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UNIVERSITYOFMUMBAI

Revised syllabus (Rev- 2016) from Academic Year 2016 -17
Under

FACULTY OF TECHNOLOGY

Electronics Engineering

Second Year with Effect from **AY 2017-18**
Third Year with Effect from **AY 2018-19**
Final Year with Effect from **AY 2019-20**

As per **Choice Based Credit and Grading System**
With effect from the AY 2016–17

Co-ordinator, Faculty of Technology's Preamble:

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty of Technology, University of Mumbai, in one of its meeting unanimously resolved that, each Board of Studies shall prepare some Program Educational Objectives (PEO's) and give freedom to affiliated Institutes to add few (PEO's). It is also resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. It was also resolved that, maximum senior faculty from colleges and experts from industry to be involved while revising the curriculum. I am happy to state that, each Board of studies has adhered to the resolutions passed by Faculty of Technology, and developed curriculum accordingly. In addition to outcome based education, semester based credit and grading system is also introduced to ensure quality of engineering education.

Choice based Credit and Grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes and Faculty of Technology has devised a transparent credit assignment policy and adopted ten points scale to grade learner's performance. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 12-13 weeks and remaining 2-3 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

Choice based Credit and grading system is implemented from the academic year 2016-17 through optional courses at department and institute level. This will be effective for SE, TE and BE from academic year 2017-18, 2018-19 and 2019-20 respectively.

Dr. S. K. Ukarande
Co-ordinator,
Faculty of Technology,
Member - Academic Council
University of Mumbai, Mumbai

Chairman's Preamble:

Quality of education is one of the major factors to contribute to the growth of a nation and subsequently quality of education is largely decided by the syllabi of the Educational Programme and its proper implementation. In order to make B.E (Electronics) Engineering programme of University of Mumbai rich in quality, revision of the syllabi is being undertaken as per the guidelines of University of Mumbai. While deciding the core courses and department level optional courses, inputs from various stake holders were taken into account. The exposure to the latest technology and tools used all over the world is given by properly selecting courses and their hierarchy in the programme curriculum. Thus this syllabus is made to groom the postgraduate students to be made competent in all respect with best possible efforts put in by the experts in framing detailed contents of individual courses.

I, as Chairman, Board of Studies in Electronics Engineering University of Mumbai, am happy to state here that, heads of the department and senior faculty from various institutes took timely and valuable initiative to frame the Program Educational Objectives as listed below as per National Board of Accreditation (NBA) guidelines.

1. To provide students with a strong foundation in the mathematical, scientific and engineering fundamentals necessary to formulate, solve and analyze engineering problems and to prepare them for graduate studies.
2. To prepare students to demonstrate an ability to identify, formulate and solve electronics engineering problems.
3. To prepare students to demonstrate ability to design electrical and electronics systems and conduct experiments, analyze and interpret data.
4. To prepare students to demonstrate for successful career in industry to meet needs of Indian and multi-national companies.
5. To develop the ability among students to synthesize data and technical concepts from applications to product design.
6. To provide opportunity for students to work as part of teams on multidisciplinary projects.
7. To promote awareness among students for the life-long learning and to introduce them to professional ethics and codes of professional practice.

These are the suggested and expected main objectives and individual affiliated institute may add further in the list. In addition to Program Educational Objectives, for each course of undergraduate program, objectives and expected outcomes from learner's point of view are also included in the curriculum to support the philosophy of outcome based education. I strongly believe that small step taken in right direction will definitely help in providing quality education to the stake holders.

At the end I must outset extend my gratitude to all experts who contributed to make curriculum competent at par with latest technological development in the field of electronics engineering.

Dr.Sudhakar S. Mande

Chairman, Board of Studies in Electronics Engineering, University of Mumbai

S.E. (Electronics Engineering) – Semester III

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELX301	Applied Mathematics III	04	---	01@	04	---	01	05
ELX302	Electronic Devices and Circuits I	04	---	---	04	---	---	04
ELX303	Digital Circuit Design	04	---	---	04	---	---	04
ELX304	Electrical Network Analysis and Synthesis	04	---	---	04	---	---	04
ELX305	Electronics Instruments and Measurement	04	---	---	04	---	---	04
ELXL301	Electronic Devices and Circuits I Laboratory		02	---	---	01	---	01
ELXL302	Digital Circuit Design Laboratory		02	---	---	01	---	01
ELXL303	Electrical Network and Measurement Laboratory		02	---	---	01	---	01
ELXL304	Object Oriented Programming Methodology Laboratory		02+02#	---	---	02	---	02
	Total	**20**	**10**	**01**	**20**	**05**	**01**	**26**

@1 hour tutorial classwise

#02 hours classwise and 02 hours batchwise

Course Code	Course Name	Examination Scheme – Semester III							
		Theory					Term Work	Oral /Prac	Total
		Internal Assessment (IA)			End Sem Exam Marks	Exam Duration (Hours)			
		Test I	Test II	AVG.					
ELX301	Applied Mathematics III	20	20	20	80	03	25	---	125
ELX302	Electronic Devices and Circuits I	20	20	20	80	03	---	---	100
ELX303	Digital Circuit Design	20	20	20	80	03	---	---	100
ELX304	Electrical Network Analysis and Synthesis	20	20	20	80	03	---	---	100
ELX305	Electronic Instruments and Measurements	20	20	20	80	03	---	---	100
ELXL301	Electronic Devices and Circuits I Laboratory						25	25	50
ELXL302	Digital Circuit Design Laboratory						25	25	50
ELXL303	Electrical Network and Measurement Laboratory						25	---	25
ELXL304	Object Oriented Programming Methodology Laboratory						25	25	50
Total		**100**	**100**	**100**	**400**	**15**	**125**	**75**	**700**

S.E. (Electronics Engineering) – Semester IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELX401	Applied Mathematics IV	04	---	01@	04	---	01	04
ELX402	Electronic Devices and Circuits II	04	---	---	04	---	---	04
ELX 403	Microprocessors and Applications	04	---	---	04	---	---	04
ELX 404	Digital System Design	04	---	---	04	---	---	04
ELX 405	Principles of Communication Engineering	04	---	---	04	---	---	04
ELX 406	Linear Control Systems	04	---	---	04	---	---	04
ELXL 401	Electronic Devices and Circuits II Laboratory		02	---	---	01	---	01
ELXL 402	Microprocessors and Applications Laboratory		02	---	---	01	---	01
ELXL 403	Digital System Design Laboratory		02	---	---	01	---	01
ELXL 404	Principles of Communication Engineering Laboratory		02	---	---	01	---	01
	Total	**24**	**08**	**---**	**24**	**04**	**01**	**29**

@1 hour tutorial classwise

Course Code	Course Name	Examination Scheme – Semester IV							
		Theory					Term Work	Oral /Prac	Total
		Internal Assessment (IA)			End Sem Exam Marks	Exam Duration (Hours)			
		Test I	Test II	AVG.					
ELX401	Applied Mathematics IV	20	20	20	80	3	25	---	125
ELX 402	Electronic Devices and Circuits II	20	20	20	80	3	---	---	100
ELX 403	Microprocessors and Applications	20	20	20	80	3	---	---	100
ELX 404	Digital System Design	20	20	20	80	3	---	---	100
ELX 405	Principles of Communication Engineering	20	20	20	80	3	---	---	100
ELX 406	Linear Control Systems	20	20	20	80	3	---	---	100
ELXL401	Electronic Devices and Circuits II Laboratory						25	25	50
ELXL402	Microprocessors and Applications Laboratory						25	25	50
ELXL 403	Digital System Design Laboratory						25	25	50
ELXL404	Principles of Communication Engineering Laboratory						25	--	50
Total		**120**	**120**	**120**	**480**	**18**	**125**	**75**	**800**

T.E. (Electronics Engineering) – Semester V

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELX501	Micro-controllers and Applications	04	--	--	04	--	--	04
ELX 502	Digital Communication	04	--	--	04	--		04
ELX 503	Engineering Electromagnetics	04	--	@01	04	--	01	05
ELX 504	Design with Linear Integrated Circuits	04	--	--	04	--	--	04
ELXDLO501X	Department Level optional courses I	04		--	04		--	04
ELXL501	Micro-controllers and Applications Laboratory		02			01	--	01
ELXL502	Digital Communication Laboratory		02			01	--	01
ELXL503	Design with Linear Integrated Circuits Laboratory		02			01	--	01
ELX 505	Business Communication & Ethics		02+02#		---	02	--	02
ELX DLOl50X	Department Level optional course-I Laboratory		02			01	--	01
	TOTAL	**20**	**12**	**01**	**20**	**06**	**01**	**27**

@1 hour to be taken as classwise

2 hours classwise and 2 hours batchwise

Course Code	Course Name	Examination Scheme – Semester V							
		Theory					Term Work	Oral /Prac	Total
		Internal Assessment (IA)			End Sem Exam Marks	Exam Duration (Hours)			
		Test I	Test II	AVG.					
ELX501	Micro-controllers and Applications	20	20	20	80	03	---	---	100
ELX502	Digital Communication	20	20	20	80	03	---	---	100
ELX503	Engineering Electromagnetics	20	20	20	80	03	25	---	125
ELX504	Design with Linear Integrated Circuits	20	20	20	80	03	---	---	100
ELXDLO501X	Department Level Elective-I	20	20	20	80	03	---	---	100
ELXL501	Micro-controllers and Applications Laboratory						25	25	50
ELXL502	Digital Communication Lab.						25	---	25
ELXL503	Design with Linear Integrated Circuits Laboratory						25	25	50
ELXL504	Business Communication & Ethics	---	---	---	---	---	50	---	50
ELXLDLO501X	Department Elective I laboratory						25	25	50
Total		**100**	**100**	**100**	**400**	**15**	**175**	**75**	**750**

Course Code	Department Level Optional Course I
ELXDLO5011	Data Base and Management System
ELXDLO5012	Digital Control system
ELXDLO5013	ASIC Verification
ELXDLO5014	Biomedical Instrumentation

T.E. (Electronics Engineering) – Semester VI

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELX601	Embedded System and RTOS	04		---	04	---	---	04
ELX602	Computer Communication Network	04		---	04	---	---	04
ELX 603	VLSI Design	04		---	04	---	---	04
ELX 604	Signals and systems	04		@01	04	---	01	05
ELXDLO502X	Department Level Optional courses II	04	--	---	04	---	---	04
ELXL601	Embedded System and RTOS Laboratory		02			01	---	01
ELXL602	Computer Communication Network Laboratory		02			01		01
ELXL603	VLSI Design Laboratory		02			01	---	01
ELXLDLO502X	Department Level Optional courses II Laboratory		02			01	---	01
	TOTAL	**20**	**10**	**01**	**20**	**04**	**01**	**25**

