Kurukshetra University, Kurukshetra

(Established by the State Legislature Act XII of 1956)
('A+' Grade, NAAC Accredited)

।। योगस्थः कुरु कर्माणि ।।
समबुद्धि व योग युक्त होकर कर्म करो

(Perform Actions while Steadfasting in the State of Yoga)

DEPARTMENT OF ELECTRONIC SCIENCE

CBCS CURRICULUM (2020-21)
Program Name: M.Sc. (Electronic Science)
(For the Batches Admitted from 2020-2021)

OUTCOME BASED EDUCATION SYSTEM

CBCS CURRICULUM (2020 -21)

Program Name: M.Sc. (Electronic Science)

(For the Batches Admitted from 2020-2021)

VISION

Be globally acknowledged as a distinguished centre of academic excellence.

MISSION

To prepare a class of proficient scholars and professionals with ingrained human values and commitment to expand the frontiers of knowledge for the advancement of society.

DEPARTMENT VISION AND MISSION

VISION

- To become center of quality education, research with innovation in the field of electronic science and be recognized at National and International level for serving society.

MISSION

- **M1:** To provide quality education to aspiring young minds for improving their scientific knowledge and technical skills in the area of Electronic Science.
- **M2:** To produce socially committed trained professionals who can contribute effectively to the advancement of their organization and society through their scientific knowledge.
- **M3:** To foster innovation in Electronic Science and allied areas by collaborating with industry and other R&D organizations.

Mapping of University Vision and Mission to Department Vision and Mission

Acclaimed as modal Centre of Learning and Research by

University Vision and Mission	**Department Vision and Mission**
High quality knowledge delivery through state of art infrastructure and ethical values to the students	**Yes**
Students excellence will make them professionals and innovators emerging as global leaders	**Yes**
Research and development will help in furtherance of Faculty knowledge	**Yes**

Programme Educational Objectives (PEOs):

The Department of Electronic Science have formulated the Programme Educational Objectives (PEO's) that are broad statements to achieve the mission of the Department. The PEOs have been defined after consultation with all stakeholders. The PEO's of the M.Sc. (Electronic Science) Program are as follows:

- **PEO1**: To develop ability to analyze, design, develop, optimize and implement complex electronic systems using state of the art approaches and provide practical solutions to electronics related problems.
- **PEO2**: To develop ability to work independently as well as collaboratively and demonstrate leadership, managerial skills and ethical & social responsibility.
- **PEO3:** To promote the life-long learning by pursuing higher education and participation in research and development activities to meet all challenges to transform them as responsible citizens of the nation

Program Specific Outcomes (PSO's):

- **PSO1:** Ability to use the techniques, skills, and cutting-edge tools for technical practice in the field of Electronics.
- **PSO2:** Ability to design and implement complex electronic systems in the various technological advanced areas.
- **PSO3:** Ability to design and perform electronics experiments, as well as to analyze and interpret data

PEOs to Mission statement mapping

PEO's	MISSION OF THE DEPARTMENT		
	M1	M2	M3
PEO1	3	1	3
PEO2	1	3	2
PEO3	3	2	3

Program Outcomes (PO) with Graduate Attributes

Programme Outcomes are attributes of the graduates from the programme that are indicative of the graduates' ability and competence to work as an engineering professional upon graduation. Program Outcomes are statements that describe what students are expected to know or do by the time of graduation, they must relate to knowledge and skills that the students acquire from the programme. The achievement of all outcomes indicates that the student is well prepared to achieve the program educational objectives down the road. The M.Sc. (Electronic Science) program has following eleven PO's. The course syllabi and the overall curriculum are designed to achieve these outcomes:

S. No	Graduate Attributes	Program Outcomes (POs)
1	Knowledge	**PO1**: Capability of demonstrating comprehensive disciplinary knowledge gained during course of' study.
2	Research Aptitude	**PO2:** Capability to ask relevant/appropriate questions for identifying, formulating and analyzing the research problems and to draw conclusion from the analysis.
3	Communication	**PO3:** Ability to communicate effectively on general and scientific topics with the scientific community and with society at large
4	Problem Solving	**PO4:** Capability of applying knowledge to solve scientific and other problems
5	Individual and Team Work	**PO5:** Capable to learn and work effectively as an individual, and as a member or leader in diverse teams, in multidisciplinary settings.
6	Investigation of Problems	**PO6**: Ability of critical thinking, analytical reasoning and research based knowledge including design of experiments, analysis and interpretation of data to provide conclusions
7	Modern Tool Design	**PO7:** ability to use and learn techniques, skills and modern tools for scientific practices
8	Science and Society	**PO8:** Ability to apply reasoning to assess the different issues related to society and the consequent responsibilities relevant to professional scientific practices
9	Life-Long Learning	**PO9:** Aptitude to apply knowledge and skills that are necessary for participating in learning activities throughout life.
10	Ethics	**PO10:** Capability to identify and apply ethical issues related to one’s work, avoid unethical behavior such as fabrication of data, committing plagiarism and unbiased truthful actions in all aspects of work.
11	Project Management	**PO11:** Ability to demonstrate knowledge and understanding of the scientific principles and apply these to manage projects.

Mapping of PEO’s with PO’s

S. No.	*Program Educational Objectives*	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
1	Ability to analyze, design, develop, optimize and implement complex electronic systems using state of the art approaches derived from engineering sciences and practical solutions to electronics related problems.	√	√		√		√	√					√	√	√
2	Ability to work independently as well as collaboratively and to demonstrate leadership, managerial skills and ethical and social responsibility.			√		√			√		√	√			
3	Ability to engage in the life-long learning by pursuing higher education and participation in research and development activities to meet all challenges to transform them as responsible citizens of the nation			√	√		√	√	√	√		√	√	√	√

Kurukshetra University, Kurukshetra

Scheme of Examination & Syllabus of M.Sc. Electronic Science (CBCS)

(I to IV Semesters) w.e.f. Session 2020-2021 (in phased manner)

Part-I Course Subjects

Course No.	Name		Marks			Exam Time	Credit	Workload/ contact hrs. per week
			Sessional*	Exam	Total			
Semester I								
EL 11	Mathematical & Computational Techniques in Electronics		25	75	100	3 hrs.	4	4
EL 12	Physics of Solid State Devices		25	75	100	3 hrs.	4	4
EL 13	IC Fabrication Technology		25	75	100	3 hrs.	4	4
EL 14	EM Theory and Electronic Communication		25	75	100	3 hrs.	4	4
EL 15	Electronic Instrumentation & Control System		25	75	100	3 hrs.	4	4
EL 16	Analog Circuit Design Lab		25	75	100	4 hrs.	8	16
EL 17	Digital Circuit Design & Programming Lab		25	75	100	4 hrs.	8	16
						Total	36	52
Semester-II								
EL 21	Digital Circuits and System Design		25	75	100	3 hrs.	4	4
EL 22	Device Models & Circuit Simulation		25	75	100	3 hrs.	4	4
EL 23	Verilog- Hardware Description Language		25	75	100	3 hrs.	4	4
EL 24	System Design Using Embedded Processors		25	75	100	3 hrs.	4	4
EL 25	Option		25	75				
(i)	Foundations of MEMS		25	75	100	3 hrs.	4	4
(ii)	Nano Electronics – Materials & Devices		25	75	100	3 hrs.	4	4
(iii)	Materials for VLSI		25	75	100	3 hrs.	4	4
EL 26	Electronic Circuits Simulation & Microcontroller Lab		25	75	100	4 hrs.	8	16
EL 27	IC Processing & Characterization lab		25	75	100	4 hrs.	8	16
						Total	36	52
Semester-III								
EL 31	MOS Solid State Circuits		25	75	100	3 hrs.	4	4
EL 32	Semiconductor Material & Device Characterization		25	75	100	3 hrs.	4	4
EL 33	Microwave & Optoelectronic Devices		25	75	100	3 hrs.	4	4
EL 34	Option		25	75				
(i)	Custom Microelectronics & ASICs		25	75	100	3 hrs.	4	4
(ii)	RF Microelectronics		25	75	100	3 hrs.	4	4
(iii)	Digital Signal Processing		25	75	100	3 hrs.	4	4
EL 35	Option		25	75				
(i)	Digital Communication		25	75	100	3 hrs.	4	4

