMOS inverter and its sizing rules, single input NMOS NOR and NAND logic circuits, CMOS inverters, CMOS NOR logic gate, CMOS NAND logic gate, power dissipation , CMOS AND NMOS power dissipation, latch-up and its prevention, signal propagation delays, ratio-logic models, inverter pair delay, NMOS,NAND and NOR delays, CMOS logic delays.voltage.	**10**	**CO1**
Unit-II Dynamic MOS storage circuits, dynamic charge storage, simple shift register, clocked CMOS logic, dynamic RAM memory, register storage circuits, datapath operators, bit-parallel adders, bit-serial adders, carry-save addition, pipelining, pipeline architecture, Floor planning methods, block placement and channel definition, routing, power	**10**	**CO2**

distribution.		
Unit-III Layout Design rules, resistance estimation, capacitance estimation, MOS capacitor characteristics, MOS device capacitances, diffusion capacitances, single wire capacitance, capacitance design guide, inductance estimation, analytical delay models, gate delay model, power dissipation, static and dynamic power dissipation, short-circuit dissipation, total power dissipation.	**10**	**CO3**
Unit-IV CMOS tests methods, need for testing, functionality tests, manufacturing tests and principles, fault models, stuck-at faults, short-circuit and open-circuit faults, Automatic test pattern generation, geometrical specification languages, parameterized layout representation, graphical symbolic layout, layout equation symbology, design rule checks, digital circuit simulation, logic level simulation, switch level simulation, RTL level simulation.	**10**	**CO4**

References
1. VLSI Design Techniques for Analog and Digital Circuits by Randall L. Geiger, Phillip E. Allen and Noel R. Strader, McGraw-Hill. 2. Principles of CMOS VLSI Design- A System Perspective by Neil H.E. Weste and Kamrin Eshraghin, Second Edition, Addison-Wesley. 3. Modern VLSI design – System –on-Chip Design by Wayne Wolf, PHI, Third Edition. 4. Fundamentals of Digital Logic Design by Pucknell (P.Hall)

Note for Examiner(s): *There shall be nine questions in total. Question number 1 will be compulsory and will consist of short conceptual type answers covering all the Units. There shall be eight more questions, two from each unit. Students are required to attempt four questions, selecting one from each unit in addition to the compulsory question. All questions will carry equal marks.*

Assessment Pattern:

Outcomes	**Internal Evaluation (25 Marks)**			**Semester End Examination (75 Marks)**
	Test1	**Test2**	**Assignment/Attendance**	**SEE**
Marks	**10**	**10**	**5**	**75**
CO1	5	-	-	19
CO2	5	-	-	19
CO3		5		18
CO4		5	-	19

Course Code: EL32	**Course Name:** Semiconductor Materials and Device Characterization	**L**	**T**	**P**	**C**
		4	**0**	**0**	**4**
Year and Semester	**2nd Year** **IIIrd Semester**	**Contact hours per week:** (4 Hrs) Exam: (3 Hrs)			
Pre-requisite of course	**NIL**	**Evaluation**			
		Sessional: 25	**Examination: 75**		

Course Objectives:

1	To explain the electrical and analytical techniques for semiconductor characterization
2	To learn the characterization tools for finding out mobility, resistivity and carrier concentration in semiconductor materials.
3	To understand the data obtained from semiconductor characterization techniques
4	To learn the surface characterization techniques such as AFM, SEM, TEM etc.

Course Outcomes: On completion of the course, student would be able to:

CO1	Describe the working principals of various electrical and analytical techniques for characterizations of semiconductor materials and devices.
CO2	Estimate the carrier concentration, mobility and resistivity of semiconductor materials using IV and CV characteristics of semiconductor devices.
CO3	Interpret the data obtained from electrical and analytical semiconductor characterization techniques
CO4	Analyze the surface and bulk behavior of semiconductors using various analytical techniques.

Mapping of Course Outcomes to Program Outcomes:

CO's	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3		1		2	3			--	--	2		
CO2	3	3		3		3	3			--	--	3		
CO3	3	3		3		3	3			--	--	3		
CO4	3	3		3		3	3			--	--	3		

CONTENTS	**Hrs**	**COs**
Unit-1 Resistivity measurement: Four point probe, Correction factors, Resistivity of arbitrarily shaped samples, Resistivity profiling: Anodic oxidation-four point probe, spreading resistance, contact less resistivity methods, conductivity type measurements. Carrier and doping concentration measurements: Capacitance measurements, Differential capacitance, Maximum-Minimum MOS-C capacitance, MOSFET substrate voltage-gate voltage, MOSFET threshold voltage.	**10**	**CO1, CO2**
Unit-2 Metal-Semiconductor Contacts: Contact resistance, Measurement techniques (introduction only), Hall effect and Mobility: Mobility, Conductivity mobility, Magnetoresistance mobility, MOSFET mobility: Effective mobility, field-effect mobility and Saturation mobility, Oxide and interface trapped charge: Characterization	**10**	**CO1, CO2**

using Capacitance-Voltage curves only.		
Unit-3 Deep level Transient Spectroscopy: Conventional DLTS(only), Ellipsometry: theory and applications, Transmission measurements: theory and instrumentation, Fourier Transform Infrared spectroscopy, Reflection Measurements, Line width measurements, Photoluminescence	**10**	**CO3, CO4**
Unit-4 Scanning Electron Microscopy, Auger Electron Spectroscopy, Electron Microprobe, Secondary Ion Mass Spectroscopy and X-ray Photoelectron Spectroscopy (Principle, instrumentation and its applications), Transmission Electron Microscopy, Electron Beam Induced Current, LEED and RHEED (idea only). Scanning Tunneling Microscope, Atomic Force Microscope (brief), Raman spectroscopy.	**10**	**CO3, CO4**

References

1. Semiconductor Material and Device Characterization-Dieter K.Schroder (John Wiley & Sons).
2. Technique of Physics Vol.13, The Electrical Characterization of Semiconductors, Measurement of Minority carrier Properties-J.W.Octon and P.Blood (Academic Press)
3. VLSI Technology-S.M.Sze (McGraw Hill Publications).
4. Nano – A Perspective – T.Pradeep (TMH)