@ 1 hour classwise

Course Code	Course Name	Examination Scheme – Semester VI							
		Theory					Term Work	Oral /Prac	Total
		Internal Assessment (IA)			End Sem Exam Marks	Exam Duration (Hours)			
		Test I	Test II	AVG.					
ELX601	Embedded System and RTOS	20	20	20	80	03	---	---	100
ELX602	Computer Communication Network	20	20	20	80	03	---	---	100
ELX603	VLSI Design	20	20	20	80	03	---	---	100
ELX604	Signals and systems	20	20	20	80	03	25	25	150
ELXDLO602X	Department Level Optional courses II*	20	20	20	80	03	---	---	100
ELXL601	Embedded System and RTOS Laboratory						25	25	50
ELXL602	Computer Communication Network Laboratory						25	25	50
ELXL603	VLSI Design Laboratory						25	25	50
ELXLDLO602X	Department Level Optional Courses II Laboratory						25	25	50
Total		**100**	**100**	**100**	**400**	**15**	**125**	**100**	**750**

Course Code	Department Level Optional Course II
ELXDLO6021	Microwave Engineering
ELXDLO6022	Electronics Product Design
ELXDLO6023	Wireless Communication
ELXDLO6024	Computer Organization and Architecture

B.E. (Electronics Engineering) – Semester VII

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELX701	Instrumentation System Design	04		---	04	---	---	04
ELX702	Power Electronics	04		---	04	---	---	04
ELX703	Digital signal processing	04		---	04	---	---	04
ELXDLO703X	Department Level Optional course III	04		---	04	---	---	04
ILO701X	Institute Level Optional Course I#	03		---	03	---	---	03
ELXL701	Instrumentation System Design Laboratory		02			01	---	01
ELXL702	Power Electronics Laboratory		02			01	---	01
ELXL703	Digital signal processing Laboratory		02			01	---	01
ELXL704	Project-I	---	06	---	---	03	---	03
ELXLDLO703X	Department Level Optional course III Laboratory		02			01	---	01
	TOTAL	**19**	**14**	**---**	**19**	**07**	**---**	**26**

Course Code	Course Name	Examination Scheme – Semester VII							
		Theory					Term Work	Oral /Prac	Total
		Internal Assessment (IA)			End Sem Exam Marks	Exam Duration (Hours)			
		Test I	Test II	AVG.					
ELX701	Instrumentation System Design	20	20	20	80	03	---	---	100
ELX 702	Power Electronics	20	20	20	80	03	---	---	100
ELX 703	Digital signal processing	20	20	20	80	03	---	---	100
ELXDLO703X	Department Level Optional courses III*	20	20	20	80	03	---	---	100
ILO701X	Institute Level Optional Course #I	20	20	20	80	03	---	---	100
ELXL701	Instrumentation System Design Laboratory						25	25	50
ELXL702	Power Electronics Laboratory						25	25	50
ELXL703	Digital signal processing Laboratory						25	25	50
ELXL704	Project-I	---	---	---	---	---	50	50	100
ELXLDLO703X	Department Level Optional courses III Laboratory						25	25	50
Total		**100**	**100**	**100**	**400**	**15**	**150**	**150**	**800**

#Common to all branches

Course Code	Department Level Optional Course III	Course Code	Institute Level Optional Course I#
ELXDLO7031	Neural Network and Fuzzy Logic	ILO7011	Product Lifecycle Management
ELXDLO7032	Advance Networking Technologies	ILO7012	Reliability Engineering
ELXDLO7033	Robotics	ILO7013	Management Information System
ELXDLO7034	Integrated Circuit Technology	ILO7014	Design of Experiments
		ILO7015	Operation Research
		ILO7016	Cyber Security and Laws
		ILO7017	Disaster Management and Mitigation Measures
		ILO7018	Energy Audit and Management
		ILO7019	Development Engineering

B.E. (Electronics Engineering) – Semester VIII

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELX801	Internet of Things	04		---	04	---	---	04
ELX 802	Analog and Mixed VLSI Design	04		---	04	---	---	04
ELXDLO804X	Department Level Optional course IV	04		---	04	---	---	04
ILO802X	Institute Level Optional course II#	03		---	03	---	---	03
ELX801	Internet of Things Laboratory		02			01	---	01
ELXL802	Analog and Mixed VLSI Design Laboratory		02			01	---	01
ELXL803	Project-II		12	---	---	06	---	06
ELXLDLO804X	Department Level Optional Courses IV Laboratory		02			01	---	01
	TOTAL	**15**	**18**	**---**	**15**	**09**	---	**24**

Course Code	Course Name	Examination Scheme – Semester VII							
		Theory					Term Work	Oral /Prac	Total
		Internal Assessment (IA)			End Sem Exam Marks	Exam Duration (Hours)			
		Test I	Test II	AVG.					
ELX801	Internet of Things	20	20	20	80	03	---	---	100
ELX 802	Analog and Mixed VLSI Design	20	20	20	80	03	---	---	100
ELXDLO804X	Department Level Optional course IV	20	20	20	80	03	---	---	100
ILO802X	Institute Level Optional course II#	20	20	20	80	03	---	---	100
ELXL801	Internet of Things Laboratory						25	25	50
ELXL802	Analog and Mixed VLSI Design Laboratory						25	25	50
ELX803	Project-II	---	---	---	---	---	100	50	150
ELXLDLO804X	Department Level Optional Courses IV Laboratory						25	25	50
Total		**80**	**80**	**80**	**320**	**15**	**150**	**150**	**700**

#Common to all branches

Course Code	Department Level Elective Course IV	Course Code	Institute Level Elective Course II[#]
ELXDLO8041	Advanced Power Electronics	ILO8021	Project Management
ELXDLO8042	MEMS Technology	ILO8022	Finance Management
ELXDLO8043	Virtual Instrumentation	ILO8023	Entrepreneurship Development and Management
ELXDLO8044	Digital Image Processing	ILO8024	Human Resource Management
		ILO8025	Professional Ethics and CSR
		ILO8026	Research Methodology
		ILO8027	IPR and Patenting
		ILO8028	Digital Business Management
		ILO8029	Environmental Management

S.E. (Electronics Engineering) – Semester III

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELX301	Applied Mathematics III	04	---	01@	04	---	01	05
ELX302	Electronic Devices and Circuits I	04	---	---	04	---	---	04
ELX303	Digital Circuit Design	04	---	---	04	---	---	04
ELX304	Electrical Network Analysis and Synthesis	04	---	---	04	---	---	04
ELX305	Electronic Instruments and Measurements	04	---	---	04	---	---	04
ELXL301	Electronic Devices and Circuits I Laboratory		02	---	---	01	---	01
ELXL302	Digital Circuit Design Laboratory		02	---	---	01	---	01
ELXL303	Electrical Network and Measurement Laboratory		02	---	---	01	---	01
ELXL304	Object Oriented Programming Methodology Laboratory		02+02#	---	---	01	---	02
	Total	**20**	**08**	**02**	**20**	**04**	**01**	**26**

@1 hour tutorial classwise

#02 hours classwise and 02hours batchwise

Course Code	Course Name	Examination Scheme – Semester III							
		Theory					Term Work	Oral /Prac	Total
		Internal Assessment (IA)			End Sem Exam Marks	Exam Duration (Hours)			
		Test I	Test II	AVG.					
ELX301	Applied Mathematics III	20	20	20	80	03	25	---	125
ELX302	Electronic Devices and Circuits I	20	20	20	80	03	--	---	100
ELX303	Digital Circuit Design	20	20	20	80	03	---	---	100
ELX304	Electrical Network Analysis and Synthesis	20	20	20	80	03	---	---	100
ELX305	Electronic Instruments and Measurements	20	20	20	80	03	---	---	100
ELXL301	Electronic Devices and Circuits I Laboratory						25	25	50
ELXL302	Digital Circuit Design Laboratory						25	25	50
ELXL303	Electrical Network and Measurement Laboratory						25	--	50
ELXL304	Object Oriented Programming Methodology Laboratory						25	25	25
Total		**100**	**100**	**100**	**400**	**15**	**125**	**75**	**700**

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELX301	Applied Mathematics III	04	--	01	04	--	01	05

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral &Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ELX301	Applied Mathematics III	20	20	20	80	25	--	125

Prerequisite:

FEC 101: Applied Mathematics I
FEC 201: Applied Mathematics II

Course objectives:

1. To build the strong foundation in Mathematics of students needed for the field of Electronics and Telecommunication Engineering
2. To provide students with mathematics fundamentals necessary to formulate, solve and analyses complex engineering problems.
3. To prepare student to apply reasoning informed by the contextual knowledge to engineering practice.
4. To prepare students to work as part of teams on multi-disciplinary projects.

Course outcomes:

1. Students will be able demonstrate basic knowledge of Laplace Transform. Fourier series, Bessel Functions, Vector Algebra and Complex Variable.
2. Students will be able to identify and model the problems in the field of Electronics and Telecommunication Engineering with feasible and practical solution.
3. Students will be able to apply the application of Mathematics in Electronics and Telecommunication Engineering.