(ii)	Optical Fiber Communication		25	75	100	3 hrs.	4	4
(iii)	Wireless & Mobile Communication		25	75	100	3 hrs.	4	4
EL 36	Communication Lab		25	75	100	4 hrs.	8	16
EL 37	CAD Tools & Embedded Systems Lab		25	75	100	4 hrs.	8	16
						Total	36	52
Semester IV								
EL 41	Project report & Viva Voce **		0	0	300		20	-
EL 42	Current Topic Seminar in Electronics		0	0	100	1 hr.	4	-
						Total	24	-

Total credits = 132

Note:
*(i) In theory papers, the internal assessment will be based on two class tests, one assignment and the attendance in the class. Where two teachers are teaching the subject, average of the tests and assignments will be considered.

**(ii) The Project is to be carried out for six months during Jan-June in an Industry or Institute of repute or in the Department labs. The students are required to submit a dissertation. Evaluation will be done by examiners appointed by the PG Board of studies and will be based on the dissertation and Viva Voce.

Part-II
The students of Department of Electronic Science will take two open choices (2 credit each) offered by other Departments of Science Faculty and have to earn 4 credit in addition to credit earned in Part-I.

Part-III
Open choice offered by the Department of Electronic Science for the students of other Departments of Science Faculty as under:

Open Elective

Course No.	Name		Marks			Exam Time	Credits	Workload/ contact hrs. per week
			Sess	Exam	Tot			
OE 203	Fundamental of Nanomaterials		15	35	50	3 hrs.	2	2
OE 303	MEMS: An Interdisciplinary Approach		15	35	50	3 hrs.	2	2

The open choice will be offered in II/III sem.

Detailed Syllabus

Course Code: EL11	Course Name: **Mathematical & Computational Techniques in Electronics**		L	T	P	C
			4	**0**	**0**	**4**
Year and Semester	**1st Year** **I 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 role of mathematics & computational methods in Electronics
2.	To acquire the knowledge of various applied mathematical techniques/methods to develop simulation analysis tools for digital and analog electronic circuits
3.	To understand the use of various analysis i.e. AC, DC & transient techniques for solving linear and non linear electronic & electrical circuits
4.	To acquire knowledge of various simulation & modeling software tools for electronic circuits

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

CO1	Ability to understand the role of applied mathematical techniques for their use in designing, simulation & modeling of for digital and analog electronic circuits
CO2	Ability to design software tools for simulation & modeling of electronic circuits
CO3	Understand different techniques for simulation & modeling of electronic circuits
CO4	Develop skill to design software tools to be used in electronics

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	2	3	3	3	3	--	--	--	3	3	3	
CO2	3	3	2	3	3	3	3	--	--	--	3	3	3	
CO3	3	3	2	3	3	3	3	--	--	--	3	3	3	
CO4	3	3	2	3	3	3	3	--	--	--	3	3	3	

CONTENTS	**Hrs.**	**COs**
Unit I Role of simulation in IC design, DC Analysis of linear networks, Node analysis, Loop analysis, Hybrid formulation techniques, 2b Method, Tableau Method, Modified node analysis, Transient analysis of linear and non-linear circuits, Possible formulation techniques, Numerical solution of ordinary differential equations, Associated circuit models for inductors and capacitors, Use of associated circuit models	**10**	**CO1, CO2, CO3 and CO4**
Unit II DC analysis of Non-Linear circuits, DC analysis of Non-linear equation in one unknown, Newton-Raphson techniques for many variables, linearized equivalent for Newton-Raphson technique, General Consideration in solving Non-linear Circuits,	**10**	**CO1, CO2, CO3 and**

Network graphs: basic concepts, formation of incidence matrix and its properties, Cut set matrix, State variable analysis: Introduction, State Space model, State-Space model applicable for electrical circuits.		**CO4**
Unit III Laplace transforms: Definition, Fundamental rules, Operational methods in applied mathematics; Integral transform, Application of the operational calculus to the solution of partial differential equations, Evaluation of integrals, Laplace transforms of periodic functions, Applications of the Laplace transform to the solution of linear integral equations, Systems of linear differential equations with constant coefficient, solving electrical circuits using Laplace transform.	**10**	**CO1, CO2, CO3 and CO4**
Unit IV Digital signal analysis, Continuous and discrete-time signal, sampling theorem, Fourier series, Examples of Fourier expansions of functions, Fourier transform and its properties, applications of Fourier transform in circuit analysis, Discrete Fourier transform and its properties, DFT and Fourier transform, Relation to the Fourier transform: Aliasing, DFT and Fourier series, Fast Fourier transform, Redundancy in the DFT, Z-transform: definition, Z-transforms of some common sequences, Properties of the Z-transforms.	**10**	**CO1, CO2, CO3 and CO4**

References:

1. Applied Mathematics for Engineers and Physicists by Louis A. Pipes and Lawrence R. Harvill.
2. Digital Signal Analysis by Samuel D. Stearns and Don R. Hush.
3. Computer Simulation of Electronic Circuits by R. Raghuram.
4. Scientific and Engineering Applications with PC's by Raymond Annino & Richard Drives.
5. Schaum's Outline of Laplace Transforms by Murray R Spiegel (Author)
6. Schaum's Outline of Signals and Systems by Hwei Hsu (Author)
7. Circuit Theory by Abhijit Chakrabarthi, Dhanpat Rai & Sons.
8. Basic Engineering Circuit Analysis by J. David Irwin, 3rd Ed., Macmillan Publishing Company, New York.