Note for Examiner(s): *There shall be nine questions in total. Question number 1 will be compulsory and will consist of short conceptual type answers covering all the Units. There shall be eight more questions, two from each unit. Students are required to attempt four questions, selecting one from each unit in addition to the compulsory question. All questions will carry equal marks.*

Assessment Pattern:

Outcomes	**Internal Evaluation (25 Marks)**			**Semester End Examination (75 Marks)**
	Test1	**Test2**	**Assignment/Attendance**	**SEE**
Marks	**10**	**10**	**5.0**	**75**
CO1	5	-	-	19
CO2	5	-	-	19
CO3		5		18
CO4		5	-	19

Course Code: EL33	Course Name: Microwave & Optoelectronic Devices	L	T	P	C
		4	0	0	4
Year and Semester	2nd Year IIIrd Semester	Contact hours per week: (4 Hrs) Exam duration: (3 Hrs)			
Pre-requisite of course	Knowledge of EM Theory	Evaluation			
		Sessional: 25	Examination: 75		

Course Objectives:

1. To learn the basic microwave parameters and working of passive components.
2. To learn the working of microwave vacuum active components.
3. To understand the working of microwave solid state devices.
4. To learn the structure and working of solid state lasers and LEDs.
5. To Learn the working of displays and quantum well based devices.
6. To learn the working of various detectors and fibers used in fibre-optic communication

Course Outcomes: On completion of the course, student will have:

CO1	Ability to understand the basic microwave parameters and working of passive components.
CO2	Ability to comprehend the working of microwave vacuum active components.
CO3	Ability to understand the working of microwave solid state devices.
CO4	Ability to understand the structure and working of solid state lasers and LEDs.
CO5	Ability to comprehend the working of displays and quantum well based devices.
CO6	Ability to understand the working of various detectors and fibers used in fiber-optic communication

Mapping of Course Outcomes to Program Outcomes:

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	2		2	2		1			3	2	
CO2	3	2	2	2		2	2		1			3	2	
CO3	3	2	2	2		2	2		1			3	2	
CO4	3	2	2	2		2	2		1			3	2	
CO5	3	2	2	2		2	2		1			3	2	
CO6	3	2	2	2		2	2		1			3	2	

CONTENTS	Hrs	COs
Unit I Microwave Introduction, Waveguides, Rectangular Waveguides - excitation of modes, power transmission, power losses, Microwave parameters-cut off frequency, Characteristic Impedance, Attenuation constant, Phase, Reflection Coefficient, SWR, Power. Microwave passive components (brief)-discontinuities, bands, flanges, TEE's, directional coupler, matched load, attenuators, phase shifter, transitions, ferrite components, slotted line, Wavemeter. Measurements of wavelength, Frequency, impedance, SWR etc. Rectangular Cavity Resonator, Q of cavity, Reentrant cavities. Conventional tubes-limitations at high frequencies, Klystron-operation, velocity modulation, bunching, output power, beam loading. Reflex Klystron-operation, velocity modulation, power output.	**11**	**CO1 CO2**
Unit II Traveling wave tube (in brief), Planar Triodes. Magnetrons (in brief). Transferred Electron Devices, Gunn Effect diode-operation, Modes of operation, microwave generation, amplification, Avalanche Transit Time Devices (in brief). - IMPATT diode, TRAPATT diode, BARITT diode. Parametric Devices & Parametric amplifiers	**9**	**CO3**

(in brief). Microwave field effect transistors-principles of operation, characteristics.		
Unit III Basic principles of light emission in semiconductors, spontaneous emission, stimulated emission, lasing, lasing threshold, efficiency of light emission. Semiconductor lasers, the laser diode, basic structure, Optical modes, lasing threshold conditions, output power and efficiency. Heterostructure, basic heterostructure, laser structure, SH lasers, DH lasers, Performance characteristics of heterojunction lasers. Electro-luminescence, LED materials, LED construction, Response times of LED's, LED's structures for optical communication applications. Display devices-liquid crystal displays	**10**	**CO4**
Unit IV Quantum well devices- Quantum wells and superlattices, Quantum well lasers, Quantum well detectors, Integrated Optical detectors, specialized photodiode structures, Techniques for modifying spectral response, factors limiting performance of integrated detectors. Optical fiber communication-Propagation in Fibers, step index fibers, graded index fibers, multipath dispersion, material dispersion combined effect, Attenuation in optical fibers, Semiconductors P-i-n photodiode detectors and Avalanche Photodiode Detectors for optical communication application, Optical fiber communication systems, OEIC.	**10**	**CO5** **CO6**

References:

1. Microwave Devices and Circuits by Samuel Y. Liao (Prentice Hall India).
2. Electronic Communication Systems by G. Kennedy (TMH).
3. Microwave Engineering by R. Chatterjee.
4. Microwave Semiconductor Devices and their Circuit Applications by H.A. Watson (McGraw Hill).
5. Integrated Optics:Theory & Technology (3rd edition) by R.G. Hunsperger.
6. Optoelectronics-An Introduction (2nd edition) by J. Wilson, J.F.B. Hawkes.
7. Optical Communication Systems by John Gowar.