Module No	Unit No.	Topic	No of Contact Hour
1	**Laplace Transform**		
	1.1	**Laplace Transform (LT) of Standard Functions:** Definition of Laplace transform, Condition of Existence of Laplace transform, Laplace transform of $e^{at}, Sin(at), \cos(at), \sinh(at), \cosh(at), t^n$ Heaviside unit step function, Dirac-delta function, Laplace transform of Periodic function	7
	1.2	**Properties of Laplace Transform:** Linearity, first shifting theorem, second shifting theorem, multiplication by t^n ,Division by *t*, Laplace Transform of derivatives and integrals, change of scale, convolution theorem, Evaluation of integrals using Laplace transform.	
2	**Inverse Laplace Transform & its Applications**		
	2.1	Partial fraction method, Method of convolution, Laplace inverse by derivative	6
	2.2	**Applications of Laplace Transform:** Solution of ordinary differential equations, Solving RLC circuit differential equation of first order and second order with boundary condition using Laplace transform (framing of differential equation is not included)	
3	**Fourier Series**		
	3.1	**Introduction:** Orthogonal and orthonormal set of functions, Introduction of Dirichlet's conditions, Euler's formulae	11
	3.2	**Fourier Series of Functions:** Exponential, trigonometric functions of any period =2L, even and odd functions, half range sine and cosine series	
	3.3	Complex form of Fourier series, Fourier integral representation, Fourier Transform and Inverse Fourier transform of constant and exponential function.	
4	**Vector Algebra & Vector Differentiation**		
	4.1	**Review of Scalar and Vector Product**: Scalar and vector product of three and four vectors, Vector differentiation, Gradient of scalar point function, Divergence and Curl of vector point function	7
	4.2	**Properties:** Solenoidal and irrotational vector fields, conservative vector field	
5	**Vector Integral**		
	5.1	Line integral	6
	5.2	Green's theorem in a plane, Gauss' divergence theorem and Stokes' theorem	
6	**Complex Variable & Bessel Functions**		
	6.1	**Analytic Function:** Necessary and sufficient conditions (No Proof), Cauchy Reiman equation Cartesian form (No Proof) Cauchy Reiman Equation in polar form (with Proof), Milne Thomson Method and it application, Harmonic function, orthogonal trajectories	11
	6.2	**Mapping:** Conformal mapping, Bilinear transformations, cross ratio, fixed points	

	6.3	**Bessel Functions:** Bessel's differential equation, Properties of Bessel function of order +1/2 and -1/2, Generating function, expression of cos(xsin θ), sin (x sin θ) in term of Besselfunctions	
		Total	**48**

Text books:

1. H.K. Das, "*Advanced engineering mathematics*", S . Chand, 2008
2. A. Datta, *"Mathematical Methods in Science and Engineering",* 2012
3. B.S. Grewal, *"Higher Engineering Mathematics",* Khanna Publication

Reference Books:

1. B. V. Ramana, *"Higher Engineering Mathematics",* Tata Mc-Graw Hill Publication
2. Wylie and Barret, *"Advanced Engineering Mathematics",* Tata Mc-Graw Hill 6th Edition
3. Erwin Kreysizg, *"Advanced Engineering Mathematics",* John Wiley & Sons, Inc
4. Murry R. Spieget, *"Vector Analysis",* Schaum's outline series, Mc-Graw Hill Publication

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered for final Internal Assessment.

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.
5. Weightage of each module in question paper will be proportional to the number of respective lecture hours mentioned in the syllabus.

Term Work/ Tutorial:
At least 08 assignments covering entire syllabus must be given during the "**class wise tutorial'**. The assignments should be students centric and an attempt should be made to make assignments more meaningful, interesting and innovative. Term work assessment must be based on the overall performance of the student with every assignment graded from time to time. The grades will be converted to marks as per "**credit and grading system"** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELX302	Electronic Device and Circuits I	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral &Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ELX302	Electronic Device and Circuits I	20	20	20	80	-	-	100

Course Objectives:

1. To deliver the knowledge about physics of basic semiconductor devices and circuits.
2. To enhance comprehension capabilities of students through understanding of electronic devices and circuits
3. To introduce and motivate students to the use of advanced microelectronic devices
4. To analyze and design electronic circuits using semiconductor devices.

Course Outcomes:

1. Students will be able to explain working of semiconductor devices.
2. Students will be able to analyze characteristics of semiconductor devices.
3. Students will be able to perform DC and AC analysis of Electronics circuits.
4. Students will be able to compare various biasing circuits as well as various configurations of BJT,JFET and MOSFETs.
5. Students will be able to select best circuit for the given specifications/application.
6. Students will be able to design electronics circuits for given specifications.

Module No.	Unit No.	Topics	Hours
1		**PN junction Diode Analysis and applications.**	**08**
	1.1	PN junction Diode: Basic Structure, Energy Band Diagrams, Zero Applied Bias, Forward bias, Reverse bias, PN junction current, drift and diffusion current, junction capacitance, , DC load line, small signal model , Applied Bias, Reverse Applied Bias, temperature effects.	
	1.2	Clippers and Clampers	
2		**Bipolar Junction Transistor**	**12**
	2.1	BJT operations, voltages and currents, BJT characteristics (CE, CB, CC configurations) , early effect	
	2.2	DC Circuit Analysis: DC load line and region of Operation, Common Bipolar Transistor Configurations, biasing circuits, bias stability and compensation, analysis and design of biasing circuits.	
	2.3	AC Analysis of BJT Amplifiers : AC load line, small signal models (h-parameter model, re model, Hybrid-pi model), graphical analysis, ac equivalent circuits and analysis to obtain voltage gain, current gain, input impedance, output impedance of CE,CB and CC amplifiers	
3		**Field Effect Devices**	**10**
	3.1	JFET: Construction, operation and characteristics. MOSFET: Construction, operation and characteristics of D-MOSFET and E-MOSFET.	
	3.2	DC Circuit Analysis : DC load line and region of operation, Common-MOSFETs configurations, Analysis and Design of Biasing Circuits	
	3.3	AC Analysis: AC load line, Small-Signal model of MOSFET and its equivalent Circuit, Small-Signal Analysis MOSFET Amplifiers (Common-Source, Source Follower, Common Gate)	
4		**Special semiconductor devices – I**	**06**
	4.1	Construction, working and characteristics of : Zener diode, Schottkey diode, Varactor diode, Tunnel diode, Solar Cells, Photodiodes, LEDs	
5		**Rectifiers and Regulators**	**06**
	5.1	Rectifiers: working and analysis of Half wave, Full wave and Bridge	
	5.2	Filters: C,L,LC, pi	
	5.3	Regulators: Zener shunt regulator, Series and shunt regulator using single transistor and Zener	
6		**Design of electronic circuits**	**06**
	6.1	Design of single stage CE amplifier	
	6.2	Design of single stage CS MOSFET amplifier	
	6.3	Design of full wave rectifier with LC and pi filter.	
		Total Hours	**48**

Text Books:

1. Millman and Halkies, "Integrated Electronics", TATA McGraw Hill.

2. Donald A. Neamen, "Electronic Circuit Analysis and Design", TATA McGraw Hill, 2nd Edition

Reference Books:

1. Boylestad," Electronic Devices and Circuit Theory", Pearson
2. David A. Bell, "Electronic Devices and Circuits", Oxford, Fifth Edition.
3. Muhammad H. Rashid, "Microelectronics Circuits Analysis and Design", Cengage
4. S. Salivahanan, N. Suresh Kumar,"Electronic Devices and Circuits", Tata McGraw Hill,
5. Adel S. Sedra, Kenneth C. Smith and Arun N Chandorkar,"
6. Microelectronic Circuits Theory and Applications", International Version, OXFORD International Students Edition, Fifth Edition.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered as final IA marks.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No. 1 will be compulsory and based on entire syllabus.
4. Remaining questions (Q2 to Q6) will be set from all modules.
5. Weightage of each module in question paper will be proportional to the number of respective lecture hours mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELX303	Digital Circuit Design	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral &Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ELX303	Digital Circuit Design	20	20	20	80	-	-	100

Course Objective:

1. To understand various number representations and conversion between different representation in digital electronic circuits.
2. To introduce the students to various logic gates, SOP,, POS and their minimization techniques.
3. To analyze logic processes and implementation of logical operations using combinational logic circuits.
4. To explain and describe various logic families and provide information on different IC's.
5. To understand, analyze and design sequential circuits.

Course Outcomes:

1. Students will be able to perform various logical and arithmetic operations various number systems as well as conversion of one representation to another.
2. Students will be able to apply Boolean algebra for the implementation and minimization of logic functions.
3. Students will be analyze, design and implement combinational logic circuits.
4. Students will be able to differentiate between logic families TTL and CMOS.
5. Students will be able to analyze, design and implement sequential logic circuits.

Module No.	Topics	Hrs.
1	**Number Systems and Codes:**	06
	Review of Number System, Binary Code, Binary Coded Decimal, Octal Code, Hexadecimal Code and their conversions, Binary Arithmetic: One's and two's complements,Excess-3 Code, Gray Code, Weighted code, Parity Code: Hamming Code	
2	**Logic Gates and Boolean Algebra:**	08
	Digital logic gates, Realization using NAND, NOR gates, Boolean Algebra, De Morgan's Theorem, SOP and POS representation, K Map up to four variables and Quine-McClusky method upto four variables	
3	**Combinational Logic Circuits and Hazards**	12
	Arithmetic Circuits: Adders/Subtractors:Half adder, Full adder, Half Subtractor, Full Subtractor, Ripple carry adder, Carry Look ahead adder and BCD adder, Magnitude Comparator	
	Multiplexer and De-multiplexer: Multiplexer, cascading of Multiplexer, Boolean Function implementation using single multiplexer and basic gates, De-multiplexer, encoder and decoder, Parity Circuits, ALU	
	Hazards: Timing hazards static and dynamic	
4	**Logic Families:**	06
	Basics of standard TTL (Two input NAND gate operation), CMOS (Inverter, Two input NAND gate, Two input NOR gate), Interfacing of TTL to CMOS and CMOS to TTL, ECL, Working and characteristics of logic families	
5	**Sequential Logic Principles:**	08
	Latches and Flip flops: Difference between latches and flip flops, RS, JK, Master slave flip flops, T & D flip flops with various triggering methods, Conversion of flip flops, Applications of latches and flip flops in switch debouncing, bus holder circuits, Flip flops timing considerations and Metastability	
6	**Counters and Registers:**	08
	Asynchronous and Synchronous, Up/Down, Johnson Counter, MOD N, BCD counter using Decade counter, Ring counters, Shift registers, Universal Shift Register	
Total		**48**

Text Books:

1. R. P. Jain, Modern Digital Electronics, Tata McGraw Hill Education, Third Edition 2003.
2. John F. Warkerly, Digital Design Principles and Practices, Pearson Education, Fourth Edition, 2008.

Reference Books:

1. A. Anand Kumar, Fundamentals of Digital Circuits, PHI, Fourth Edition, 2016.
2. Morris Mano / Michael D. Ciletti , Digital Design, Pearson Education, Fourth Edition, 2008.
3. Donald P. Leach / Albert Paul Malvino / Gautam Saha, Digital Principles and Applications, The McGraw Hill, Seventh Edition, 2011.
4. Thomas L. Floyd, Digital Fundamentals, Pearson Prentice Hall, Eleventh Global Edition, 2015.
5. Charles H. Roth, Fundamentals of Logic Design, Jaico Publishing House, First Edition, 2004.
6. Norman Balabanian/ Bradley Carlson, Digital Logic Design Principles, John Wiley & Sons, First Edition, 2011.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered as final IA marks.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No. 1 will be compulsory and based on entire syllabus.
4. Remaining questions (Q2 to Q6) will be set from all modules.
5. Weightage of each module in question paper will be proportional to the number of respective lecture hours mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELX304	Electrical Network Analysis and Synthesis	04	--	--	04	--	--	05

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral &Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ELX304	Electrical Network Analysis and Synthesis	20	20	20	80	-	-	100

Course Pre-requisites:

- FEC105**:** Basic Electrical Engineering
- Partial fraction expansion, matrices, calculus and Laplace Transforms.