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	-	-	20
CO2	5	2.5	-	20
CO3		5		25
CO4		2.5		10

Course Code: EL12	**Course Name:** **Physics of Solid State Devices**		L	T	P	C
			4	0	0	4
Year and Semester	**1st Year** **I Semester**	**Contact hours per week:** (4 hrs.) Exam: (3 hrs.)				
Pre-requisite of course	**NIL**	**Evaluation**				
		Sessional: 25	**Examination: 75**			

Course Objectives:

1	To learn the behaviour of semiconductor devices
2	To understand the characteristics of semiconductor devices
3	To estimate the parameters of devices from its characteristics
4	To introduce the secondary effects which limits the performance of devices
5	To introduce the concept of device models and device simulation

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

CO1	Describe the behavior of semiconductor materials and devices
CO2	Reproduce the characteristics of PN junctions/BJT/MOSFET devices
CO3	Calculate the device/material parameters using the device characteristics
CO4	Describe various effects which affects the performance of MOSFET devices
CO5	Understand concept of device models and simulation

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	1			--	--		1	
CO2	2	3		1		3	3			--	--	3	2	
CO3	2	3		3		3	3			--	--	3	3	
CO4	3	3		3		3	1			--	--	3	3	
CO5	3	3		3		3	3					3	3	

CONTENTS	**Hrs.**	**COs**
Unit-1 Energy bands in solids, Metals, Semiconductors & insulators, Direct and indirect band gap semiconductors, charge carriers in SCs electrons & holes, effective mass, intrinsic & extrinsic material, carrier conc. Fermi level, electron & hole conc. at equilibrium, temperature dependence if carrier conc. Conductivity & mobility, drift & resistance, Hall effect	**10**	**CO1**

Unit-2 Diffusion of carriers, built in fields, Equilibrium conditions, the contact potential, forward and reverse biased junctions, steady state conditions, reverse break down, transient & AC condition. Time variation of stored charge, reverse recovery metal-Semiconductor junction. Fundamentals of BJT operation, amplification with BJT's, Minority carrier distribution & terminal currents, coupled diode model, charge control analysis, switching, specification for switching transistors, HF & hetro-junction BJTs.	**10**	**CO2, CO3**
Unit-3 Equilibrium in Electronic System, Idealized Metal-semiconductor junction, Current-voltage characteristics, Non rectifying contacts, Surface effects, MOS structure, Capacitance of MOS system, MOS Electronics, Oxide of Interface charges, Basic MOSFET behaviour, Improved Models for short channel MOSFETs.	**10**	**CO2, CO3**
Unit-4 Scaling of MOSFETs, Gate coupling, velocity overshoot, high field effects, substrate current, Hot carrier effects, Gate current, Device degradation, Structure that reduce the drain field. Numerical simulation, Basic concept of simulation, Grids, Device simulation, simulation challenges	**10**	**CO4, CO5**

References

1. Device Electronics for Integrated Circuits (3rd Edition) Muller & Kammins- John Wiley
2. Physics and Technology of Semiconductor Devices by A.S. Grove.
3. Physics of Semiconductor Devices by S.M.Sze.
4. Solid State Electronic Devices (6th edition) Ben G Streetman & S.K.Banerjee, (PHI, New Delhi, 2009)

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	10	-	-	10
CO2		5	-	10
CO3		5		15
CO4			-	20
CO5				20

Course Code: EL13	Course Name: IC Fabrication Technology		L	T	P	C
			4	0	0	4
Year and Semester	**1st Year I 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 basic concepts of microelectronic processing techniques for physical implementation of VLSI circuits in IC Technology
2	To understand the kinetics of oxide growth on silicon and controlling of dopant distribution profile in semiconductors.
3	To acquire the knowledge of various fabrication steps like lithography, etching and packaging for the fabrication of VLSI chips in microelectronic industries
4	To acquire knowledge of various VLSI Process Technologies e.g. BJT, CMOS, BiCMOS etc. for IC fabrication
5	To Understand the latest developments and future needs of IC fabrication industry.

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

CO1	Describe various microelectronics fabrications technique/tools and instrumentation used for deposition of thin films.
CO2	Describe the kinetics of oxide layer growth on silicon surface and controlling the profile of dopants distribution in semiconductors.
CO3	Differentiate between various semiconductor processing techniques used for patterning (lithography and etching) of thin films and bulk structures.
CO4	Explain the process sequence for BJT, CMOS and BiCMOS Processes and their packaging.
CO5	Forecast the next generation technologies through Technological Roadmaps for implementing ICs meeting the requirement of the future.

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		2	3					3	3	
CO2	3	3		3		3	3					3	3	
CO3	3	3		3		3	3					3	3	
CO4	3	3		3		3	2					3	3	
CO5		3		3		3		2						

CONTENTS	Hrs.	COs
Unit-1 Microelectronics processing: Introduction, Clean Room, Pure Water System, Vacuum Science and Technology, Practical vacuum systems, Operating principle: Rotary Pump, Cryo Pump and Turbo Molecular Pump, Vacuum Gauges: Pirani and Penning Gauge, Sources for vacuum deposition, Sputtering (DC, RF and RF Magnetron), Chemical Vapor Deposition, reactors for chemical vapor deposition, CVD Applications, PECVD, Metallization, Epitaxy: Introduction, Vapor phase epitaxy, Liquid phase epitaxy and Molecular beam epitaxy, Hetroepitaxy.	**10**	**CO1**

Unit-2 Thermal Oxidation of Silicon, Oxide Formation, Kinetics of Oxide Growth, Oxidation Systems, Properties of Thermal Oxides of Silicon, Impurity Redistribution during Oxidation, Uses of Silicon Oxide, Basic diffusion process, Diffusion Equation, Diffusion Profiles, Evaluation of Diffused Layers, Diffusion in Silicon, Emitter-Push Effect, Lateral Diffusion, Distribution and Range of Implanted Ions, Ion Distribution, Ion Stopping, Ion Channeling, Disorder and Annealing, Multiple Implantation and Masking, Pre-deposition and Threshold Control.	**10**	**CO2**
Unit-3 Photolithography, Negative and Positive Photoresist, Resist Application, Exposure and Development, Photolithographic Process Control. E-Beam Lithography, X-Ray Beam Lithography and Ion Beam Lithography. Wet Chemical Etching, Chemical Etchants for SiO_2, Si_3N_4, Polycrystalline Silicon and other microelectronic materials, Plasma Etching, Plasma Etchants, Photoresist Removal, Lift off process, Etch Process Control,	**10**	**CO3**
Unit-4 Fundamental considerations for I.C processing, PMOS and NMOS IC Technology, CMOS I.C technology, MOS Memory technology- Static and Dynamic, Bipolar IC Technology, BiCMOS Technology, Packaging design considerations, Special package considerations, Yield loss in VLSI, Reliability requirements for VLSI.	**10**	**CO4** **CO5**

References:
1. Microchip Fabrication: A Practical Guide to Semiconductor Processing by Peter Van Zant (2nd Edition) (McGraw Hill Publishing Company).
2. Vacuum Technology by A. Roth
3. Microelectronic Processing: An Introduction to the Manufacture of Integrated Circuits by W. Scot Ruska (McGraw Hill International Edition).
4. VLSI Technology By S.M.Sze (2nd Edition)
5. Semiconductor Devices: Physics and Technology by S.M. Sze.
6. VLSI Fabrication Principles: Silicon and Gallium Arsenide by Sorab K. Ghandhi (John Wiley & Sons).