Note for Examiner(s): *There shall be nine questions in total. Question number 1 will be compulsory and will consist of short conceptual type answers covering all the Units. There shall be eight more questions, two from each unit. Students are required to attempt four questions, selecting one from each unit in addition to the compulsory question. All questions will carry equal marks.*

Assessment Pattern:

Outcomes	**Internal Evaluation (25 Marks)**			**Semester End Examination (75 Marks)**
	Test1	**Test2**	**Assignment/Attendance**	**SEE**
Marks	**10**	**10**	**5.0**	**75**
CO1	2.5			5
CO2	2.5			10
CO3	5			15
CO4		5		15
CO5		2.5		15
CO6		2.5		15

Course Code: EL34 Option (i)	**Course Name:** Custom Microelectronics & ASICs	**L**	**T**	**P**	**C**
		4	**0**	**0**	**4**
Year and Semester	2nd Year IIIrd Semester	**Contact hours per week:** (4 Hrs) **Exam duration**: (3 Hrs)			
Pre-requisite of course	Knowledge of IC Fabrication Process	**Evaluation**			
		Sessional: 25	**Examination: 75**		

Course Objectives:

1. To be able to differentiate among various IC technologies.
2. To be able to comprehend the different types of ASICs and the process involved in the implementation.
3. To learn various simulation types and delay models.
4. To learn static timing analysis.
5. To learn about the various processes involved in chip layout and testing.

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

CO1	To differentiate among the different types of approaches to implement circuits on IC.
CO2	To differentiate among the different types of ASICs and the process involved in their implementation.
CO3	To differentiate among various simulation types and delay models.
CO4	To perform static timing analysis.
CO5	To understand the various processes involved in chip layout and testing.

Mapping of Course Outcomes to Program Outcomes:

CO's	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3		2	2								2	2	
CO2	3	1	2	3							1	3	3	
CO3	3	1	2	3	3	3	3		3		2	3	3	
CO4	3	1	2	3	3	3	3		3		2	3	3	
CO5	3	2	2	2		2					2	2	2	

CONTENTS	**Hrs**	**COs**
Unit I Microelectronics evolution, why custom microelectronics, Custom microelectronic techniques. Full hand crafted custom design, fixed cell architectures, soft cell architectures, macrocells, Analog cells, Gate array techniques, sea of gates, Routing considerations.	**8**	**CO1**
Unit II ASIC design flow, ASIC library design, Programmable ASIC's, ASIC construction, physical design, CAD tools, System partitioning, FPGA partitioning, partitioning methods.	**10**	**CO2**
Unit III Types of simulation, structural simulation, static timing analysis, Gate level simulation, Net capacitance, Logic systems, cell models, delay models static timing analysis, Formal verification, Switch level simulation, Transistor level simulation.	**9**	**CO3** **CO4**
Unit IV Low level design entry, Schematic entry, Floor planning and placement, Floor	**9**	**CO5**

planning goals and objectives, placement terms and definitions, Goals and objectives physical design flow, Routing global routing, Detailed routing, Special routing, testing, Importance of testing, Boundary Scan test, Faults, Automatic test pattern generation, Built in self test, Simple test example.		

References:

1. Custom VLSI Microelectronics by Stanley L.Hurst (Prentice Hall 1992)
2. Application-Specific Integrated Circuit by Michael John Sebastian Smith (Addison Wesley)
3. Application-Specific Integrated Circuit (ASIC) Technology-Academic Press.

Note for Examiner(s): *There shall be nine questions in total. Question number 1 will be compulsory and will consist of short conceptual type answers covering all the Units. There shall be eight more questions, two from each unit. Students are required to attempt four questions, selecting one from each unit in addition to the compulsory question. All questions will carry equal marks.*

Assessment Pattern:

Outcomes	**Internal Evaluation (25 Marks)**			**Semester End Examination (75 Marks)**
	Test1	**Test2**	**Assignment/Attendance**	**SEE**
Marks	**10**	**10**	**5.0**	**75**
CO1	2.5	-		5
CO2	2.5			15
CO3	5	2.5		20
CO4		5		15
CO5		2.5		15

Course Code: EL34 Option (ii)	**Course Name:** RF Microelectronics	**L**	**T**	**P**	**C**
		4	**0**	**0**	**4**
Year and Semester	**2nd Year III nd Semester**	**Contact hours per week:** (4 Hrs) Exam: (3 Hrs)			
Pre-requisite of course		**Evaluation**			
		Sessional: 25	**Examination: 75**		

Course Objectives:

1	Understand the concept of RF microelectronic devices and components
2	Understand the design and performance parameters RF networks and microelectronic circuits
3	Understand the concept of noise in RF ICS

Course Outcomes: On completion of the course, student would be able to:

CO1	Understand the concepts of RF microelectronic devices and components
CO2	Develop essential design concepts of RF networks and microelectronic circuits
CO3	Understand various techniques for RF noise theories and frequency conversion techniques

Mapping of Course Outcomes to Program Outcomes:

CO's	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	1	2	2	1	1	1	--	--	--	--	3	1	--
CO2	3	1	2	3	1	1	1	--	--	--	--	3	1	--
CO3	3	1	2	3	1	1	1	--	--	--	--	3	1	--

CONTENTS	**Hrs**	**COs**
Unit I Importance of RF and wireless technology, IC design technology for RF circuits, RF Behavior of passive components, operation for passive components at RF Active RF Components, RF Diodes, RF BJTs, RF FET, HEMT Active RF component modelling, Transistor models,	**10**	**CO1**
Unit II Circuit representation of two port RF / Microwave Networks, Low and high frequency parameters, Formulation and properties of s parameters, Shifting reference plans, Transmission matrix, Generalized scattering parameters, Passive Circuit design, Review of Smith chart Matching and Biasing networks, Impedence matching using discrete components, microstrip line matching networks, amplifier classes of operation, RF Transistor amplifier designs, Low Noise amplifiers, Stability consideration, Constant gain noise figure circles	**10**	**CO2**
Unit III Noise considerations in active networks, Noise definition, noise sources. RF / Microwave oscillator design, Oscillator versus amplifier design, Oscillation conditions, Design of transistor oscillators, Generator Tuning networks RF / Microwave Frequency conversion II : Mixer design, Mixer types, Conversion loss for SSB mixers, SSB mixer versus DSB mixers. One diode mixers, Two diode mixers, Four diode mixers, Eight diode mixers,	**10**	**CO3**
Unit IV Frequency synthesizers, PLL, RF synthesizer architectures, Transceiver architectures, Receiver architectures, Transmitter architectures, RF / Microwave IC design,	**10**	**CO3**