Course Objectives:

1. To make the students understand DC and AC electrical networks and analyze the Networks in time and frequency domain.
2. To understand synthesis of electrical networks and study various filters.

Course Outcome:

1. Students will be able to apply their understanding of network theorems in analyzing complex circuits.
2. Students will be able to evaluate the time and frequency response of electrical circuits and thereby understand the behaviour of electrical networks.
3. Students will be able to evaluate the inter-relationship among various circuit parameters and solve complex networks using these parameters.
4. Students will be able to synthesize electrical networks for a given network function and design simple filters.

Module No.	Unit No.	Topics	Hours
1		**Analysis of DC Circuits**	**06**
	1.1	**DC Circuit Analysis:** Analysis of DC circuits with dependent sources using generalized loop, node matrix analysis.	
	1.2	**Application of Network Theorems to DC Circuits**: Superposition, Thevenin, Norton, Maximum Power Transfer and Millman theorems.	
2		**Analysis of AC Circuits**	**08**
	2.1	**Analysis of Steady State AC circuits:** Analysis of AC circuits with independent sources using generalized loop, node matrix analysis.	
	2.2	**Application of Network Theorems to AC Circuits**: Superposition, Thevenin, Norton, Maximum Power Transfer and Millman theorems.	
	2.3	**Analysis of Coupled Circuits:** Self and mutual inductances, coefficient of coupling, dot convention, equivalent circuit, solution using loop analysis.	
3		**Time and Frequency Domain Analysis of Electrical Networks**	**12**
	3.1	**Time domain analysis of R-L and R-C circuits:** Forced and natural responses, time constant, initial and final values.	
	3.2	**Solution using first order equation for standard input signals:** Transient and steady state time response, solution using universal formula.	
	3.3	**Frequency domain analysis of RLC circuits:** S-domain representation, Concept of complex frequency, applications of Laplace Transform in solving electrical networks, Driving point and Transfer Function, Poles and Zeros, calculation of residues by analytical and graphical method.	
4		**Two Port Networks**	**08**
	4.1	**Parameters:** Open Circuit, Short Circuit, Transmission and Hybrid parameters, relationships among parameters, reciprocity and symmetry conditions	
	4.2	**Series/parallel connection:** T and Pi representations, interconnection of Two-Port networks.	
5		**Synthesis of RLC Circuits**	**08**
	5.1	**Positive Real Functions:** Concept of positive real function, testing for Hurwitz polynomials, testing for necessary and sufficient conditions for positive real functions.	
	5.2	**Synthesis of RC, RL, LC circuits:** Concepts of synthesis of RC, RL, LC driving point **f**unctions.	
6		**Filters**	**06**
	6.1	**Basic filter circuits:** Low pass, high pass, band pass and band stop filters, transfer function, frequency response, cut-off frequency, bandwidth, quality factor, attenuation constant, phase shift, characteristic impedance.	
	6.2	**Design and analysis of filters:** Constant K filters	

Text Books:

1. *Circuits and Networks: Analysis and Synthesis,* A. Sudhakar and S.P. Shyammohan, Tata McGraw-Hill Publishing Company Ltd.

2. *Engineering Circuit Analysis*, William Hayt and Jack Kemmerly, McGraw-Hill.

Reference Books:

1. *Networks and Systems*, D.Roy Choudhury, New Age International Publications.
2. *Network Analysis and Synthesis*, Franklin F. Kuo, Wiley.
3. *Network Analysis*, M.E.VanValkenburg, 3/E, PHI.
4. *Shaum's Outline of Theory and Problems of Basic Circuit Analysis*, John O'Malley, McGraw-Hill.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered as final IA marks.

End Semester Examination:

- Question paper will comprise of 6 questions, each carrying 20 marks.
- The students need to solve total 4 questions.
- Question No. 1 will be compulsory and based on the entire syllabus.
- Remaining questions (Question No. 2 to 6) will be set from all the modules.
- Weightage of each module in question paper will be proportional to the number of respective lecture hours mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELX305	Electronic Instruments and Measurements	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral &Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ELX305	Electronic Instruments and Measurements	20	20	20	80	-	-	100

Course Objectives

1 To impart in-depth knowledge of measurement methods & instruments of electrical quantities

2 To explain the design aspect & performance criterion for measuring instruments

3 To understand the working principle of transducers

Course Outcomes

1 Students will be able to describe the static & dynamic characteristics of an instrument, components of general instrumentation system & different types of errors in the measurement process

2 Students will be analyze various test & measuring instruments including AC and DC bridges to determine the unknown quantity under measurement

3 Students will be able to use cathode ray oscilloscope (CRO) to perform wide range of simple to complex measurement functions for voltage, current, frequency, phase & component testing

4 Students will be able to select choice of transducer for practical & real-life applications based on their principle of operation, working, construction & characteristics

Module No	Unit No	Topic	Hours
1		**Principles of Measurements**	06
	1.1	**Principles of Measurements & Instrumentation** :- Components of a generalized measurement system, applications of instrument systems & revision of SI electrical units (units of current, charge, EMF, potential difference, voltage, resistance, conductance, magnetic flux & flux density, inductance & capacitance)	
	1.2	**Performance Characteristics** :- Static characteristics (accuracy, precision, linearity, drift, sensitivity, calibration, repeatability, reproducibility, resolution, hysteresis & dead band zone) & dynamic characteristics (speed of response, fidelity, lag & dynamic error)	
	1.3	**Errors in Measurement :-** Errors in measurement, classification of errors, remedies to eliminate or to minimize errors, statistical analysis of errors	
2		**Measurement of R, L and C**	08
	2.1	**Measurement of Resistance :-** Measurement of low, medium & high resistances by using Wheatstone bridges, Kelvin's Double bridge & mega-ohm meter (megger)	
	2.2	**Measurement of Inductance & Capacitance :-** Inductance & capacitance comparison bridge, Maxwell's bridge, Hay's bridge, Schering's bridge, Wien's bridge & LCR Q Meter	
3		**Oscilloscopes**	10
	3.1	**Cathode Ray Oscilloscope** :- Block diagram based study of CRO, control & specifications, sweep mode, role of delay line, single & dual beam, dual-trace CRO, chop & alternate modes	
	3.2	**Measurement using Oscilloscope :-** Measurement of voltage, frequency, rise time, fall time & phase difference, Lissajous figures in detecting phase & frequency difference	
	3.3	**Digital Storage Oscilloscope :-** Features like roll, refresh, storage mode & sampling rate, applications of DSO	
4		**Analog and Digital Instruments**	08
	4.1	**Digital Instruments :-** DVM (ramp, dual-slope, integrating & successive approximation), Digital multimeter, Digital frequency meter, Digital phase meter, Digital time measurement	
	4.2	**Signal Generators :-** Low frequency signal generator, function generator, pulse generator, RF signal generator & sweep frequency generators	
	4.3	**Wave Analyzer :-** Basic wave analyzer, frequency selective & heterodyne	

		wave analyser, harmonic distortion analyzer & spectrum analyzer	
5		**Transducers for Displacement and Temperature Measurement**	**08**
	5.1	**Basics of Transducers / Sensors :-** Characteristics of transducers & sensors, requirements of transducers, classification of transducers, criteria for selection of transducers	
	5.2	**Temperature :-** Resistance temperature detector (RTD), thermistor, thermocouple, their range & applications, comparison of RTD, thermistor & thermocouple	
	5.3	**Displacement :-** Potentiometers, linear variable differential transformer (LVDT), resistance strain gauges, capacitance sensors	
6		**Transducers for Pressure, Level and Flow Measurements**	**08**
	6.1	**Pressure :-** Pressure gauges, elastic pressure transducers, dead weight tester, vacuum pressure measurement – McLeod gauge & Pirani gauge	
	6.2	**Level :-** Side glass tube method, float type methods, capacitance type methods, ultrasonic type transducers, optical level detectors	
	6.3	**Flow :-** Restriction type flow meter – orifice & venturi, rotameter, magnetic type flow meter, turbine flow meter, rotameters	
		Total	**48**

Text books:

1. David A. Bell, Electronic Instrumentation & Measurements, Oxford Publishing, 2nd edition
2. H. S. Kalsi, Electronic Instrumentation, McGraw Hill, 4th edition

Reference Books:

1. C. S. Rangan, G.R. Sarma, V.S.V. Mani, Instrumentation Devices and Systems, Tata McGraw Hill, 9th edition.
2. A. K. Sawhney, Electrical & Electronic Instruments & Measurement, Dhanpat Rai & Sons, 11th edition
3. S. K. Singh, Industrial Instrumentation & Control, McGraw Hill, 3rd edition

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered as final IA marks.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.

2. The students need to solve total 4 questions.

3. Question No. 1 will be compulsory and based on entire syllabus.

4. Remaining questions (Q2 to Q6) will be set from all modules.

5. Weightage of each module in question paper will be proportional to the number of respective lecture hours mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXL301	Electronic Device and Circuits I Laboratory	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral &Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ELXL301	Electronic Device and Circuits ILaboratory	--	--	--	--	25	25	50

Term Work:

At least 6 experiments covering entire syllabus of ELX 302 (Electronic Devices and Circuits I) should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. Also each student (in group of 3/4) has to perform a ***Mini Project*** as a part of the laboratory and report of mini project should present in laboratory journal. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus. Equal weightage should be given to laboratory experiments and project while assigning term work marks.

Suggested List of Experiments, however Instructor is free to design his/her own experiments as per the guidelines

Laboratory Experiments

1. To study passive(R,L,C) and active (BJT,MOSFTET) components
2. To study equipment (CRO, Function Generator,Power supply).
3. To perform characteristics of PN junction diode.
4. To perform Clippers and Clampers.
5. To perform analysis and design Fixed bias,voltage divider bias for CE amplifier.
6. To perform CE amplifier as voltage amplifier (Calculate Av,Ai,Ri,Ro).
7. To perform CS MOSFET amplifier as voltage amplifier and measurment of its performance parametes.
8. To perform Half wave/Full wave/Bridge rectifier with LC/pi filter.
9. To perform Zener as a shunt voltage regulator.
10. To design Half wave/Full wave/Bridge rectifier with LC/pi filter.