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	-	-	15
CO2	5	-	-	15
CO3		5		15
CO4		5	-	15
CO5				15

Course Code: EL14	**Course Name:** EM Theory and Electronic Communication		**L**	**T**	**P**	**C**
			4	**0**	**0**	**4**
Year and Semester	**1st Year** **I 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 basic theory of EM waves
2. To acquire knowledge of different Radio wave propagations
3. To understand different parameters of transmission lines and basics of Antenna
4. To understand the different pulse and digital modulation techniques
5. To Acquire knowledge of modern telephone networks and satellite communication

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

CO1	Ability to explain wave equation and boundary conditions
CO2	Ability to understand ground wave, ionospheric and trophospheric propagation
CO3	Ability to analyze Smith chart for impedance matching
CO4	Ability to evaluate S parameters
CO5	Ability to explain various pulse and digital modulation techniques
CO6	Ability to explain the definition pertaining to modern telephone network
CO7	Ability to explain the definition pertaining satellite 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	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 Wave Equation and Boundary conditions, Plane monochromatic wave in non-conducting media, conducting media, Reflection and refraction at the boundary of two non-conducting media-oblique incidence, Reflection from a conducting plane-total internal reflection, Propagation between parallel conducting plates, Radio Wave propagation: Propagation in Free space, Tropospheric Propagation, Ionospheric propagation, Surface wave propagation, Propagation losses	**10**	**CO1, CO2**

Unit II Transmission lines, Characteristic impedance, standing waves, quarter and half wavelength lines, Impedance matching, Use of Smith Chart, Impedance matching using Smith Chart, Losses in Transmission lines, Wave-guides: Rectangular, losses in Wave-guides, S Parameters, Basics of Antennas: Antenna parameters, Dipole antennas, Radiation pattern, Antenna gain.	**10**	**CO3, CO4**
Unit III Pulse Communication, Pulse Amplitude modulation (PAM), Pulse Width Modulation, Pulse Position Modulation (PPM), Pulse Code Modulation and application. Digital Communication, Characteristics of Data Transmission Circuit, Data Transmission speeds, Noise, Cross talks, Echo suppressors, Distortion, Equalizers, Bit transmission, Signaling rate, Digital Communication techniques, FSK, PSK, BPSK, QPSK, DPSK. Error Detection and Correction codes.	**11**	**CO5**
Unit IV Modern Telephone networks, mobile telephone network, intelligent network and services (in brief) Satellite Communication: Introduction, Orbits, Station keeping, Satellite Attitude, Transmission Path, Path Loss, Noise considerations, the Satellite Systems, Saturation flux density, Effective Isotropic radiated Power, Multiple Access Methods.	**9**	**CO6, CO7**

References:

1. Foundations of Electromagnetic Theory JR Reitz and FZ by Reitz and Milford (Addison Wesley).
2. Electromagnetics by B.B. Laud (Wiley Eastern).
3. Mathew N. O. Sadiku, 'Principles of Electromagnetics', 6th Edition, Oxford University Press Inc. Asian edition, 2015
4. Theory and Applications of Microwaves by Brownwell and Beam (McGraw Hill).
5. Electronic Communication by George Kennedy.
6. Basic Electronic Communication by Roody & Coolen.
7. Satellite Communication by Robert M. Gagliord.
8. Electronic Communication System by W.Tomasi
9. Networks and Telecommunication Design & Operation by Martin. P. Clark

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*			*10*
CO2	*2.5*			*8.75*
CO3	*2.5*			*10*
CO4	*2.5*			*8.75*
CO5		*5*		*18.75*
CO6		*2.5*		*10*
CO7		*2.5*		*8.75*

Course Code: EL15	Course Name: Electronic Instrumentation and Control System		L	T	P	C
			4	0	0	4
Year and Semester	**1st Year I Semester**	**Contact hours per week:** (4 hrs.) Exam: (3 hrs.)				
Pre-requisite of course	NIL	**Evaluation**				
		Sessional: 25	**Examination: 75**			

Course Objectives:

1.	Understand the role of instrumentation in Electronics
2.	Acquire knowledge of transducers and actuators used in Electronic Technology and that use electronics
3.	To understand the need of control systems quantitatively and qualitatively
4.	To design controller for a specific response and specific applications

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

CO1	Ability to understand the characteristics of sensors and transducers and analyze their performance
CO2	Ability to understand and compare different methods for measuring a physical quantity and role of different instrumentation required for measuring the same
CO3	Ability to identify different control systems, analyze using SFG and design them for specified purpose
CO4	Ability to use different techniques to perform stability analysis of the designed control system and capability to do the state space analysis

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	1	3	1	1	1	-	-	--	--	3	1	-
CO2	3	1	1	3	1	1	1	-	-	--	--	3	2	-
CO3	3	1	1	3	1	1	1	-	-	--	--	3	2	-
CO4	3	1	1	3	1	1	1	-	-	-	-	1	2	-

CONTENTS	Hrs.	COs
Unit I Basic concepts of measurement: Introduction, system configuration basic characteristics of measuring devices, Transducer Classification :Introduction, Electrical transducer, classification, basic requirements, Performance characteristics of an instrumentation system: generalized system, zero order, first order, second order system, Measurement of displacement: principle of transduction, Variable resistance device, LVDT, Variable capacitance transducer, Hall effect devices, Measurement of pressure: Thin film pressure transducer, piezoelectric pressure transducer vibrating element pressure transducer	**10**	**CO1 CO2**
Unit II Measurement of position, velocity, force, torque (basics only) Measurement of flow: Head type flow meters based on differential pressure measurements, Anemometers	**10**	**CO2**

Temperature measurements: resistance type temp. sensors, thermistors, thermocouples, solid state sensors, optical pyrometers Measurement of humidity, thickness, pH (basics only) Instrumentation amplifier, Q meter, Digital storage oscilloscope, Lock-in Amplifier,		
Unit III Bioelectrical signals and their measurement, Electrodes for ECG **Control System:** Introduction: Basic components of a control system, Example of control system applications, Open loop and closed loop control system, Feedback and its effects, Types of feedback control systems, Transfer functions, block diagram, and Signal Flow graphs. Time response of feedback control systems: Steady state error analysis, Introduction and design of P, I PI, PD and PID Controllers .	**10**	**CO2 CO3 CO4**
Unit IV Stability of linear control systems: introduction, Methods of determining stability, Routh –Hurwitz stability, Nyquist Stability Criterion, Root loci technique for analysis of LTI control system, Bode plots and Nyquist plots **Introduction to State variable analysis:** Concepts of state, state variable and state models for electrical systems, Solution of state equations.	**10**	**CO3 CO4**

References:

1. Modern Electronic Instrumentation and Measurement Technique by Alfred D. Helfrick and William D. Cooper, Eastern Economy Edition
2. Instrumentation Devices and Systems by C.S. Rangan, G.R. Sarma and V.S.V Mani, Tata McGraw Hill.
3. Principles of Measurement and Instrumentation by Alan S. Morris, Prentice Hall.
4. Automatic Control Systems by Benjamin C. Kuo, Prentice Hall India.
5. Modern Control Engineering by K. Ogata, PHI.
6. Bio-Medical Instrumentation by R.S Khandpur.

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	-	-	15
CO2	5		-	20
CO3		5		20
CO4		5		20

Course Code: EL16	**Course Name:** **Analog Circuits Design Lab**		**L**	**T**	**P**	**C**
			0	**0**	**16**	**8**
Year and Semester	**1st Year** **I Semester**	**Contact hours per week:** (4 hrs.) Exam: (4 hrs.)				
Pre-requisite of course	**NIL**	**Evaluation**				
		Sessional: 25	**Examination: 75**			

Course Objectives:

1	To learn the use of various electronic equipment used for analysis of basic analog circuits and systems
2	To learn wafer handling and thin film deposition processes
2	To understand the procedures for designing of basic analog electronic circuits.
3	To learn the functioning of wave shaping circuits using operational amplifiers.
4	To Analyze and interpret experimental data
5	To know how to present the results of experiments

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

CO1	Operate various equipment used in the design and analysis of basic analog circuits.
CO2	Perform basic silicon wafer processing and deposition of thin films.
CO3	Design analog electronics circuits based on semiconductor devices (Diode/BJT/MOSFET).
CO4	Implement application oriented circuits using Op-amp and 555 timer ICs.
CO5	Analyze & Interpret the data obtained in the experiments.
CO6	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	3	2		3	2	3	3		2	1	1	2	3	3
CO2	3	3		3	2	3	3		2	1	1	2	3	3
CO3	3	3		3	2	3	3		2	1	1	2	3	3
CO4	3	3		3	2	3	2		2	1	1	2	3	3
CO5		3		3	2	3		2	2	1	1			
CO6			3		2					1				

Experiments list to be decided by department as per COs

Course Code: EL17	Course Name: Digital Circuit Design & Programming lab		L	T	P	C
			0	**0**	**16**	**8**
Year and Semester	**1st Year I Semester**	**Contact hours per week:** (4 hrs.) Exam: (4 hrs.)				
Pre-requisite of course	**NIL**	**Evaluation**				
		Sessional: 25	**Examination: 75**			

Course Objectives:

1	To learn about digital CMOS ICs
2	To learn the designing of combinational and sequential circuits
3	To lean about code writing using computer languages
4	To be familiar with computational tools like MATLAB etc.
5	To know how to analyze, interpret and present the results of experiments.

