University of Mumbai

No. AAMS_UGS/ICC/2022-23/ 182

CIRCULAR:-

Attention of the Principals of the Affiliated Colleges and Directors of the Recognized Institutions in Faculty of Science & Technology is invited to the syllabus uploaded by Academic Authority Meetings & Services which was accepted by the Academic Council at its meeting held on 14th July, 2016 **vide** item No. 4.22 relating to the revised syllabus as per Choice Based Credit and Grading System for M.E. (Electronics Engineering).

You are hereby informed that the recommendations made by the Ad-hoc Board of Studies in **Electronics Engineering** at its meeting held on 22nd June, 2022 and subsequently passed in the Faculty and then by the Board of Deans at its meeting held on 5th July, 2022 **vide** item No. 6.60 (R) have been accepted by the Academic Council at its meeting held on 11th July, 2022 **vide** item No. 6.60 (R) and that in accordance therewith, the revised syllabus of **M.E. (Electronics Engineering) (CBCS) (Sem.- I to IV) (REV - 2022 Scheme)**, has been brought into force with effect from the academic year 2022-23. (The circular is available on the University's website www.mu.ac.in).

(Prof. Sunil Bhirud)
I/c Registrar

MUMBAI – 400 032
19th November, 2022

To

The Principals of the Affiliated Colleges and Directors of the Recognized Institutions in Faculty of Science & Technology.

A.C/6.60 (R)/11/07/2022

Copy forwarded with Compliments for information to:-

1) The Dean, Faculty of Science & Technology,
2) The Chairman, Board of Studies in Electronics Engineering,
3) The Director, Board of Examinations and Evaluation,
4) The Director, Board of Students Development,
5) The Director, Department of Information & Communication Technology,
6) The Co-ordinator, MKCL.

Copy to :-

1. **The Deputy Registrar, Academic Authorities Meetings and Services (AAMS),**
2. **The Deputy Registrar, College Affiliations & Development Department (CAD),**
3. **The Deputy Registrar, (Admissions, Enrolment, Eligibility and Migration Department (AEM),**
4. **The Deputy Registrar, Research Administration & Promotion Cell (RAPC),**
5. **The Deputy Registrar, Executive Authorities Section (EA),**
6. **The Deputy Registrar, PRO, Fort, (Publication Section),**
7. **The Deputy Registrar, (Special Cell),**
8. **The Deputy Registrar, Fort/ Vidyanagari Administration Department (FAD) (VAD), Record Section,**
9. **The Director, Institute of Distance and Open Learning (IDOL Admin), Vidyanagari,**

They are requested to treat this as action taken report on the concerned resolution adopted by the Academic Council referred to in the above circular and that on separate Action Taken Report will be sent in this connection.

1. **P.A to Hon'ble Vice-Chancellor,**
2. **P.A Pro-Vice-Chancellor,**
3. **P.A to Registrar,**
4. **All Deans of all Faculties,**
5. **P.A to Finance & Account Officers, (F.& A.O),**
6. **P.A to Director, Board of Examinations and Evaluation,**
7. **P.A to Director, Innovation, Incubation and Linkages,**
8. **P.A to Director, Board of Lifelong Learning and Extension (BLLE),**
9. **The Director, Dept. of Information and Communication Technology (DICT) (CCF & UCC), Vidyanagari,**
10. **The Director of Board of Student Development,**
11. **The Director, Department of Students Walfare (DSD),**
12. **All Deputy Registrar, Examination House,**
13. **The Deputy Registrars, Finance & Accounts Section,**
14. **The Assistant Registrar, Administrative sub-Campus Thane,**
15. **The Assistant Registrar, School of Engg. & Applied Sciences, Kalyan,**
16. **The Assistant Registrar, Ratnagiri sub-centre, Ratnagiri,**
17. **The Assistant Registrar, Constituent Colleges Unit,**
18. **BUCTU,**
19. **The Receptionist,**
20. **The Telephone Operator,**
21. **The Secretary MUASA**

for information.