11. To design single stage CE Amplifier.
12. To design single stage CS Amplifier.

Guidelines for Simulation Experiments

1. SPICE simulation of and implementation for junction analysis
2. SPICE simulation of and implementation for BJT characteristics
3. SPICE simulation of and implementation for JFET characteristics
4. SPICE simulation of for MOSFET characteristics
5. SPICE simulation of Half wave/Full wave/Bridge rectifier with LC/pi filter.
6. SPICE simulation of CE amplifier
7. SPICE simulation of CS MOSFET amplifier.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXL302	Digital Circuit Design Laboratory	--	02	--	--	01	--	01

Subject Code	Subject Name	Examination Scheme						
		Theory Marks				Term Work	Oral &Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ELXL302	Digital Circuit Design Laboratory	--	--	--	--	25	25	50

Term Work:

At least 6 experiments covering entire syllabus of ELX 303 (Digital Circuit Design)
should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. Also each student (in group of 3/4) has to perform a ***Mini Project*** as a part of the laboratory and report of mini project should present in laboratory journal. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus. Equal weightage should be given to laboratory experiments and project while assigning term work marks.

Suggested List of Experiments, however Instructor is free to design his/her own experiments as per the guidelines

Laboratory Experiments

1. Verify different logic gates.
2. Simplification of Boolean functions.
3. Verify Universal gates NAND and NOR and design EXOR and EXNOR gates using Universal gates.
4. Implement Half adder, Full adder, Half subtractor and Full subtractor circuits.
5. Implement BCD adder using four bit binary adder IC-7483.
6. Flip flops conversion JK to D, JK to T and D to TFF.
7. Implement logic equations using Multiplexer.
8. Design synchronous MOD N counter using IC-7490.
9. Verify encoder and decoder operations.
10. Implement digital circuits to perform binary to gray and gray to binary operations.
11. Verify truth table of different types of flip flops.
12. Verify different counter operations.
13. Verify operations of shift registers.
14. Implement parity checker circuit.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXL303	Electrical Networks and Measurements Laboratory	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral &Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ELXL303	Electrical Network and Measurement Laboratory	--	--	--	--	25	--	25

Term Work:

At least 5 experiments covering entire syllabus of ELX 305 (Electronic Instruments and Measurements) should be set to have well predefined inference and conclusion and minimum of five tutorials covering entire syllabus of ELX304 (Electrical Network Analysis and Synthesis) with each tutorial shall have a minimum of four numerical problems solved and duly assessed. Simulation based tutorials shall be based using any circuit simulation tool like Spice/LTspice are encouraged. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.

Suggested List of Experiments for ELX305

1.To experimentally determine static characteristics of instruments & perform error analysis
2.To measure low & medium resistances using Kelvin's Bridge & Kelvin's Double Bridge
3.To measure high resistances using mega-ohm-meter (megger)
4.Study of CRO & understand various front panel controls
5.Study of function / signal generator & understand various front panel controls
6.Study of spectrum / wave analyser & understand various front panel controls
7.Study of linear variable differential transducer (LVDT)
8.Study of strain gauges
9.Study of thermistor characteristics
10.Study of RTD characteristics

Suggested topics (but not limited to) for tutorial for ELX304 are as follows:
1. Find Open circuit parameters, Short circuit parameters, Hybrid parameters of 2 port network.
2. Obtain the Frequency response of Low pass and High pass filters.
3. Find the time response of R-L and R-C circuits and obtain the time constants.
4. Study of dependent sources – Voltage controlled voltage source and Current controlled current source.
5. Verification of Superposition theorem and Thevenin's theorem in AC circuits.
6. Time response of a 2nd order system.

7. Calculation of driving point functions for various circuit topologies.
8. Simulation of initial/final conditions (switching) of RLC circuit with DC source on any circuit simulation platform.
9. Simulation of initial/final conditions (switching) of RLC circuit with AC source on any circuit simulation platform.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXL304	Object Oriented Programming Methodology Laboratory	02 Classwise	02 Batchwise	--	--	02	--	02

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral &Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ELXL304	Object Oriented Programming Methodology Laboratory	--	--	--	--	25	25	50

Prerequisite:
FEC205: Structured Programming Approach

Course Objective:
1.To learn the object oriented programming concepts.
2.To study various java programming concept like multithreading, exception handling, packages etc.
3.To explain components of GUI based programming.

Course Outcomes: At the end of the course Student should be able:
1.To apply fundamental programming constructs.
2.To illustrate the concept of packages, classes and objects.
3.To elaborate the concept of strings, arrays and vectors.
4.To implement the concept of inheritance and interfaces.
5.To implement the notion of exception handling and multithreading.
6.To develop GUI based application.

Module No	Unit No	Topic	Hours
1		**Introduction to Object Oriented Programming**	02
	1.1	OOP Concepts: Object, Class, Encapsulation, Abstraction, Inheritance, Polymorphism	
	1.2	Features of Java, JVM	
	1.3	3 Basic Constructs/Notions: Constants, variables and data types, Operators and Expressions, Revision of Branching and looping	
2		**Classes, Object and Packages**	05
	2.1	Class, Object, Method	
	2.2	Constructor, Static members and methods	
	2.3	Passing and returning Objects	
	2.4	Method Overloading	
	2.5	Packages in java, creating user defined packages, access specifiers.	
3		**Array, String and Vector**	04
	3.1	Arrays, Strings, String Buffer	
	3.2	Wrapper classes, Vector	
4		**Inheritance and Interface**	03
	4.1	Types of Inheritance, super keyword, Method Overriding, abstract class and abstract method, final keyword	
	4.2	Implementing interfaces, extending interfaces	
5		**Exception Handling and Multithreading**	04
	5.1	Error vs Exception, try, catch, finally, throw, throws, creating own exception	
	5.2	Thread lifecycle, Thread class methods, creating threads, Synchronization	
6		**GUI programming in JAVA**	
	6.1	Applet: Applet life cycle, Creating applets, Graphics class methods, Font and Color class, parameter passing.	
	6.2	Event Handling: Event classes and event listener	

	6.3	Introduction to AWT: Working with windows, Using AWT controls- push Buttons, Label, Text Fields, Text Area, Check Box, and Radio Buttons.	**08**
	6.4	Programming using JDBC: Introduction to JDBC, JDBC Drivers & Architecture.	
		Total	**26**

Text books:

1. Herbert Schildt, 'JAVA: The Complete Reference', Ninth Edition, Oracle Press.
2. Sachin Malhotra and Saurabh Chaudhary, "Programming in Java", Oxford University Press, 2010

Reference Books:

1. Ivor Horton, 'Beginning JAVA', Wiley India.
2. DietalandDietal, 'Java: How to Program', 8/e,PHI
3. 'JAVA Programming', Black Book, Dreamtech Press.
4. 'Learn to Master Java programming', Staredusolutions

Digital Material:

1. www.nptelvideos.in
2. www.w3schools.com
3. http://spoken-tutorial.org
4. www.staredusolutions.org

Suggested List of Programming Assignments/Laboratory Work:

1.Program on various ways to accept data through keyboard and unsigned right shift operator.
2.Program on branching, looping, labelled break and labelled continue.
3.Program to create class with members and methods, accept and display details for single object.
4.Program on constructor and constructor overloading
5.Program on method overloading
6.Program on passing object as argument and returning object
7.Program on creating user defined package
8.Program on 1D array
9.Program on 2D array
10.Program on String
11.Program on StringBuffer
12.Program on Vector
13.Program on single and multilevel inheritance (Use super keyword)
14.Program on abstract class
15.Program on interface demonstrating concept of multiple inheritance
16.Program on dynamic method dispatch using base class and interface reference.
17.Program to demonstrate try, catch, throw, throws and finally.
18.Program to demonstrate user defined exception
19.Program on multithreading
20.Program on concept of synchronization
21.Program on Applet to demonstrate Graphics, Font and Color class.

22.Program on passing parameters to applets
23.Program to create GUI application without event handling using AWT controls
24.Program to create GUI application with event handling using AWT controls
25.Mini Project based on content of the syllabus. (Group of 2-3 students)

Term Work:
At least 10-12 experiments covering entire syllabus of ELXL304 (Object Oriented Programming Methodology) should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Experiment must be graded from time to time. Also each student (in group of 3/4) has to perform a **Mini Project** as a part of the laboratory and report of mini project should present in laboratory journal. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus. Equal weightage should be given to laboratory experiments and project while assigning term work marks.

S.E. (Electronics Engineering) – Semester IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELX401	Applied Mathematics IV	04	---	01@	04	---	01	05
ELX 402	Electronic Devices and Circuits II	04	---	---	04	---	---	04
ELX 403	Microprocessors and Applications	04	---	---	04	---	---	04
ELX 404	Digital System Design	04	---	---	04	---	---	04
ELX 405	Principles of Communication Engineering	04	---	---	04	---	---	04
ELX 406	Linear Control Systems	04	---	---	04	---	---	04
ELXL 401	Electronic Devices and Circuits II Lab.		02	---	---	01	---	01
ELXL 402	Microprocessors and Applications Lab.		02	---	---	01	---	01
ELXL 403	Digital System Design Lab.		02	---	---	01	---	01
ELXL 404	Principles of Communication Engineering Lab.		02	---	---	01	---	01
	Total	**24**	**08**	**01**	**24**	**04**	**01**	**29**

@1 hour tutorial classwise

Course Code	Course Name	Examination Scheme – Semester IV							
		Theory					Term Work	Oral /Prac	Total
		Internal Assessment (IA)			End Sem Exam Marks	Exam Duration (Hours)			
		Test I	Test II	AVG.					
ELX401	Applied Mathematics IV	20	20	20	80	3	25	---	125
ELX 402	Electronic Devices and Circuits II	20	20	20	80	3	---	---	100
ELX 403	Microprocessors and Applications	20	20	20	80	3	---	---	100
ELX 404	Digital System Design	20	20	20	80	3	---	---	100
ELX 405	Principles of Communication Engineering	20	20	20	80	3	---	---	100
ELX 406	Linear Control Systems	20	20	20	80	3	---	---	100
ELXL401	Electronic Devices and Circuits II Laboratory						25	25	50
ELXL402	Microprocessors and Applications Laboratory						25	25	50
ELXL 403	Digital System Design Laboratory						25	25	50
ELXL404	Principles of Communication Engineering Laboratory						25	--	50
Total		**120**	**120**	**120**	**480**	**18**	**100**	**75**	**800**

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/ Practical	Tutorial	Total
ELX401	Applied Mathematics IV	04	--	01	04	--	01	05

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral &Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ELX401	Applied Mathematics IV	20	20	20	80	25	--	100

Prerequisite:

FEC 101: Applied Mathematics I
FEC 201: Applied Mathematics II
ELX 301: Applied Mathematics III

Course objectives:

1. To build the strong foundation in Mathematics of students needed for the field of Electronics and Telecommunication Engineering
2. To provide students with mathematics fundamentals necessary to formulate, solve and analyses complex engineering problems.
3. To prepare student to apply reasoning informed by the contextual knowledge to engineering practice.
4. To prepare students to work as part of teams on multi-disciplinary projects.