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

CO1	Select CMOS digital ICs for a given application and specifications.
CO2	Design combinational and sequential circuits.
CO3	Write a program/code using high level computer language for solving scientific problems
CO4	Operate advanced simulation/computational tools like MATLAB etc.
CO5	Analyze & Interpret the data obtained in the experiments.
CO6	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	2	3	3
CO2	1	2		3	2	3	3		2	1	1	2	3	3
CO3	1	2		3	2	3	3		2	1	1	2	3	3
CO4	1	2		3	2	3	2		2	1	1	2	3	3
CO5		2		3	2	3		2	2	1	1			
CO6			3		2					1				

Experiments list to be decided by department as per COs

Course Code: EL21	**Course Name:** Digital Circuits and System Design	**L**	**T**	**P**	**C**
		4	**0**	**0**	**4**

Year and Semester	**1st Year** **II 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 theory and practical aspect of CMOS Circuits
2. To Acquire knowledge of Programmable Logic Devices
3. To understand the analysis and designing of Clocked Synchronous State- machine
4. To understand the Synchronous Design Methodology
5. To Obtain basic Knowledge of VHDL and FPGA.

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

CO1	Ability to design CMOS Circuit
CO2	Ability to understand and compare different CMOS logic families
CO3	Ability to understand types of CMOS PLDs
CO4	Ability to implement basic circuits in VHDL
CO5	Ability to analyzing State Machines
CO6	Ability to designing State Machines
CO7	Ability to define Impediments to Synchronous Design Methodology
CO8	Ability to perform experiments related to FPGA

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	2	3
CO2	3	1	3	3	2	2	3			--	--	3	2	3
CO3	3	1	3	3	2	2	3			--	--	3	2	3
CO4	3	1	2	3	2	2	3					2	2	3
CO5	3	1	3	3	2	2	3					3	2	3
CO6	3	1	3	3	2	2	3					3	2	3
CO7	3	1	3	3	2	2	3					3	2	2
CO8	3	1	3	3	2	2	3					3	2	2

CONTENTS	Hrs.	COs
Unit I Introduction to CMOS Circuits, Logic families, CMOS logic, Electrical behaviour of CMOS circuits, CMOS steady state electrical behaviour, CMOS dynamic electrical behaviour, CMOS Input and Output structures, CMOS logic families, CMOS/TTL interfacing, Timing Hazards, Quine-McCluskey Method of finding Minimal SOP and POS Expressions.	**10**	**CO1, CO2**
Unit II Combinational Logic Design Practice: Documentation standards, circuit timing, Combinational PLDs: Programmable logic array (PLA), Implementation of combinational logic using PLA, Programmable array logic (PAL), Generic Array logic (GAL), Description of some basic PLDs, Complex Programmable Logic Devices (CPLDs), Combinational PLD applications. Implementation of following in VHDL decoders, encoders, three state devices, multiplexers, exclusive-OR gates and parity circuits, comparators, adders, combinational multipliers.	**10**	**CO3, CO4**
Unit III Bistable elements, Latches and Flip-Flops, Clocked Synchronous State-machine Analysis, Clocked Synchronous State- machine Design, Designing State Machines using State Diagrams, State-machine Synthesis using Transition Lists.	**11**	**CO5, CO6**
Unit IV Sequential PLDs, Registers: Shift Registers and counters, Iterative versus Sequential Circuits, Synchronous Design Methodology, Impediments to Synchronous Design, Synchronizer Failure and Meta stability, Field Programmable Gate Arrays	**9**	**CO7, CO8**

Reference:

1. Digital Design: Principles & Practices-John F. Wakerly (4th edition, Prentice Hall).
2. Programmable Logic: PLDs and FPGAs- R.C. Seals, G.F. Whapshott (McGraw-Hill, Publication)

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*			*10*
CO2	*2.5*			*8.75*
CO3	*2.5*			*10*
CO4	*2.5*			*8.75*
CO5		*2.5*		*10*
CO6		*2.5*		*8.75*
CO7		*2.5*		*8.75*
CO8		*2.5*		*10*

Course Code: EL22	Course Name: Device Models & Circuit Simulation		L	T	P	C
			4	0	0	4
Year and Semester	**1st Year** **II Semester**	**Contact hours per week:** (4 hrs.) Exam: (3 hrs.)				
Pre-requisite of course	**NIL**	**Evaluation**				
		Sessional: 25	**Examination: 75**			

Course Objectives:

1.	To learn the mathematical models of semicondcutor devices.
2.	To understand the concept of device and circuit simulation using device models.
3.	To understand the working of IC building blocks like current mirrors and active resistors.
4.	To develop skills for analysing the single stage and differenctial ampifier ciruits.
5.	To understand working of operational amplifier configurations..

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

CO1	Describe the behavior of semiconductor devices using mathematical models.
CO2	Reproduce the characteristics of semiconductor devices using their models for circuit simulation.
CO3	Design various analog circuits/systems like switches, current mirrors and active resistors and amplifier circuits using MOSFET devices.
CO4	Analyze the performance of MOSFET based analog building blocks in integrated circuits.
CO5	Differentiate the various operational amplifier configurations in term of performance in ICs.

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	2	2		2	2			--	--	2	2	
CO2	3	3	2	2		2	3			--	--	3	2	
CO3	2	3	2	3		3	3			--	--	3	3	
CO4	2	3	2	3		3	3			--	--	3	3	
CO5	3	3	2	2		3	3			--	--	3	2	

CONTENTS	Hrs.	COs
Unit I Device Modeling, DC models, small signal models, use of device models in circuit analysis, diode models, dc diode model, small signal diode model, HF diode model, BJT models, dc BJT models, small signal BJT model, HF BJT model, MOS models, dc MOSFET model, small signal MOSFET model, HF MOSFET model, short channel Devices, sub-threshold operation, Modeling noise sources in MOSFET's.	**10**	**CO1, CO2**