AC – 11 July, 2022
Item No. – 6.60 (R)

University of Mumbai

Revised Syllabus for

M.E. (Electronics Engineering)

(Sem. - I to IV)

(Choice Based Credit System)

(With effect from the academic year 2022-23)

University of Mumbai

Syllabus for Approval

O: _____ Title of Course	M.E. (Electronics Engineering)
O: 5134 Eligibility	Passed B.E./ B.Tech (Electronics Engg.); B.E./ B.Tech (Electronics and Telecommunication Engg.); B.E. (Electrical and Electronics Engg); B.E. (Electronics and Computer Science)
R: _____ Passing Marks	45%
No. of years/Semesters:	2 Years / 4 Semester
Level:	P.G. / ~~U.G./~~ ~~Diploma / Certificate~~
Pattern:	~~Yearly~~ / Semester
Status:	~~New~~ / Revised 2019 'C'
To be implemented from Academic Year:	With effect from Academic Year : 2022-23

Dr. R. N. Awale
Chairman
of Ad-hoc Board of Studies in Electronics Engineering

Dr. Suresh K. Ukarande
Associate Dean,
Faculty of Science and Technology

Dr Anuradha Majumdar
Dean,
Faculty of Science and Technology

Preamble

Tomeetthechallengeofensuringexcellenceinengineeringeducation,theissueofqualityneedstobe addressed, debated and taken forward in a systematic manner. Accreditation is the principal meansof quality assurance in higher education. The major emphasis of accreditation process is to measurethe outcomes of the program that is being accredited. In line with this Faculty of Science andTechnology (in particular Engineering)of University of Mumbai has taken a lead in incorporatingphilosophyof outcome based educationinthe processof curriculumdevelopment.

Faculty 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 betaught,which will enhancelearner‟s learning process.Choicebased Creditandgrading systemenables a much-required shift in focus from teacher-centric to learner-centric education since

theworkload estimated is based on the investment of time in learning and not in teaching. It also focusesoncontinuousevaluationwhichwillenhancethequalityofeducation.Creditassignmentforcoursesis based on 15 weeks teaching learning process, however content of courses is to be taught in 12-13weeks and remaining 2-3 weeks to be utilized for revision, guest lectures, coverage of content beyondsyllabus etc. There was a concern that the earlier revised curriculum more focused on providinginformation and knowledge across various domains of the said program, which led to heavily loadingof students in terms of direct contact hours. In this regard, faculty of science and technology resolvedthat to minimize the burden of contact hours, total credits of entire program will be of 170, whereinfocus is not only on providing knowledge but also on building skills, attitude and self-learning.Therefore in the present curriculum skill based laboratories and mini projects are made mandatoryacross all disciplines of engineering in second and third year of programs, which will definitelyfacilitate self-learning of students. The overall credits and approach of curriculum proposed in thepresentrevisionisin linewith AICTE modelcurriculum.

The present curriculum will be implemented for Second Year of Engineering from the academic year2020-21. Subsequently this will be carried forward for Third Year and Final Year Engineering in theacademicyears 2021-22, 2022-23, respectively.

Dr.S. K. Ukarande
AssociateDean
Facultyof Science andTechnology
UniversityofMumbai

DrAnuradha Muzumdar
Dean
Facultyof Science andTechnology
UniversityofMumbai

IncorporationandimplementationofOnlineContentsfromNPTEL/SwayamPlatform

The curriculum revisionis mainly focused onknowledge component, skill based activitiesandprojectbasedactivities.Self-learningopportunitiesareprovidedtolearners.Intherevision process this time in particular Revised syllabus of „C „ scheme wherever possibleadditional resource linksof platforms such as NPTEL, Swayamare appropriately provided.In an earlier revision of curriculum in the year 2012 and 2016 in Revised scheme „A' and „B'respectively,effortsweremadetouseonlinecontentsmoreappropriatelyasadditionallearningmaterials to enhancelearningof students.

In the current revision based on the recommendation of AICTE model curriculum overallcredits are reduced to171, to provideopportunity of self-learning to learner.Learnersarenowgettingsufficienttimeforself-learningeitherthroughonlinecoursesoradditionalprojectsforenhancingtheir knowledgeand skill sets.

The Principals/ HoD‟s/ Faculties of all the institute are required to motivate and encouragelearners to use additional online resources available on platforms such as NPTEL/ Swayam.Learners can be advised to take up online courses, on successful completion they are requiredtosubmitcertificationfor the same. Thiswilldefinitely helplearnerstofacilitate theirenhancedlearningbasedon theirinterest.