Course outcomes:

1 Students will demonstrate basic knowledge of Calculus of variation, Vector Spaces, Matrix Theory, Random Variables, Probability Distributions, Correlation and Complex Integration.

2 Students will demonstrate an ability to identify and Model the problems in the field of Electronics and Telecommunication and solve it.

3 Students will be able to apply the application of Mathematics in Telecommunication Engineering.

Module No.	Unit No.	Topics	Hrs.
1		**Calculus of Variation:**	**06**
	1.1	Euler's Langrange equation, solution of Euler's Langrange equation (only results for different cases for Function) independent of a variable, independent of another variable, independent of differentiation of a variable and independent of both variables	
	1.2	Isoperimetric problems, several dependent variables	
	1.3	Functions involving higher order derivatives: Rayleigh-Ritz method	
		Linear Algebra: Vector Spaces	**06**
2	**2.1**	Vectors in n-dimensional vector space: properties, dot product, cross product, norm and distance properties in n-dimensional vector space.	
	2.2	Vector spaces over real field, properties of vector spaces over real field, subspaces.	
	2.3	The Cauchy-Schwarz inequality, Orthogonal Subspaces, Gram-Schmidt process.	
3		**Linear Algebra: Matrix Theory**	**10**
	3.1	Characteristic equation, Eigen values and Eigen vectors, properties of Eigen values and Eigen vectors	
	3.2	Cayley-Hamilton theorem (without proof), examples based on verification of Cayley- Hamilton theorem.	
	3.3	Similarity of matrices, Diagonalisation of matrices.	
	3.4	Functions of square matrix, derogatory and non-derogatory matrices.	
4		**Probability**	**10**
	4.1	Baye's Theorem (without proof)	
	4.2	Random variable: Probability distribution for discrete and continuous random variables, Density function and distribution function, expectation, variance.	
	4.3	Moments, Moment Generating Function.	
	4.4	Probability distribution: Binomial distribution, Poisson & normal distribution (For detailed study)	
5		**Correlation**	**04**
	5.1	Karl Pearson's coefficient of correlation,Covariance,Spearman's Rank correlation,	
	5.2	Lines of Regression.	
6		**Complex integration**	**12**
	6.1	Complex Integration:Line Integral, Cauchy's Integral theorem for simply connected regions, Cauchy's Integral formula.	
	6.2	Taylor's and Laurent's Series	
	6.3	Zeros, singularities, poles of f(z), residues, Cauchy's Residue theorem.	
	6.4	Applications of Residue theorem to evaluate real Integrals of different types.	
		Total	**48**

Text books:

1. H.K. Das, "*Advanced engineering mathematics*", S . Chand, 2008
2. A. Datta, *"Mathematical Methods in Science and Engineering",* 2012
3. B.S. Grewal, *"Higher Engineering Mathematics",* Khanna Publication
4. P.N.Wartilar&J.N.Wartikar, "*A Text Book of Applied Mathematics*" Vol.I and II,VidyarthiGrihaPrakashan., Pune.

Reference Books:

1. B. V. Ramana, *"Higher Engineering Mathematics",* Tata Mc-Graw Hill Publication
2. Wylie and Barret, *"Advanced Engineering Mathematics",* Tata Mc-Graw Hill 6th Edition
3. Erwin Kreysizg, *"Advanced Engineering Mathematics",* John Wiley & Sons, Inc
4. Seymour Lipschutz ,"*Beginning Linear Algebra*" Schaum's outline series, Mc-Graw Hill Publication
5. Seymour Lipschutz, "*Probability*" Schaum's outline series, Mc-Graw Hill Publication

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered as final IA marks.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No. 1 will be compulsory and based on entire syllabus.
4. Remaining questions (Q2 to Q6) will be set from all modules.
5. Weightage of each module in question paper will be proportional to the number of respective lecture hours mentioned in the syllabus.

Term Work/ Tutorial:

At least 08 assignments covering entire syllabus must be given during the "**class wise tutorial'**. The assignments should be students centric and an attempt should be made to make assignments more meaningful, interesting and innovative. Term work assessment must be based on the overall performance of the student with every assignment graded from time to time. The grades will be converted to marks as per "**credit and grading system"** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/ Practical	Tutorial	Total
ELX402	Electronic Devices &Circuits-II	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral &Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ELX402	Electronic Devices & Circuits-II	20	20	20	80	--	--	100

Prerequisite:

- **FEC105:** Basic Electrical & Electronics Engineering
- **ELX302:** Electronic Device and Circuits I

Course Objectives:

1. To enhance comprehension capabilities of students through understanding of electronic devices and circuits
2. To perform DC and AC analysis of single stage and multistage amplifiers
3. To introduce and motivate students to the use of advanced microelectronic devices
4. To design electronic circuits using semiconductor devices.

Course Outcome:

1. Students will be able to Ability to understand amplifiers through frequency response.
2. Students will be able to perform DC and Ac analysis of single stage and multistage amplifiers, oscillators, differential amplifiers and power amplifiers.
3. Students will be able to derive expression for performance parameters in terms of circuit and device parameters.
4. Student will be able to select appropriate circuit for given specifications/applications.
5. Students will be able to explain working and construction details of special, semiconductor devices.

Module No.	Topics	Hours
1	**Frequency response of amplifiers.**	**8**
1.1	High frequency equivalent circuit of BJT and MOSFET, Miller's theorem, effect of Miller's capacitance, unity gain bandwidth	
1.2	Effect of coupling, bypass and load capacitors on single stage BJT and MOSFET amplifiers.	
2	**Frequency Response of Multistage Amplifiers.**	**6**
2.1	Effect of parasitic capacitances on BJT and MOSFET amplifiers. Low, mid and high frequency response of multistage amplifiers (CE-CE, CE-CB, CS-CS, CS-CG)	
3	**Feedback Amplifiers and Oscillators**	**8**
3.1	Types of Negative Feedback block diagram representation, Effect of negative feedback on Input impedance, Output impedance, Gain and Bandwidth with derivation, feedback topologies (Introduction only).	
3.2	Positive feedback and principle of oscillations, RC oscillators: Phase shift oscillators, Wien bridge oscillators, LC Oscillators: Hartley, Colpitts and clapp, Tunned Oscillator, Twin T Oscillator, Crystal Oscillator (BJT circuit analysis).	
4	**Differential Amplifiers**	**10**
4.1	MOSFET current sources, Cascode current mirror, advanced MOSFET active load, small signal analysis: MOSFET active load	
4.2	Basic MOSFET differential amplifier, DC characteristics, transfer characteristics, differential and common mode input impedances.	
4.3	MOSFET differential amplifier with active load, MOSFET differential amplifier with cascode active load,	
5	**Power Amplifiers**	**8**
	Power BJTs, Heat sinks, Power BJTs, Power MOSFETs, Heat Sinks, Class A, Class B, Class C and Class AB operation, Power efficiency, Class AB output stage with diode biasing, VBE multiplier biasing, input buffer transistors, Darlington configuration.	
6	**Special Semiconductor Devices - II**	**8**
	PNPN diode, SCR, DIAC, TRIAC, UJT, IGBT, HEMT, Gunn diode, IMPATT diode, HBT	
	Total Hours	**48**

Text Books:

1. Millman and Halkies, “Integrated Electronics”, TATA McGraw Hill.
2. Donald A. Neamen, “Electronic Circuit Analysis and Design”, TATA McGraw Hill, 2nd Edition

Reference Books:

1. Boylestad," Electronic Devices and Circuit Theory", Pearson
2. David A. Bell, “Electronic Devices and Circuits”, Oxford, Fifth Edition.
3. Muhammad H. Rashid, “Microelectronics Circuits Analysis and Design”, Cengage
4. S. Salivahanan, N. Suresh Kumar,“Electronic Devices and Circuits”, Tata McGraw Hill,
5. Adel S. Sedra, Kenneth C. Smith and Arun N Chandorkar,” Microelectronic Circuits Theory and Applications”, International Version, OXFORD International Students Edition, Fifth Edition.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered as final IA marks.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No. 1 will be compulsory and based on entire syllabus.
4. Remaining questions (Q2 to Q6) will be set from all modules.
5. Weightage of each module in question paper will be proportional to the number of respective lecture hours mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/ Practical	Tutorial	Total
ELX403	Microprocessors & Applications	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral &Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ELX403	Microprocessors and Applications	20	20	20	80	--	--	100

Prerequisite*:*

- **ELX303**:Digital Circuit Design

Course Objectives:

1. To develop background knowledge and core expertise in microprocessor.
2. To study the concepts and basic architecture of 8086 and Co-processor 8087.
3. To know the importance of different peripheral devices and their interfacing to 8086.
4. To know the design aspects of basic microprocessor.
5. To write assembly language programs in microprocessor for various applications.

Course Outcomes:

1.Students will be able to understand and explain 16-bit microprocessor architecture.
2.Students will be able to understand and write programmes for 8086 microprocessor.
3.Students will be able to use various peripheral devices to design Single Board Computer(SBC).
4.Students will be able to understand and explain 32-bit microprocessor architecture.