Unit II Circuit simulation, Circuit simulation using SPICE, Diode model, Large signal diode current, HF diode Model, BJT model, HF BJT model, MOSFET Model, Level 1 large signal model, HF MOSFET model, IC Building blocks: switches (BJT & MOS), Active Resistors (BJT & MOS), Current sources and sinks-BJT and MOS as Current Source/Sinks, Widlar Current source, Wilson current source, Current sources as active load. CE/CS amplifier with depletion load, CE/CS amplifier with complementary load.	**10**	**CO3, CO4**
Unit III Inverting Amplifiers, General concepts of inverting amplifiers, MOS inverting amplifiers, CMOS Cascode amplifiers: current and voltage driven cascode amplifier, Differential amplifiers-CMOS differential amplifiers, Frequency and noise response of CMOS differential Amplifiers. CMOS output amplifiers with and without feedback.	**11**	**CO3 CO4**
Unit IV Operational Amplifiers - Characterization, CMOS two stage OP Amp, OP Amp macro-model, Simulation and measurement of OP Amps, comparators, characterization of comparators, High gain comparators, Propagation delay of two-stage comparators, Comparators using positive feedback, Autozeroing.	**9**	**CO4 CO5**

References:

1. VLSI Design Techniques for Analogue and Digital Circuits by R.L. Geiger, P.E. Allen and N.R. Strader.
2. Analysis and Design of Analogue I.C's (2nd edition) by P.R. Gray, R.G. Meyer.
3. The SPICE book by Andrei Vladimirescu.
4. Computer Simulation of Electronic Circuits by Raghuram.

Additional References:

1. Semiconductor Device Modeling with SPICE by P. Antogneth & G. Massobrio.

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.*

1. Instructions for questions papers

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	-	-	10
CO2	2.5	-	-	15
CO3	2.5	5		20
CO4		5	-	20
CO5			5	10

Course Code: EL23	**Course Name:** Verilog Hardware Description Language		**L**	**T**	**P**	**C**
			4	**0**	**0**	**4**
Year and Semester	**1st Year** **II Semester**	**Contact hours per week:** (4 hrs.) Exam: (3 hrs.)				
Pre-requisite of course	**NIL**	**Evaluation**				
		Sessional: 25	**Examination: 75**			

Course Objectives:

1. Understand the evolution and role of CAD in design of Digital Circuits and basics of Verilog HDL.
2. To be able to differentiate digital design forms of Gate, Dataflow Switch and Behavirol levels.
3. To be able to design Verilog models using Gate, Dataflow Switch and Behavirol levels.
4. Be able to design a digital circuit using Generate block, tasks and functions.
5. Be able to design a digital circuit according to given delay specifications.
6. To understand the concepts of verification and UDPs.

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

CO1	To understand the concept of digital circuit design and basics of Verilog HDL
CO2	To design Verilog models for digital circuits using Gate level, Dataflow and Switch level modeling.
CO3	To design Verilog models for digital circuits using Behavirol level modeling.
CO4	To design Verilog code using Generate blocks, tasks and functions. .
CO5	To incorporate delays in different forms in Verilog models
CO6	To understand the concepts and role of verification and UDPs in Verilog models.

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		3		2	2					1	1	
CO2	3	3	2	3	3	3	3		3		3	3	3	
CO3	3	3	2	3	3	3	3		3		3	3	3	
CO4	3	2		3		3	2					2	2	
CO5	3	2		3		2	2					2	2	
CO6	3	1		3		2	2					2	2	

CONTENTS	**Hrs.**	**COs**
Unit I Benefits of CAD, Integrated circuit design techniques, Hierarchical design, Design abstraction, Computer aided design, Concepts of CPLD, FPGA. Introduction to HDLs, Verilog and its capabilities, Hierarchical Modeling Concepts: Design Methodologies, Modules, Instances, Components of Simulation and Test Bench. Basic Concepts: Lexical Conventions, Data Types, System Tasks and Compiler Directives. Modules and Ports.	**9**	**CO1**
Unit II Gate-Level Modeling: Gate Types, Gate Delays. Dataflow Modeling, Continuous Assignments, Delays, Expressions, Operators, and Operands, Operator Types, Switch-Level Modeling: Switch-Modeling Elements.	**11**	**CO2**

Unit III Behavioral Modeling: Structured Procedures, Procedural Assignments, Timing Controls, Conditional Statements, Multiway Branching, Loops, Sequential and Parallel Blocks, Generate Blocks. Tasks and Functions.	**11**	**CO3 CO4**
Unit IV Timing and Delays, Types of Delay Models, Path Delay Modeling, Timing Checks, Delay Back-Annotation, User-Defined Primitives (brief), Programming Language Interface (brief), Logic Synthesis with Verilog, Synthesis Design Flow, Verification of Gate-Level Netlist. Verification Techniques (brief) : Traditional Verification Flow, Assertion Checking, Formal Verification	**9**	**CO5 CO6**

References:

1. Custom VLSI Microelectronics by Stanley L.Hurst (Prentice Hall 1992)
2. Verilog HDL - Samir Palnitkar (Pearson)
3. A Verilog HDl Primer - J. Bhaskar (Pearson)
4. Modern VLSI Design- A Systems Approach- Wayne Wolf-PTR Prentice Hall-1994

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			15
CO4		5		15
CO5		2.5		15
CO6		2.5		10

Course Code: EL24	Course Name: System Design Using Embedded Processors	L	T	P	C
		4	0	0	4
Year and Semester	**1st Year II Semester**	**Contact hours per week:** (4 hrs.) Exam: (3 hrs.)			
Pre-requisite of course	NIL	**Evaluation**			
		Sessional: 25	**Examination: 75**		

Course Objectives:

1	To impart knowledge about the basic concepts, structure and functions of embedded systems
2	To impart knowledge about the applications of embedded systems
3	To familiarize the students with 8051 architecture and programming
4	Impart knowledge about the real world interfacing and Real Time operating systems

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

CO1	Ability to design a system, component, or process to meet desired needs within realistic constraints
CO2	Ability to analyze given problem and write programs using 8051 assembly language
CO3	Ability to design interfacing circuits using standard peripherals
CO4	Ability to understand the concepts of interfacing in real world applications
CO5	Ability to understand design and management of RTOS

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	1	2	1	1	1	--	--	--	--	3	1	--
CO2	3	1	1	3	1	1	1	--	--	--	--	3	1	--
CO3	3	1	1	2	1	1	1	--	--	--	--	3	1	--
CO4	3	1	1	2	1	1	1	--	--	--	--	3	1	--
CO5	3	1	1	2	1	1	1	--	--	--	--	3	1	--

CONTENTS	Hrs	COs
Unit I Introduction to Embedded Systems: Definition, Processor embedded into a system, embedded hardware units and devices into a system, embedded software in a system, examples of Embedded systems, Embedded SOC and Use of VLSI Circuit Design Technology, Complex Systems Design and Processes, Design Process in Embedded System, Formalization of System Design, Design Process and Design Examples, Classification of Embedded Systems, Skills Required for an Embedded System Design	**10**	**CO1**
Unit II Difference between Microprocessor and Microcontroller. *8051 Microcontroller*: Architecture: CPU Block diagram, Memory Organization, Program memory, Data Memory, Interrupts, Peripherals: Timers, Serial Port, I/O Port Programming: Addressing Modes, Instruction Set, Programming. *Microcontroller based System Design:* Introduction, A microcontroller	**10**	**CO2** **CO3**

specification, microcontroller design, testing the design, timing subroutines and lookup tables. Interfacing of LCD and A/D to 8051.		
Unit III Real World Interfacing, Introduction to Advanced Architectures: 80x86, ARM7, SHARC, DSP Processor and Memory Organization, Instruction Level Parallelism, Performance Metrics, Memory Types, Memory Maps and addresses, Processor and Memory Selection, Device and Communication Buses for Device Network: I/O type examples, serial Communication Devices, Parallel Device Ports, Wireless Devices, Timer and Counting Devices, watchdog Timer, Real Time Clock, Networked Embedded Systems, Internet Enabled Systems.	**10**	**CO4**
Unit IV **Real Time Operating Systems** OS Services, Process Management, Timer Functions, Event Functions, Memory Management, Device File and IO Subsystem Management, Interrupt Routines in RTOS Environment and Handling Interrupt Source Cells, Real-Time operating Systems, Basic Design using an RTOS, RTOS task Scheduling Models, Interrupt latency and Response of the Tasks as performance Metrics, OS Security Issues, Case study of Digital camera Hardware and Software Architecture.	**10**	**CO5**