Microwave ICs, MIC Materials, Types of MICs, Hybrid vs monolithic MICs, Case studies, Relating to design of different circuits employed in RF Microelectronics		

References:

1. Behzad Razavi, "RF Microelectronics" Prentice Hall PTR , 1998
2. R.Ludwig, P.Bretchko, RF Circuit Design, Pearson Education Asia, 2000.
3. Matthew M. Radmanesh, Radio Frequency and Microwave Electronics Illustrated, Pearson Education (Asia) Ltd., 2001

Note for Examiner(s): ***Instructions:*** *There shall be nine questions in total. Question number 1 will be compulsory and will consist of short conceptual type answers covering all the Units. There shall be eight more questions, two from each unit. Students are required to attempt four questions, selecting one from each unit in addition to the compulsory question. All questions will carry equal marks.*

Assessment Pattern:

Outcomes	**Internal Evaluation (25 Marks)**			**Semester End Examination (75 Marks)**
	Test1	**Test2**	**Assignment/Attendance**	**SEE**
Marks	**10**	**10**	**5.0**	**75**
CO1	5	-	-	17
CO2	5	5	-	17
CO3		5		41

Course Code: EL34 Option (iii)	**Course Name:** Digital Signal Processing	**L**	**T**	**P**	**C**
		4	**0**	**0**	**4**
Year and Semester	**2nd Year III nd Semester**	**Contact hours per week:** (4 Hrs) Exam: (3 Hrs)			
Pre-requisite of course		**Evaluation**			
		Sessional: 25	**Examination: 75**		

Course Objectives:

1	Understand the need of Digital Signal Processing
2	Understand the various techniques used in Digital Signal Processing
3	Design various filters and study their practical applications

Course Outcomes: On completion of the course, student would be able to:

CO1	Student would be able to understand the concepts of DSP
CO2	Student would be able develop essential design concepts
CO3	Would be able to apply the knowledge gained in practical applications

Mapping of Course Outcomes to Program Outcomes:

CO's	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	1	2	2	1	1	1	--	--	--	--	3	1	--
CO2	3	1	2	3	1	1	1	--	--	--	--	3	1	--
CO3	3	1	2	3	1	1	1	--	--	--	--	3	1	--

CONTENTS	**Hrs**	**COs**
Unit I Characterization and Classification of signals, Typical signal processing operation. Examples of typical signals, Typical signal Processing Applications, Need of Digital Signal Processing.	**10**	**CO1**
Unit II Time Domain Representation of Signals and System- Discrete time signals, Operation on sequences, Discrete time systems, Time domain characterization of LTI Discrete- time systems, State-space Representation of LTI Discrete Time Systems.	**10**	**CO1, CO2**
Unit III The Discrete-Time Fourier Transform, Discrete Fourier Transform, Discrete Fourier Transform Properties, The z-transform, The inverse z-transform, Properties of z-transform Transform Domain Representations of LTI Systems- The frequency Response, the transfer function all types of transfer functions.	**10**	**CO1 CO2**
Unit IV Digital Filter Structure- Block diagram Representation signal-flow-graph representation, equivalent structures, Basic FIR Digital Filter Structures, Basic IIR Filter structures. Digital Filter Design- Low Pass IIR Digital Filter Design Examples	**10**	**CO1 CO2 CO3**

References:

1. Digital signal processing by Sanjit K.Mitra (TMH)
2. Digital Signal Processing Prokais (Pearson)
3. Introduction to Digital Signal Processing by Johnson (PHI)
4. Digital Signal Processing: Theory, Analysis and Digital Filter Design by Nair (PHI)

Note for Examiner(s): ***Instructions:*** *There shall be nine questions in total. Question number 1 will be compulsory and will consist of short conceptual type answers covering all the Units. There shall be eight more questions, two from each unit. Students are required to attempt four questions, selecting one from each unit in addition to the compulsory question. All questions will carry equal marks.*

Assessment Pattern:

Outcomes	Internal Evaluation (25 Marks)			Semester End Examination (75 Marks)
	Test1	Test2	Assignment/Attendance	SEE
Marks	**10**	**10**	**5.0**	**75**
CO1	5	-	-	30
CO2	5	5	-	30
CO3		5		15

Course Code: EL35 Option (i)	**Course Name:** Digital Communication	**L**	**T**	**P**	**C**
		4	**0**	**0**	**4**
Year and Semester	**2nd Year III nd Semester**	**Contact hours per week:** (4 Hrs) Exam: (3 Hrs)			
Pre-requisite of course		**Evaluation**			
		Sessional: 25	**Examination: 75**		

Course Objectives:

1	Understand the need and application of Digital Communication
2	Understand the design and performance parameters of component blocks
3	Understand the digital transmission of Analog signals

Course Outcomes: On completion of the course, student would be able to:

CO1	Understand the concepts of building blocks and theoretical concepts of digital communication system
CO2	Develop essential design concepts of each of the blocks of digital communication system
CO3	Understand various techniques for digital transmission of analog signals and multiple access techniques for data transmission

Mapping of Course Outcomes to Program Outcomes:

CO's	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	1	2	2	1	1	1	--	--	--	--	3	1	--
CO2	3	1	2	3	1	1	1	--	--	--	--	3	1	--
CO3	3	1	2	3	1	1	1	--	--	--	--	3	1	--

CONTENTS	**Hrs**	**COs**
Unit I Introduction :Model of Communication System, Elements of a Digital Communication System, Analysis and Design of Communication System, Classification of Signals and Systems A brief review of Random Signal Theory : Probabilities, Random Variables and Random Processes Information and Channel Capacity : Measure of Information, Encoding of the Source output – Shannon Encoding Algorithm and Huffman Encoding algorithm (Ref. 3), Discrete Communication Channels : Only Memoryless, Continuous Communication Channel : Shannon- Hartley Theorem	**10**	**CO1**
Unit II Digital Modulation Techniques: Introduction, Binay Phase-Shift Keying, Differential Phase-Shift Keying, Differentially- Encoded PSK, Quardrature Phase Shift Keying, M-ary PSK, Quadrature Amplitude Shift Keying, Binary FSK, Similarity of BFSK and BPSK, M-ary FSK, Minimum Shift Keying, Duobinary Encoding, A Comparison of Narrowband FM System (Ref 2)	**10**	**CO1, CO2 and CO3**
Unit III Error control coding : Examples of Error control coding, Methods of controlling errors, Types of errors and codes, Linear block codes, Binary cyclic codes. Convolutional Codes-Trellis Code	**10**	**CO1 CO2 CO3**