Module No.	Topics	Hrs.
1.	**Intel 8086 Architecture:** Major features of 8086 processor, 8086 CPU Architecture and the pipelined operation, Programmer's Model, Memory Segmentation and 8086 pin description in detail.	05
2.	**Instruction Set of 8086 and Programming:** Addressing modes of 8086, Instruction Set of 8086 microprocessor in detail, Assembler directives,Procedures and Macros, Programming 8086 in assembly language, Mixed mode Programming with C-language and assembly language.	07
3.	**8086 Interrupts:** Interrupt types in 8086, Dedicated interrupts, Software interrupts, Programming examples related to INT 21H (DOS Interrupts).	05
4.	**Designing the 8086 CPU module:** Generating the 8086 System Clock and Reset Signals using 8284 clock generator, 8086 Minimum and Maximum Mode CPU Modules, Minimum and Maximum Mode Timing Diagrams, Memory interfacing.	07
5.	**Single Board Computer Design:** 8086 – 8087 coprocessor interfacing. Functional Block Diagram and description, Operating Modes, Control Word Formats and Applications of the Peripheral Controllers - 8255-PPI,8259- PIC and 8237-DMAC. Keyboard and Seven Segment Display Interface using 8255. System design using peripheral controllers.	12
6.	**Introduction to 32-bit Intel Pentium Architecture:** Features of Pentium Processor, Pentium Superscalar architecture, Pipelining, Branch Prediction, Instruction and Data cache.	12
	Total	48

Text Books:

1)8086/8088 family: Design Programming and Interfacing: By John Uffenbeck (Pearson Education)
2)Microprocessor and Interfacing: By Douglas Hall (TMH Publication)
3)The Intel Microprocessor family: Hardware and Software principles and Applications: By James L. Antonakos (Cengage Learning)

Reference Books:

1) 8086 Microprocessor Programming and Interfacing the PC: By Kenneth Ayala (West Publication)
2) Pentium Processor System Architecture: By Don Anderson & Tom Shanley (Mindshare, Inc.) (Addison-Wesley Publisher)
3) The INTEL Microprocessors, Architecture, Programming and Interfacing: By Barry B. Brey (PearsonPublishers, 8th Edition)
4) Microcomputer Systems: 8086/8088 family Architecture, Programming and Design: By Liu & Gibson (PHI Publication).

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No. 1 will be compulsory and based on entire syllabus.
4. Remaining questions (Q2 to Q6) will be set from all modules.
5. Weightage of each module in question paper will be proportional to the number of respective lecture hours mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELX404	Digital System Design	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral &Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ELX404	Digital System Design	20	20	20	80	--	--	100

Prerequisite*:*

- **ELX303**: Digital Circuit Design

Course Objectives:

1. To perform analysis of synchronous sequential circuits.
2. To perform the design of synchronous and asynchronous counters using intuitive approaches.
3. To apply fundamental design procedure for synchronous sequential circuits; consisting of the steps as construction of initial state transition table/diagram, perform state reduction and state assignment, develop flip-flop excitations, and design of registers and counters.
4. To understand the basics of Hardware Description language. .
5. To make VHDL implementations on the structured design of synchronous sequential circuits.
6. To apply algorithmic state machines (ASMs) approach for large-size digital system design; consisting of the steps as development of ASM charts and ASM blocks, make state assignment on ASMs, and perform data path and control path designs.

Course Outcome:

1. Students will be able to design and implement synchronous sequential logic circuits.
2. Students will be able to analyze various types of digital logic circuits.
3. Students will be able to understand engineering concepts in the design of digital circuits.
4. Students will be able to understand the role of hardware description languages in digital circuit implementation.
5. Students will be able to describe simple hardware functions using a hardware description language.
6. Students will be able to understand the purpose of and steps involved in digital circuit implementation using Field-Programmable Gate Arrays.

Module No.	Topics	Hrs.
1	**Sequential logic design** Mealy and Moore models, state machine notations, clocked synchronous state machine analysis, construction of state diagram, sequence detector (word problem), state reduction techniques (inspection, partition and implication chart method), clocked synchronous state machine design, design examples like a few simple machines and traffic light controller, vending machine.	**09**
2	**Algorithmic State Machine (ASM) Chart and Register Transfer Luanguage(RTL)** Standard symbols for ASM Chart, Realization techniques for sequential/logic functions using ASM Chart, Top Down Design Example, Generalized ASM output, ASM Chart representation of control unit, RTL, Construction of data unit using RTL Description, Timing of connection and transfer, sequencing of control, Combinational logic and conditional transfer, Graphical and RTL Bus notation, Design examples of waveform controllable generator ,pulse width adjustor using ASM chart, design data unit and control unit for sequential circuits using RTL Description.	**08**
3	**Sequential logic design practices** Synchronous counter design and applications, MSI asynchronous counters (IC 7490, 7493), MSI synchronous counters (IC 74161, 74163, 74168, 74169) and applications, decoding binary counter states, MSI shift registers, Synchronous design methodology, impediments in synchronous design, synchronizer failure and metastability.	**09**
4	**Introduction to VHDL** Introduction to Hardware Description Language, Core features of VHDL, data types, concurrent and sequential statements, data flow, behavioral, structural architectures, subprograms, Examples like Adder, subtractor, Multiplexers, De-multiplexers, encoder, decoder.	**08**
5	**Design of Sequential circuits using VHDL** VHDL code for flip flop, counters, registers, Moore, Mealy type FSMs, Serial adders, sequence detector.	**08**
6	**Programmable Logic Devices** ROM, RAM, SRAM, PLA, PAL, CPLD and FPGA architecture. Numerical based on PLA and PAL.	**06**
	Total	**48**

Text Books:

1. Digital Logic Applications and Design – John M. Yarbrough, Thomson Publications, 2006
2. Digital Design, Morris Mano Second Edition, PHI, 2002
3. Volnei A. Pedroni, "Circuit Design with VHDL" MIT Press (2004)

Reference Books:

1. Digital Design Principles and Practices, 3rd ed. by Wakerly. Prentice Hall, 2000
2. Digital Design – Morris Mano, M.D.Ciletti, 4th Edition, PHI
3. Digital Circuits and Logic Design – Samuel C. Lee , PHI
4. William I.Flectcher, "An Engineering Approach to Digital Design", PrenticeHall of India.
5. Parag K Lala, "Digital System design using PLD", BS Publications, 2003.
6. Charles H. Roth Jr., "Fundamentals of Logic design", Thomson Learning, 2004.
7. Stephen Brown, Zvonko Vranesic, "Fundamentals of Digital Logic Design" McGraw Hill, 2nd edition Charles H.Roth Jr "Fundamentals of Logic Design" Thomson Learning 2004

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No. 1 will be compulsory and based on entire syllabus.
4. Remaining questions (Q2 to Q6) will be set from all modules.
5. Weightage of each module in question paper will be proportional to the number of respective lecture hours mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELX405	Principles of Communication Engineering	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral &Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ELX405	Principles of Communication Engineering	20	20	20	80	--	--	100

Prerequisite:

- Applied Mathematics-III
- Applied Mathematics-IV

Course Objectives:

1. Understand the need for various analog modulation techniques
2. Analyse the characteristics of the receivers
3. Understand pulse modulation methods
4. Identify the necessity of multiplexing

Course Outcomes:

1. Students will be able to comprehend the need for various components in analog communication systems
2. Students will be able to analyse various analog modulation methods
3. Students will be able to design modulators, demodulators for amplitude and frequency modulated systems.
4. Students will be able to assess the characteristics of pulse modulation techniques.
5. Recognize the need for multiplexing techniques.

Module No.	Unit No.	Topics	Hrs
1		**Introduction to Electronic Communication**	06
	1.1	**Introduction:** Electromagnetic frequency spectrum, concepts of wave propagation-ground wave, sky wave and space wave	
	1.2	**Elements of communication systems:** Information sources, communication channels, noise, sources of noises, need for modulation, bandwidth and power trade-off.	
	1.3	**1.3 Representation of the signals:** Fourier series, Fourier transform, two sided spectrum	
2		**Amplitude Modulation and demodulation**	10
	2.1	**Amplitude Modulation :** Types of Analog Modulation, Principles of Amplitude Modulation , AM for a Complex Modulating Signal, AM Power Distribution, AM Current Distribution, Limitations of AM , AM modulators and Demodulator	
	2.2	**Types of AM**: Modulation & Demodulation Techniques: DSB-SC, SSB-SC , Vestigial-Sideband (VSB) Modulation , Comparison of AM, DSBSC, SSB and VSB	
	2.3	**2.3** Applications of AM	
3		**Angle modulation and demodulation**	08
	3.1	Frequency Modulation: Principles of Angle Modulation, Theory of FM—Basic Concepts, Spectrum Analysis of FM Wave, Narrowband and Wideband FM, Noise triangle,Pre-emphasis, de-emphasis FM Generation: Direct methods and Indirect method,FM Detection: Frequency discriminator and Phase discriminator methods	
	3.2	**Phase Modulation** : Theory of Phase Modulation, Relationship between FM and PM, Advantages and Disadvantages of Angle Modulation, Comparison of AM, FM and PM	
	3.3	3 Applications of FM and PM	
4		**Radio Transmitters and Receivers**	08
	4.1	Radio receivers: Receiver Characteristics : Sensitivity, Selectivity, Fidelity, Image frequency rejection ratio, TRF Receivers and its characteristics , Concept of Heterodyning , Superheterodyne Receiver , choice of Intermediate frequency	
	4.2	**AM Transmitters and Receivers**: AM Radio Transmitters, AM Radio Receivers, Practical diode detector, Automatic Gain control(AGC), Types of AGC.	
	4.3	**FM Transmitters and Receivers**: FM Transmitters, FM Receivers , Automatic Frequency control(AFC) , Importance of Limiter,Communication Receivers	
5		**Pulse-Modulation and demodulation**	08
	5.1	**Introduction to digital transmission of signals**: comparison of Digital Analog Transmissions, Concept of regenerative Repeater	
	5.2	**Sampling and quantization**: Sampling Theorem, Aliasing error, Natural Sampling , Flat top sampling, Quantization of Signals	
	5.3	**Pulse Modulation Techniques** :Generation and detection of Pulse	

		Amplitude Modulation (PAM), Pulse Width Modulation (PWM), Pulse Position Modulation (PPM)	
6		**PCM and Multiplexing**	08
	6.1	**PCM**: Pulse-Code Modulation (PCM), Noise Performance of PCM Systems, Differential PCM (DPCM), Adaptive Differential PCM (ADPCM), Delta Modulation, Adaptive Delta Modulation, Continuous Variable Slope DM (CVSDM), Comparison of PCM Techniques	
	6.2	Multiplexing in Telecommunications Networks, Synchronous and Asynchronous TDM, Single-Channel PCM Transmission System, T1 Digital Carrier System, FDM	
		Total	48

Text Books:

1.Kennedy and Davis "Electronics communication system ",Tata McGraw Hill
2.T L Singal , Analog and Digital communication, Tata McGraw Hill
3.R P Singh &Sapre , Analog and Digital communication, Tata McGraw Hill 2nd Ed.