References:

1. Embedded Systems: Architecture, Programming and Design ,2nd Edition, Raj Kamal, Tata-McGraw Hill, 2011.
2. The 8051 Microcontroller and Embedded Systems Using Assembly and C Second Edition, Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin D. McKinlay, Pearson.
3. Advanced Microprocessors and Peripherals, 3rd Edition, Ray and Bhurchandi, Tata McGraw Hill, 2006.
4. The 8051 Micro controller 3rd Edition, Keneth Ayala, Cengage Publishers.

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	-		20
CO2	5			15
CO3		2.5		10
CO4		2.5		15
CO5		5		15

Course Code: EL25(i)	**Course Name:** Foundations of MEMS		**L**	**T**	**P**	**C**
			4	**0**	**0**	**4**
Year and Semester	**1st Year** **II Semester**	**Contact hours per week:** (4 hrs.) Exam: (3 hrs.)				
Pre-requisite of course	**NIL**	**Evaluation**				
		Sessional: 25	**Examination: 75**			

Course Objectives:

1.	Lay foundation for understanding of the state-of-art MEMS technology and explain the influence of scaling and militarization in MEMS
2.	Give exposure to various materials and micromachining techniques used for fabrication of MEMS devices
3.	Introduce different sensing and actuation mechanisms used in MEMS
4.	Introduction of analytical methods for designing some typical MEMS applications

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

CO1	Understand the multidisplinary nature, components, need , principle of operation and applications of MEMS
CO2	Understand various sensing and actuation mechanism used in MEMS devices and compare their merits and demerits.
CO3	Understand the choice of material and fabrication processes for MEMS
CO4	Design their device and simulate their design using MEMS design tools

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	2	2	1	2	2	--	--	--	--	3	3	-
CO2	3	3	2	3	1	2	2	--	--	--	--	3	3	2
CO3	3	3	2	3	1	2	2	--	--	--	--	3	3	2
CO4	3	3	2	3	1	2	2	--	--	--	--	3	3	2

CONTENTS	**Hrs.**	**COs**
Unit I MEMS & Microsystem- Definition, Intrinsic Characteristic of MEMS: Minitiarization, Microelectronics, Integration, Parallel Fabrication with Precision. Sensors and Actuator: Energy Domains and Transducers, Sensor Consideration, Actuator Considerations, Scaling in MEMS	**10**	**CO1 and CO2**
Unit II Microfabrication and Material for MEMS: Si as substrate material, mechanical properties of Silicon, Silicon Compounds (SiO_2, Si_3N_4, SiC, polySi, Silicon), Piezoresistors, Piezoelectric crystals, Polymers, Packaging Materials. Micromachining Processes: Overview of microelectronic fabrication processes used in MEMS, Bulk Micromachining, Anisotropic wet etching, DRIE, Etch stop techniques, Surface Micromachining – General description, Case studies using MEMS Design Tools, Special Microfabrication Techniques (Introduction only): LIGA process, Low Temperature Cofired Ceramic (LTCC), HexSil Process, Bonding.	**10**	**CO1, CO3, CO4**

Unit III Electrostatic Sensing and Actuation: Introduction, Parallel Plate Capacitor, Actuators based on thermal expansion, Applications- Interial Sensors, flowsensors, Piezoresistive sensors- origin and expressing of piezoresistivitiy, single crystal Silicon, Polycrystalline Silicon, Stress analysis of Mechanical Elements, Applications: tactile sensor, pressure sensor, few case studies using MEMS Design tools	**10**	**CO1 CO2 CO4**
Unit IV Piezoelectric Sensing and Actuation-Introduction: Mathematics Description of Piezoelectric Effects, Cantilever Piezoelectric Actuator Model, Application: Acoustic sensor Microfluidics- Motivation, Essential Biology concepts, Basic fluid Mechanic Concepts, Design and fabrication of Selected components channels, valves Case studies of selected MEMS Products: Blood pressure sensor, Microphone, acceleration sensor, gyros, few case studies using MEMS Design Tools	**10**	**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 (75 Marks)**
	Test1	**Test2**	**Assignment/Attendance**	**SEE**
Marks	**10**	**10**	**5.0**	**75**
CO1	5	-	-	20
CO2	5	2.5	-	25
CO3		5		20
CO4		2.5		10

Course Code: EL25(ii)	**Course Name:** Nano Electronics– Materials & Devices		**L**	**T**	**P**	**C**
			4	**0**	**0**	**4**
Year and Semester	**1st Year** **II Semester**	**Contact hours per week:** (4 hrs.) Exam: (3 hrs.)				
Pre-requisite of course	**NIL**	**Evaluation**				
		Sessional: 25	**Examination: 75**			

Course Objectives:

1.	To know about technological issues involved in nano scale devices
2.	To learn about concept and applications of charge confinement in low dimensional structures
3.	To understand the synthesis process for nano-electronic structures
4.	To understand the techniques for characterization of nanoelectronic structures

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

CO1	Understand various issues related to nanoscale electronic devices.
CO2	Compare various techniques for creating low dimensional semiconductor nanostructures
CO3	Synthesize nanostructures/devices for electronics applications.
CO4	Explain the techniques used for characterization of nano electronic structures

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	2	2		2	2			--	--	2	2	
CO2	3	3	2	2		2	3			--	--	3	2	
CO3	2	3	2	3		3	3			--	--	3	3	
CO4	2	3	2	3		3	3			--	--	3	3	

CONTENTS	**Hrs.**	**COs**
Unit I Overview of progress of microelectronics worldwide. International technology roadmap characteristics. CMOS scaling. Nanoscale MOSFET, FinFET, vertical MOSFETS's limits of CMOS technology. Materials & processes for advanced sub 65nm CMOD technology. From microelectronics towards nanoelectronics. Noval approaches towards future devices. Introduction to nanotechnology and nanomaterials. Applications in different fields. Bottom up and top down approaches.	**10**	**CO1**
Unit II Top Down Approaches: Semiconductor Low dimensional systems- Two dimensional confinement of carriers, Quantum wells, One dimensional Quantum systems; quantum wires, Zero dimensional quantum structures: Quantum Dots. Quantum devices: Resonant tunneling diode & transistor. Coulomb Blockade, Single Electron Transistor, Introduction to Spintronics, Material requirements for spintronics, Spin devices: Spin Transistor, Spin values etc. Quantum computation.	**10**	**CO1, CO2**
Unit III Bottom up Approaches: Molecular Electronics involving single molecules as electronic devices, chemical approaches to nanostructure materials. Band structures and transport in the molecular	**10**	**CO3**

system. Molecular switches and logic gates. Molecular interconnects. Cabon nanotubes, structures and synthesis, growth mechanism and properties, devices applications. Nanowires:synthesis and characterization.		
Unit IV Nanofabrication: Thin film techniques, MBE, CVD, PECVD, Sol gel, Plasma arching electrodeposition, ball milling, atomic layer deposition, self-assembly, template manufacturing, spray pyrolysis. Nanomanipulation and nano lithography: E-beam and nano imprint lithography, advanced nanolithography, High resolution nanolithography, Dip-Pen lithography, AFM Lithography.	**10**	**CO4**

References

1. "Nanoelectronics and Information Technology", (Advanced Electronic and Novel Devices), Waser Ranier, Wiley- VCH (2003)
2. "The Physics of Low-dimensional Semiconductors". John H. Davies, Cambridge University Press, 1998.
3. "Introduction to Nano Technology", John Wiley & Sons, 2003.
4. "Introduction to Molecular Electronics", M.C. Petty, M.R.Bryce, and D.Bloor, Edward Arnold (1995).
5. "Quantum Hetrostructures", V.Mitin, V. Kochelap, and M.Stroscio, Cambridge University Press.