Unit IV Digital Transmission of Analog Signals, Sampling theory and Practice, Quantizing of Analog Signals, , PCM, Delta Modulation, Q-level differential PCM, Time Division Multiplexing, Spread Spectrum and Multiple Access Techniques, Introduction to Spread Spectrum Modulation , Code Acquisition and Tracking , Spread Spectrum as a Multiple Access Techniques..	**10**	**CO1** **CO2** **CO3**

References:

1. Digital and Analog Communication Systems by K. Sam Shanmugan (John wiley & Sons 1994).
2. Principles of Communication System by Taub and Schilling (McGraw Hill International).
3. An Introduction to Analog & Digital Communication by Simon Haykin.
4. John G.Proakis, "Digital Communication" McGraw Hill 3rd Edition, 1995

Note for Examiner(s): ***Instructions:*** *There shall be nine questions in total. Question number 1 will be compulsory and will consist of short conceptual type answers covering all the Units. There shall be eight more questions, two from each unit. Students are required to attempt four questions, selecting one from each unit in addition to the compulsory question. All questions will carry equal marks.*

Assessment Pattern:

Outcomes	**Internal Evaluation (25 Marks)**			**Semester End Examination (75Marks)**
	Test1	**Test2**	**Assignment/Attendance**	**SEE**
Marks	**10**	**10**	**5.0**	**75**
CO1	5	-	-	30
CO2	5	5	-	30
CO3		5		15

Course Code: EL 35 **Option** (ii)	**Course Name: Optical Fiber Communication**	**L**	**T**	**P**	**C**
		4	**0**	**0**	**4**
Year and Semester	**2nd Year** **III Semester**	**Contact hours per week:** (4 hrs.) Exam: (3 hrs.)			
Pre-requisite of course	NIL	**Evaluation**			
		Sessional:25	**Examination: 75**		

Course Objectives:

1. To understand the basics of optical communication systems.
2. To acquire knowledge of optical fibers.
3. To understand different Semiconductor lasers for optical communication
4. To understand the difference between semiconductor lasers and LED.
5. To Acquire detailed knowledge of Optical fiber systems

Course Outcomes: On completion of the course, student will have:

CO1	Ability to explain the basic communication system
CO2	Ability to explain the principal and applications of optical fibers.
CO3	Ability to analyze dispersion and attenuation in optical fibers
CO4	Ability to evaluate efficiency of lasers and LEDs.
CO5	Ability to explain various LED structures and their characteristics and reliability
CO6	Ability to explain the modulation and demodulation of Optical fiber systems
CO7	Ability to discuss optical fiber communication applications & future developments

i. Mapping of Course Outcomes to Program Outcomes:

CO's	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	1	3	3		2	2			--	--	3	3	3
CO2	3	1	3	3		3	2			--	--	3	3	3
CO3	3	1	2	3		3	2			--	--	3	3	3
CO4	3	1	2	1		3	1					2	2	1
CO5	3	1	2	3		3	2					3	3	3
CO6	3	1	2	3		3	2					3	3	3
CO7	3	1	3			3	2					3	3	3

CONTENTS	**Hrs.**	**COs**
Unit I Optical communication, Introduction, the measurement of information & capacity of a telecommunication channel, communication system architecture, the basic communication system, Optical communication system, the economic merits, optical fibers digital telecommunication system, analogue system, application & future developments, optical satellite communication.	**10**	**CO1**

Unit II Elementary discussion of propagation in Fibers, Propagation a ray model, signal degradation in optical fibers, Material dispersion, the combined effect of material dispersion & multipath dispersion, RMS pulse widths & frequency response, attenuation in optical fibers, attenuation mechanisms, assessment of silica fibers & cables, power launching and coupling, fiber connectors, splices & couples.	**10**	**CO2, CO3**
Unit III Semiconductor lasers for optical communication, the development of stripe geometry lasers, direct modulation of Semiconductor lasers, optical & electrical characterization of stripe geometry & buried heterostructure lasers, sources for longer wavelength LED's efficiency of DHLED. LED structures, characteristics, reliability, modulation (AM, FM & pulse modulation).	**11**	**CO4 CO5**
Unit IV Optical fiber systems, intensity modulation/direct detection, the optical transmitter circuit, the optical receiver circuit, system design consideration, digital systems, planning consideration, analog system, coherent optical fiber system, detection principles, practical constraints, modulation formats, Demodulation schemes, receiver sensitivities, optical fiber communication application & future developments (Public, Military, Industrial & Computer) application, local area networks.	**9**	**CO6, CO7**

References:

1. Optical fiber communications (Principle and Practice) 2nd edition-John M.Senior (Prentice Hall India Pvt. Ltd, New Delhi).
2. Optical Communication Systems Second edition-John Gowar (Prentice Hall India Pvt. Ltd, New Delhi).
3. Optical Fiber Communications - Gerd Keiser (McGraw Hill International editions, Singapore).

Additional References:

1. Fundamental of optical fiber communication second edition-Michael K.Barnoski (Academic Press, Orlando).
2. Fiber Optic Communication Systems-Govind P.Agarwal (John Wiley & Sons, Singapore).