Reference books :

1.Wayne Tomasi "Electronics communication systems" Pearson Education, Third Edition, 2001.
2.Taub and Schilling "Principles of communication systems", Tata McGraw Hill
3.Roy Blake, "Electronics communication system", Thomson learning, Second Edition.
4.B.P. Lathi "Modern Digital and analog Communication system" Third Edition, OXFORD
5.Robert J. Schoenbeck "Electronics communications modulation and transmission"
6.Lean W couch "Digital and Analog communication system", Pearson Education, Sixth Edition
7.Roddy Coolen, "Electronic Communications" PHI

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both thetest will be considered as final IA marks.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No. 1 will be compulsory and based on entire syllabus.
4. Remaining questions (Q2 to Q6) will be set from all modules.
5. Weightage of each module in question paper will be proportional to the number of respective lecture hours mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELX406	Linear Control System	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral &Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ELX406	Linear Control System	20	20	20	80	--	--	100

Prerequisites Topics:
Differential Equations; Laplace transforms and Matrices.

Course Objectives:

1. To teach fundamental concepts of Control systems and mathematical modelling of the system.
2. To teach the concepts of time response and frequency response analysis of Control Systems.
3. To teach the concepts of state variable models as applicable to linear time invariant systems
4. To teach concepts of controllers and compensators

Course Outcomes:
1. Students will be able to understand the basic concepts of control system and identify control systems in real life applications.
2. Students will be able to derive the mathematical model of different types of control systems and represent them in various forms
3. Students will be able to analyze systems using time domain analysis techniques
4. Students will be able to apply concepts of frequency domain techniques in stability analysis of control systems
5. Students will be able to create state variable models of systems andanalyze their controllability, observability and time response
6. Students will be able to identify controllers and compensators in different controllers.

Module No.	Topics	Hrs.
1	**Models for Control System**	08
	1.1 Introduction: Open loop and closed loop systems; feedback and feed-forward control structure; examples of control systems.	
	1.2 Mathematical Modelling: Types of models; Impulse response model; State Variable model and Transfer function model for Electrical, Mechanical and Thermal systems	
	1.3 Manipulations: Block Diagram Representation of complex systems, Block diagram reduction, Signal flow graph and the Mason's gain rule for determining overall transfer function of Single Input, Single output systems	
2	**Time Response Analysis**	08
	2.1 Dynamic Response: Standard test signals; Transient and steady state behaviour of first and second order systems	
	2.2. Performance Specifications for a second order system and derivations for rise time, settling time, peak time, peak overshoot and steady state error	
	2.3. Steady State errors in feedbackcontrol systems and their types, Error constants and type of system.	
3	**State Variable Models**	10
	3.1 State variable models: State variable models of electrical systems	
	3.2 State transition equation: Concept of state transition matrix; Properties of state transition matrix; Solution of homogeneous systems; solution of nonhomogeneous systems.	
	3.3 Controllability and Observability: Concept of controllability; Controllability analysis of LTI systems; Concept of observability; Observability analysis of LTI systems using Kalman approach.	
4	**Stability Analysis in Time Domain**	06
	4.1 Concepts of Stability: Concept of absolute, relative and robust stability; Routh stability criterion.	
	4.2 Root Locus Analysis: Root-locus concepts; General rules for constructing root-locus; Root-locus analysis of control systems.	
5	**Stability Analysis in Frequency Domain**	10
	5.1 Introduction: Frequency domain specifications, Response peak and peak resonating frequency; Relationship between time and frequency domain specifications of system; Stability margins.	
	5.2 Bode plot: Magnitude and phase plot; Method of plotting Bode plot; Stability margins on the Bode plots; Stability analysis using Bode plot.	
	5.3 Nyquist Criterion: Polar plots, Nyquist stability criterions; Nyquist plot; Gain and phase margins.	
6	**Compensators and Controllers**	06
	6.1 Compensators: Types of compensation; Need of compensation; Lag compensator; Lead compensator.	
	6.2 Controllers: Concept of ON/OFF controllers; Concept of P, PI, PD and PID Controllers.	
	6.3 Advances in Control Systems: Introduction to Robust Control, Adaptive Control and Model Predictive control.	
	Total	**48**

Text Books

1. K. Ogata, Modern Control Engineering, Pearson Education India, Fifth Edition, 2015.
2. I. J. Nagrath, M. Gopal, Control Systems Engineering, New Age International, Fifth Edition, 2012.

Reference Books

1. M. Gopal, Control Systems: Principle and design, Tata McGraw Hill, First Edition, 1998
2. Richard C. Dorf and Robert H. Bishop, Modern Control System, Pearson, Eleventh Edition, 2013.
3. Norman S. Nise, Control Systems Engineering, John Wiley and Sons, Fifth Edition, 2010.
4. Farid Golnaraghi and Benjamin C. Kuo, Automatic Control Systems, Wiley, Ninth Edition, 2014.
5. S.P. Eugene Xavier and Joseph Cyril Babu, Principles of Control Systems, S. Chand, First Edition

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both thetest will be considered as final IA marks.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No. 1 will be compulsory and based on entire syllabus.
4. Remaining questions (Q2 to Q6) will be set from all modules.
5. Weightage of each module in question paper will be proportional to the number of respective lecture hours mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXL401	Electronic Devices and Circuits II Laboratory	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral &Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ELXL401	Electronic Devices and Circuits II Laboratory	--	--	--	--	25	25	50

Term Work:

At least 6 experiments covering entire syllabus of ELX 402 (Electronic Devices and Circuits II) should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. Also each student (in group of 3/4) has to perform a ***Mini Project*** as a part of the laboratory and report of mini project should present in laboratory journal. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus. Equal weightage should be given to laboratory experiments and project while assigning term work marks.

Suggested List of Experiments, however Instructor is free to design own experiments as per the guidelines

Laboratory Experiments

1. To perform frequency response of single stage CE amplifier.
2. To perform frequency response of single stage CS MOSFET amplifier..
3. To perform frequency response of Cascode amplifier.
4. To perform frequency response of two stage RC coupled CE amplifier
5. To perform RC phase shift oscillator
6. To perform Wein Bridge oscillator.
7. To perform Hartley oscillator.
8. To perform Colpitts oscillator
9. To perform Crystal oscilator.
10. To perform Class B push pull amplifier
11. To perform Class AB amplifier

Guidelines for Simulation Experiments:

1. SPICE simulation ofs of frequency response of single stage CE amplifier

2. SPICE simulation of of frequency response of single stage CS MOSFET amplifier..
3. SPICE simulation of of frequency response of Cascode amplifier.
4. SPICE simulation of of frequency response of two stage RC coupled CE amplifier
5. SPICE simulation of RC phase shift oscillator
6. SPICE simulation of Wein Bridge oscillator.
7. SPICE simulation of Hartley oscillator.
8. SPICE simulation of Colpitts oscillator
9. SPICE simulation of Crystal oscilator.
10. SPICE simulation of Class B push pull amplifier
11. SPICE simulation of Class AB amplifier

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXL402	Microprocessors and Applications Laboratory	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral &Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ELXL402	Microprocessors and Applications Laboratory	--	--	--	--	25	25	50

Term Work:

At least 6 experiments covering entire syllabus of ELX 403 (Microprocessors and Applications) should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. Also each student (in group of 3/4) has to perform a ***Mini Project*** as a part of the laboratory and report of mini project should present in laboratory journal. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus. Equal weightage should be given to laboratory experiments and project while assigning term work marks.

Suggested List of Experiments, however Instructor is free to design own experiments as per the guidelines

1. Write a program to arrange block of data in (i) Ascending and (ii) Descending order.
2. Write a program to find out any power of a number.
3. Write a programmable delay.
4. Write a program to find out largest number in an array.
5. Experiment on String instructions (e.g Reversing of string &Palindrome).
6. Write a program to multiply 32 bit numbers.
7. Menu driven programming.
8. Write a program for code conversion.
9. Programming the 8255 to read or write to port (any one application).
10. Programming the 8259 to demonstrate rotating priority, Specific priorityetc.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXL403	Digital System Design Laboratory	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral &Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ELXL403	Digital System design Laboratory	--	--	--	--	25	25	50

Term Work:

At least 6 experiments covering entire syllabus of ELX 404 (Digital System Design)
should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. Also each student (in group of 3/4) has to perform a ***Mini Project*** as a part of the laboratory and report of mini project should present in laboratory journal. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus. Equal weightage should be given to laboratory experiments and project while assigning term work marks.

Suggested List of Experiments, however Instructor is free to design own experiments as per the guidelines

Experiments based on Hardware:

1. Implementation of Counter using IC 7490, IC 7493
2. Implementation of Synchronous Counter using MSI counter ICs
3. Implementation of Universal Shift Register using IC 74194
4. Design and implement Moore Machine
5. Design and implement Mealy Machine
6. Serial Adder using a Melay/Moore Machine.
7. Design Sequence Detector using FF

Suggested experiments based on software:

1. Implement basic digital logic gates and simulate with HDL.

2. Implement basic Flip Flops and simulate with HDL.
4. Design and implement full adder logic with HDL and simulate the same.
5. Design and implement multiplexer with HDL and simulate the same.
6. Design and implement multiplexer with HDL and simulate the same.
7. Design and implement decoder (74138) with HDL and simulate the same.
8. Design and implement 4-bit counter with HDL and simulate the same.
9. Design and implement shift register with HDL and simulate the same.
10. Design and simulate the Finite State Machine (FSM) design by HDL.
11. Design and simulate the ALU design by HDL.

Additional suggested experiments (optional)

Implementation of any of above using **CPLD/FPGA**

Course Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ELXL404	Principles of Communication Engineering Laboratory	--	02	--	--	01	--	01

Subject Code	Subject Name	Examination Scheme						
		Theory Marks				Term Work	Oral &Practical	Total
		Internal assessment			End Sem. Exam			
		Test1	Test 2	Avg.				
ELXL404	Principles of Communication Engineering Laboratory	--	--	--	--	25	--	25

Term Work:

At least 6 experiments covering entire syllabus of ELX 405 (Principles of Communication Engineering) should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. Also each student (in group of 3/4) has to perform a ***Mini Project*** as a part of the laboratory and report of mini project should present in laboratory journal. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Equal weightage should be given to laboratory experiments and project while assigning term work marks.

Suggested List of Experiments, however Instructor is free to design own experiments as per the guidelines

1. Amplitude Modulation and demodulation
2. DSB-SC Balanced Modulator
3. Frequency Modulation and Demodulation
4. Super-heterodyne radio receiver
5. Pulse Amplitude Modulation
6. Verification of Sampling Theorem
7. Pulse Width Modulation
8. Pulse Position Modulation
9. Pulse Code Modulation
10. Delta Modulation
11. Adaptive Delta Modulation
12. Time Division Multiplexing