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	-	-	20
CO2	5	2.5	-	20
CO3		5		25
CO4		2.5		10

Course Code: EL25(iii)	Course Name: Materials for VLSI		L	T	P	C
			4	0	0	4
Year and Semester	**1st Year II Semester**	**Contact hours per week:** (4 hrs.) Exam: (3 hrs.)				
Pre-requisite of course	**NIL**	**Evaluation**				
		Sessional: 25	**Examination: 75**			

Course Objectives:

1.	Basic knowledge of materials used in the fabrication of VLSI chips
2.	Exposure to properties of various materials used in the fabrication technology
3.	Basic concept of silicon wafer; processing & applications in VLSI chips
4.	Introduction of the role of various materials processing techniques used in IC fabrication

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

CO1	Understand the role of various materials used in VLSI fabrication technology
CO2	Understand various mechanism of the process technology for physical implementation of different materials in IC Fabrication
CO3	Analyze the choice of material and fabrication processes for IC Fabrication
CO4	Skill to conduct research on new materials for VLSI and able to work in IC fabrication laboratory

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	2	2	1	2	2	--	--	--	--	3	3	-
CO2	3	3	2	3	1	2	2	--	--	--	--	3	3	2
CO3	3	3	2	3	1	2	2	--	--	--	--	3	3	2
CO4	3	3	2	3	1	2	2	--	--	--	--	3	3	2

CONTENTS	Hrs.	COs
Unit I Silicon Crystal growth and wafer preparations, starting materials, Metallurgical grade silicon, Polycrystalline Silicon, Single Crystal growth, Introduction, Float-Zone method, Czocharlski method, Impurities, impurity inhomogeneity, Wafer shaping process cleaning mechanical properties of the wafer.	**10**	**CO1, CO2, CO3**
Unit II Silicon wafer criteria for VLSI/ULSI technology, High technology silicon wafer concept, VLSI/ULSI wafer characteristics, structural and chemical and mechanical characteristics, Deposited films. Polysilicon, Deposition variables, structure, Doping polysilicon, oxidation of polysilicon, properties of Polysilicon, Silicon dioxide, deposition methods, Deposition variable, Step coverage, p-glass flow, properties of silicon dioxide.	**10**	**CO1, CO3, CO4**
Unit III Silicon nitride, nitride properties of silicon nitride, plasma-assisted deposition, deposition variable, properties of plasma assisted deposited filing, other material, materials for contacts and interconnects, Metallization, Applications, gates and interconnections, Ohmic contacts, Metallization choices, Metals or allays, properties, stability and semiconductor and insulating, patterning, Self-aligned silicides.	**10**	**CO1 CO2 CO4**

Unit IV		
Metallization problem, deposition, processing, metallurgical and chemical interactions, electro-migration, New role of metallization, multilevel structures, epitaxial metals, diffusion barriers and redundant metal links, Assembly and packaging of VLSI devices package types, packaging design considerations, thermal design considerations, electrical considerations, mechanical design considerations, VLSI assembly technologies, wafer preparation, die-banding, wire bonding, package fabrication technologies ceramic package, glass-sealed refractory package, plastic molding technology molding process, special package considerations.	**10**	**CO1 CO2 CO3 CO4**

References:

1. Semiconductor Silicon Crystal Technology, Fumio Shimura, academic Press, Inc.
2. VLSI Technology, SM Sze, McGraw Hill International Ed.

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	-	-	20
CO2	5	2.5	-	20
CO3		5		25
CO4		2.5		10

Course Code: EL26	**Course Name:** Electronic Circuits Simulation & Microcontroller Lab	**L**	**T**	**P**	**C**
		0	**0**	**16**	**8**
Year and Semester	**1st Year** **II Semester**	**Contact hours per week:** (4 hrs.) Exam: (4 hrs.)			
Pre-requisite of course	**NIL**	**Evaluation**			
		Sessional: 25	**Examination: 75**		

Course Objectives:

1	To learn about simulation tools used in the designing of electronic circuits and systems
2	To perform simulations of various analog circuits involving semiconductor devices
3	To use a standard IDE for editing, compiling, debugging and simulation of microcontroller programs
4	To learn about the basics of interfacing of various peripheral devices to the microcontroller systems
5	To learn use of cutting edge simulations tools in the specialized areas.
6	To Analyze and interpret experimental data
7	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 electronic design
CO2	Perform the simulation of analog electronic circuits involving BJT/MOSFET Devices
CO3	Be proficient in use of IDE's for designing, testing of microcontroller based system
CO4	Interface various I/O devices and design and evaluate systems that will provide solutions to real-world problem
CO5	Operate Cutting edge simulation tools in the specialized areas like MEMS/Nanoelectronics/VLSI etc.
CO6	Analyze & Interpret the data obtained in the experiments.
CO7	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	1	2		3	2	3	3		2	1	1	3	3	3
CO4	1	2		3	2	3	2		2	1	1	2	3	3
CO5		2		3	2	3		2	2	1	1			
CO6			3		2					1				

Experiments list to be decided by department as per COs

Course Code: EL27	Course Name: IC Processing & Characterization lab		L	T	P	C
			0	0	16	8
Year and Semester	**1st Year** **II Semester**	**Contact hours per week:** (4 hrs.) Exam: (4 hrs.)				
Pre-requisite of course	**NIL**	**Evaluation**				
		Sessional: 25	**Examination: 75**			

Course Objectives:

1	To learn about various semiconductor materials characterization techniques
2	To learn about the semiconductor device parameters like junction capacitance etc.
3	To know about optoelectronic device characterization.
4	To lean about equipment used for thin film deposition techniques for device fabrication
5	To Analyze and interpret experimental data
6	To know how to present the results of experiments

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

CO1	Evaluate the semiconductor materials with the help of important parameters like band gap, conductivity value and its type
CO2	Extract semiconductor devices parameters.
CO3	Characterize optoelectronic devices like solar cell, LED and photodetectors etc.
CO4	Operate physical vapor deposition equipment for deposition of thin films for semiconductor device fabrication
CO5	Analyze & Interpret the data obtained in the experiments.
CO6	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	1	2		3	2	3	3		2	1	1	3	3	3
CO4	1	2		3	2	3	2		2	1	1	2	3	3
CO5		2		3	2	3		2	2	1	1			
CO6			3		2					1				

Experiments list to be decided by department as per COs