Note for Examiner(s): *There shall be nine questions in total. Question number 1 will be compulsory and will consist of short conceptual type answers covering all the Units. There shall be eight more questions, two from each unit. Students are required to attempt four questions, selecting one from each unit in addition to the compulsory question. All questions will carry equal marks.*

Assessment Pattern:

Outcomes	Internal Evaluation (25 Marks)			Semester End Examination (75 Marks)
	Test1	**Test2**	**Assignment/Attendance**	**SEE**
Marks	**10**	**10**	**5.0**	**75**
CO1	*5.0*			*18.75*
CO2	*2.5*			*8.75*
CO3	*2.5*			*10*
CO4		*2.5*		*8.75*
CO5		*2.5*		*10*
CO6		*2.5*		*10*
CO7		*2.5*		*8.75*

Course Code: EL35 Option (iii)	**Course Name:** Wireless and Mobile Communication	**L**	**T**	**P**	**C**
		4	**0**	**0**	**4**
Year and Semester	**2nd Year III nd Semester**	**Contact hours per week:** (4 Hrs) Exam: (3 Hrs)			
Pre-requisite of course		**Evaluation**			
		Sessional: 25	**Examination: 75**		

Course Objectives:

1	Understand the need and application of Wireless and Mobile Communication
2	Understand the design and performance parameters of component blocks
3	Understand the difference between wireless and mobile communication

Course Outcomes: On completion of the course, student would be able to:

CO1	Student would be able to understand the concepts of building blocks of communication system
CO2	Student would be able develop essential design concepts
CO3	Would be able to apply the knowledge gained in practical applications

Mapping of Course Outcomes to Program Outcomes:

CO's	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	1	2	2	1	1	1	--	--	--	--	3	1	--
CO2	3	1	2	3	1	1	1	--	--	--	--	3	1	--
CO3	3	1	2	3	1	1	1	--	--	--	--	3	1	--

CONTENTS	**Hrs**	**COs**
Unit I SERVICES AND TECHNICAL CHALLENGES : - Types of Services, Requirements for the services, Multipath propagation, Spectrum, Limitations, Noise and Interference limited systems, Principles of Cellular networks,, Multiple Access Schemes. Propagation Mechanisms (Qualitative treatment), Propagation effects with mobile radio, Channel Classification, Link calculations, Narrowband and Wideband models.	**10**	**CO1**
Unit II SIGNAL PROCESSING IN WIRELESS SYSTEMS:- Principle of Diversity, Macro-diversity, Micro-diversity, Signal Combining Techniques, Transmit diversity, Equalisers - Linear and Decision Feedback equalisers, Review of Channel coding and Speech coding techniques. Spread Spectrum Systems - Cellular Code Division Multiple Access Systems- Principle, Power control, Effects of multipath propagation on Code Division Multiple Access, Orthogonal Frequency Division Multiplexing – Principle, Cyclic Prefix, Transceiver implementation .	**10**	**CO1, CO2**
Unit III CELLULAR TELEPHONE CONCEPTS: -Introduction, Mobile telephone Service,	**10**	**CO1 CO2**

Cellular Telephone, Frequency reuse, Interference, Cell splitting, Sectoring, Segmentation and Dualisation, Cellular System Topology, Roaming and Hands offs, Cellular telephone network components, Cellular telephone call processing, Digital Cellular Telephone, Global System for Mobile Communications .		**CO3**
Unit IV Ultra Wide Band (UWB) Wireless- Definition and Features, Channels, Data Modulation, Bit error Performance of UWB. Wireless standards GPRS, WCDMA, LTE and WiMAX	**10**	**CO1** **CO2** **CO3**

References:

1. Andreas.F. Molisch, "Wireless Communications", John Wiley – India, 2006.
2. Simon Haykin & Michael Moher, "Modern Wireless Communications", Pearson Education 2007
3. Electronic Communications Systems by Wayne Tomasi, Pearson Education

Additional References:
1. Rappaport. T.S., "Wireless communications", Pearson Education, 2003.
2. Gordon L. Stuber, "Principles of Mobile Communication", Springer International Ltd., 2001.
3. Andrea Goldsmith, Wireless Communications, Cambridge University Press, 2007.

Note for Examiner(s): ***Instructions:*** *There shall be nine questions in total. Question number 1 will be compulsory and will consist of short conceptual type answers covering all the Units. There shall be eight more questions, two from each unit. Students are required to attempt four questions, selecting one from each unit in addition to the compulsory question. All questions will carry equal marks.*

Assessment Pattern:

Outcomes	**Internal Evaluation (25 Marks)**			**Semester End Examination (75 Marks)**
	Test1	**Test2**	**Assignment/Attendance**	**SEE**
Marks	**10**	**10**	**5.0**	**75**
CO1	5	-	-	30
CO2	5	5	-	30
CO3		5		15

Course Code: EL36	**Course Name:** Communication Lab	**L**	**T**	**P**	**C**
		0	**0**	**16**	**8**
Year and Semester	**2nd Year** **IIInd Semester**	**Contact hours per week:** (16 Hrs) Exam: (4 Hrs)			
Pre-requisite of course	**NIL**	**Evaluation**			
		Sessional: 25	**Examination: 75**		

Course Objectives:

1	To learn about simulation tools used for electronic communication system designing.
2	To perform simulations of various communication systems.
3	To Analyze and interpret experimental data
4	To know how to present the results of experiments

Course Outcomes: On completion of the course, student would be able to:

CO1	Familiarize with Simulation Tools, Test Benches used in designing of communication systems
CO2	Perform the simulation of electronic communication circuits.
CO3	Analyze & Interpret the data obtained in the experiments.
CO4	Present the experimental results and conclusions in the form of written report in clear and concise manner.

Mapping of Course Outcomes to Program Outcomes:

CO's	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	1	2		3	2	3	3		2	1	1	3	3	3
CO2	1	2		3	2	3	3		2	1	1	2	3	3
CO3		2		3	2	3		2	2	1	1			
CO4			3		2					1				

List of Experiments list to be prepared by department as per COs

Course Code: EL37	**Course Name:** CAD Tools & Embedded Systems Lab	**L**	**T**	**P**	**C**
		0	**0**	**16**	**8**
Year and Semester	**Ist Year** **3rd Semester**	**Contact hours per week:** (16 Hrs) Exam: (4 Hrs)			
Pre-requisite of course	**NIL**	**Evaluation**			
		Sessional: 25	**Examination: 75**		

Course Objectives:

1	To learn about various CAD tools for digital circuits and systems
2	To learn about the programming techniques for embedded systems.
3	To Analyze and interpret experimental data
4	To know how to present the results of experiments

Course Outcomes: On completion of the course, student would be able to:

CO1	Operate various CAD tools for designing and simulation of digital systems
CO2	Write and execute the programs for embedded systems
CO3	Analyze & Interpret the data obtained in the experiments.
CO4	Present the experimental results and conclusions in the form of written report in clear and concise manner.

Mapping of Course Outcomes to Program Outcomes:

CO's	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	1	2		3	2	3	3		2	1	1	3	3	3
CO2	1	2		3	2	3	3		2	1	1	2	3	3
CO3		2		3	2	3		2	2	1	1			
CO4			3		2					1				

List of Experiments list to be prepared by department as per COs

Course Code: EL41	Course Name: Project Report & Viva-Voce	L	T	P	C
		0	0	0	20
Year and Semester	2nd Year 4th Semester	Contact hours per week: (10 Hrs) Exam: Viva-Voce			
Pre-requisite of course	NIL	Evaluation			
		Examination: 300			

Course Objectives:

1	To learn about ways of literature survey in a given domain
2	To understand the impact of scientific/industrial research/project on the society
3	To know ways to carry out scientific research/ projects using existing scientific/technical knowledge
4	To lean about financial management/planning of research project.
5	To communicate the findings of research/project work effectively to the scientific community using oral presentations and written reports/papers.
6	To appreciate the importance of team work in professional environment
7	To understand the professional ethics required in a industry/organization

Course Outcomes: On completion of the course, student would be able to:

CO1	Ability to engage in independent study to research literature in the identified domain.
CO2	Ability to identify the community that shall benefit through the solution to the identified engineering problem and demonstrate concern for environment.
CO3	Ability to engage in independent study to identify the mathematical concepts, science concepts, engineering concepts and management principles necessary to solve the identified engineering problem
CO4	Ability to analyze and interpret results of experiments conducted on the designed solution(s) to arrive at valid conclusions
CO5	Ability to perform the budget analysis of the project through the utilization of resources (finance, power, area, bandwidth, weight, size, any other)
CO6	Ability to engage in effective written communication through the project report, journal/poster presentation of the project work
CO7	Ability to engage in effective oral communication through presentation and demonstration of the project work
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

Mapping of Course Outcomes to Program Outcomes:

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	1	3		3		3			3		2	1	3	3
CO2	1	2	2	3		3		3	3		3	1	3	3
CO3	1	3		3		3	3	2	2		2	3	3	3
CO4	1	3		3		3	2	2	2		1	2	3	3
CO5		3		3		3		2	2		3		3	
CO6		2	3		2				3	2	2			3
CO7		2	3		2				3	2	3			3
CO8		2			3				3					3
CO9		2							2	3	2			

Course Code: EL42	**Course Name:** Current Topic Seminar in Electronics	**L**	**T**	**P**	**C**
		0	**0**	**0**	**4**
Year and Semester	**2nd Year** **4th Semester**	**Contact hours per week:** (4 Hrs.) Exam: 1 hour			
Pre-requisite of course	**NIL**	**Evaluation**			
		Examination:100			

Course Objectives:

1	To learn about ways of literature survey in a given domain
2	To understand the impact of scientific/industrial research/project on the society
3	To know ways to carry out scientific research/ projects using existing scientific/technical knowledge
4	To develop the ability to communicate the scientific information effectively through written report and oral presentations.

Course Outcomes: On completion of the course, student would be able to:

CO1	Ability to engage in independent study to research literature in the identified domain.
CO2	Ability to identify the community that shall benefit through the solution to the identified engineering problem and also demonstrate concern for environment.
CO3	Ability to engage in independent study to identify the mathematical concepts, science concepts, engineering concepts and management principles necessary to solve the identified engineering problem
CO4	Ability to engage in effective written communication through the report.
CO5	Ability to engage in effective oral communication through presentation
CO6	Ability to perform in the team, contribute to the team and mentor/lead the team
CO7	Ability to abide by the norms of professional ethics

Mapping of Course Outcomes to Program Outcomes:

CO's	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	1	3		3		3			3		2	1	3	3
CO2	1	2	2	3		3		3	3		3	1	3	3
CO3	1	3		3		3	3	2	2		2	3	3	3
CO4		2	3		2				3	2	2			3
CO5		2	3		2				3	2	3			3
CO6		2			3				3					3
CO7		2							2	3	2			

OPEN ELECTIVE COURSES

Course Code: OE 203	**Course Name:** Fundamentals of Nanomaterials	**L**	**T**	**P**	**C**
		2	**0**	**0**	**2**
Year and Semester	**Ist Year** **II Semester**	**Contact hours per week:** (2 Hrs) Exam: (1.5 Hrs)			
Pre-requisite of course	**NIL**	**Evaluation**			
		Sessional: 15	**Examination: 35**		

Course Objectives:

1. Get familiarized with the concepts of Nanoscience and Technology.
2. Understand the properties and applications of semi conducting materials,
3. Understand general properties and application of nanomaterials.
4. Acquire knowledge of synthesis and characterization techniques

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

CO1	Explain general concepts of Nanomaterials
CO2	Synthesize nanomaterials
CO3	Identify the phase using search peak analysis from XRD pattern
CO4	Interpret the characterized results

Mapping of Course Outcomes to Program Outcomes:

CO's	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	1	2	1		1	1			--	--	3	3	3
CO2	3	1	2	1		1	2			--	--	3	3	3
CO3	3	1	2	1		1	1			--	--	3	3	3
CO4	3	1	2	1		1	1					2	2	1

CONTENTS	**Hrs**	**COs**
UNIT I **NANODIMENSIONAL MATERIALS AND THEIR SYNTHESIS** Basic concepts of Nano science and technology, Properties and technological advantages of Nano materials, Nanostructures: Quantum wire, Quantum well, Quantum dot, Size Effects, Quantum confinement, Fraction of Surface Atoms, specific Surface Energy and Surface Stress ,Effect on the Lattice Parameter, Phonon Density of States, Material processing by Sol – Gel method, Chemical Vapour deposition and Physical Vapour deposition, hydrothermal/solvothermal methods, and Microwave Synthesis of materials	**6**	**CO1 CO2 CO4**
UNIT II **CHARACTERIZATION OF NANOMATERIALS** Fundamentals of the techniques, experimental approaches and data interpretation,	**6**	**CO1, CO2, CO3**

applications/limitations of X ray characterization: X-ray sources, wide angle, extended x-ray absorption technique, Scanning probe microscope (AFM and STM), Electron microscopy: SEM/TEM, high resolution imaging, defects in nanomaterials Spectroscopy: electron energy-loss mechanisms, electron filtered imaging, prospects of scanning probe microscopes, optical spectroscopy of metal/semiconductor nanoparticles: UV-Vis spectroscopy, FTIR Spectroscopy		**CO4**

References:

1 C. N. R. Rao, A. Mu¨ller, A. K. Cheetham, The Chemistry of Nanomaterials :Synthesis, Properties and Applications, Volume 1, Wiley-VCH, Verlag GmbH, Germany (2004).
2 C. Bre´chignac P. Houdy M. Lahmani, Nanomaterials and Nanochemistry, Springer Berlin Heidelberg, Germany (2006).
3 Guozhong Cao, Nanostructures & Nanomaterials Synthesis, Properties G;Z: Applications, World Scientific Publishing Private, Ltd., Singapore (2004).
4 Zhong Lin Wang, Characterization Of Nanophase Materials, Wiley-VCH, Verlag GmbH, Germany (2004). 5) Carl C. Koch, Nanostructured Materials: Processing, Properties and Potential Applications, Noyes Publications, William Andrew Publishing Norwich, New York, U.S.A (2002).
5. Hari Singh Nalwa, "Nanostructured Materials and Nanotechnology", Academic Press, 2002

Note for Examiner(s): ***Instructions:*** *There shall be nine questions in total. Question number 1 will be compulsory and will consist of short conceptual type answers covering all the Units. There shall be eight more questions, two from each unit. Students are required to attempt four questions, selecting one from each unit in addition to the compulsory question. All questions will carry equal marks.*

Assessment Pattern:

Outcomes	**Internal Evaluation (25 Marks)**			**Semester End Examination (35 Marks)**
	Test1	**Test2**	**Assignment/Attendance**	**SEE**
Marks	**10**	**5**	**5.0**	**35**
CO1	5	-	-	10
CO2	2.5		-	5
CO3		2.5		10
CO4	2.5	2.5		10

Course Code: OE 303	Course Name: MEMS an Interdisciplinary Approach	L	T	P	C
		2	0	0	2
Year and Semester	2nd Year III Semester	Contact hours per week: (2 Hrs) Exam: (1.5 Hrs)			
Pre-requisite of course	NIL	Evaluation			
		Sessional: 15	Examination: 35		

Course Objectives:

1. Understand the role of MEMS in daily life applications
2. Appreciate the interdisciplinary nature of this field
3. Expose the students to career and research prospects in this field

Course Outcomes: On completion of the course, student:

CO1	Will be able to understand the role of various science discipline including his/her own in this field
CO2	Would become aware of role of their field in MEMS and hence career choice
CO3	Would gain basic knowledge to take up higher studies in this field
CO4	Would be able to appreciate the MEMS technology and its applications in daily life

Mapping of Course Outcomes to Program Outcomes:

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	1	2	1		1	1			--	--	3	3	3
CO2	3	1	2	1		1	2			--	--	3	3	3
CO3	3	1	2	1		1	1			--	--	3	3	3
CO4	3	1	2	1		1	1					2	2	1

CONTENTS	Hrs	COs
Unit I Definition of MEMS, historical perspective of MEMS, advantages of MEMS. Scale effects at microscale- geometry, thermal, electrostatic, electrical, fluidics, gravity. MEMS domains Materials used in MEMS and their properties, micromachining techniques-bulk and surface micromachining, Sensing and detection mechanisms in MEMS, MEMS in daily life	**6**	**CO1 CO3 CO4**
Unit II **MEMS technology in Healthcare:** BioMEMS, Lab-on-chip, µTAS, Drug Delivery, point-of-care devices, cantilever sensors **MEMS technology in Physics and Geophysics** Accelerometers, pressure sensors, gyroscopes, MOEMS, microactuators, seismic sensors **MEMS Technology in Chemistry** Gas sensor, Electrochemical Immunoassay, microreactors, Chemical Sensors Design Tools for MEMS: Comsol, Coventore and Intellisuite based applications	**6**	**CO1, CO2, CO3 CO4**

References:

1. Foundations of MEMS, Liu, Pearson India

2. Microfabrication by Marc Madaon, CRC Press
3. MEMS & Microsystems Design and Manufacture by Tai-Ran H Su, Tata Mcgraw
4. Microsystem Design by S.D. Senturia, Ruiwer Academic Publisher

Note for Examiner(s): ***Instructions:*** *There shall be nine questions in total. Question number 1 will be compulsory and will consist of short conceptual type answers covering all the Units. There shall be eight more questions, two from each unit. Students are required to attempt four questions, selecting one from each unit in addition to the compulsory question. All questions will carry equal marks.*

Assessment Pattern:

Outcomes	**Internal Evaluation (25 Marks)**			**Semester End Examination (35 Marks)**
	Test1	**Test2**	**Assignment/Attendance**	**SEE**
Marks	**10**	**5**	**5.0**	**35**
CO1	5	-	-	10
CO2	2.5		-	5
CO3		2.5		10
CO4	2.5	2.5		10