Dr.S. K. Ukarande
AssociateDean
Facultyof Science andTechnology
UniversityofMumbai

DrAnuradha Muzumdar
Dean
Facultyof Science andTechnology
UniversityofMumbai

Preface

Technical education in the country is undergoing a paradigm shift in current days. Think tank at national levelare deliberating on the issues, which are of utmost importance and posed challenge to all the spheres of technicaleducation. Eventually, impact of these developments was visible and as well adopted on bigger scale by almostall universities across the country. These are primarily an adoption of CBCS (Choice base Credit System) andOBE (Outcome based Education) with student centric and learning centric approach. Education sector in thecountry,aswell,facingcriticalchallenges,suchas,thequalityofgraduates,employability,basicskills,abilityto take challenges, work ability in the fields, adoption to the situation, leadership qualities, communication skillsand ethical behaviour. On other hand, the aspirants for admission to engineering programs are on decline overthe years. An overall admission status across the country is almost 50%; posing threat with more than half thevacancies in various colleges and make their survival difficult. In light of these, an All India Council forTechnicalEducation(AICTE),thenationalregulator,tookinitiativesandenforcedcertainpoliciesforbetterment, in timely manner. Few of them are highlighted here, these are design of model curriculum for allprevailing streams, mandatory induction program for new entrants, introduction of skill based and inter/crossdiscipline courses, mandatory industry internships, creation of digital contents, mandate for use of ICT inteachinglearning,virtuallaboratoryandsoon.

TokeepthepacewiththesedevelopmentsinTechnicaleducation,itismandatoryfortheInstitutes&Universitiestoadoptt heseinitiativesinphasedmanner,eitherpartiallyorintoto.Hence,theongoingcurriculum revision process has a crucial role to play. The BoS of Electronics Engineering under the faculty ofScience & Technology, under the gamut of Mumbai University has initiated a step towards adoption of theseinitiatives. We, the members of Electronics Engineering Board of Studies of Mumbai University feel privilegedto present the revised version of curriculum for Electronics Engineering program to be implemented fromacademicyear 2020-21. Someofthe highlightsoftherevisionare;

i. Curriculum has been framed with reduced credits andweekly contact hours, thereby providing freeslots to the students to brain storm, debate, explore and apply the engineering principles. The leisureprovided through this revision shall favour to inculcate innovation and research attitude amongst thestudents.
ii. Newskillbasedcourses have beenincorporatedincurriculumkeepinginviewAICTEmodelcurriculum.
iii. Skillbased Labcourseshavebeenintroduced,whichshallchangethethoughtprocessand enhancetheprogrammingskillsandlogicalthinkingofthestudents
iv. Mini-project with assigned credits shall provide an opportunity to work in a group, balancing the groupdynamics, develop leadership qualities, facilitate decision making and enhance problem solving abilitywith focus towards socio-economic development of the country. In addition, it shall be directapplicationoftheoretical knowledgeinpractice,thereby, nurturelearnerstobecomeindustryreadyandenlighten students for Research, Innovation and Entrepreneurship thereby to nurture start-up ecosystemwithbettermeans.
v. AnusageofICTthroughNPTEL/SWAYAMandotherDigitalinitiativesofGovt.ofIndia shallbeencouraged, facilitating the students for self learning and achieve the Graduate Attribute (GA)specified byNationalBoardofaccreditation(NBA) i.e. lifelonglearning.

Thus, this revision of curriculum aimed at creating deep impact on the teaching learning methodology to beadopted by affiliated Institutes, thereby nurturing the student fraternity in multifaceted directions and createcompetent technical manpower with legitimate skills. In times to come, these graduates shall shoulder theresponsibilities of proliferation of future technologies and support in a big way for 'Make in India' initiative, areality.Inthe process,

BoS, Electronics Engineering got whole hearted support from all stakeholders including faculty, Heads ofdepartment of affiliating institutes, experts faculty who detailed out the course contents, alumni, industry expertsand university official providing all procedural support time to time. We put on record their involvement andsincerelythankone and allforcontributionand supportextendedforthis noble cause.

BoardsofStudiesinElectronicsEngineering

Sr.No.	Name	Designation	Sr.No.	Name	Designation
1	Dr.R.N.Awale	Chairman	5	Dr.RajaniMangala	Member
2	Dr.JyothiDigge	Member	6	Dr.VikasGupta	Member
3	Dr.V.A.Vyawahare	Member	7	Dr.D. J.Pete	Member
4	Dr.SrijaUnnikrishnan	Member	8	Dr.VivekAgarwal	Member

ProgramStructureforMEElectronicsEngineering

UNIVERSITYOFMUMBAI

(WithEffectfrom2022-2023)

SemesterI

Course Code	CourseName	Teaching Scheme(Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELXC1011	Advanced DigitalCommunication	03	---	---	03	---	---	03
ELXC1012	AdvancedVLSIDesign	03	---	---	03	---	---	03
ELXC1013	Power ElectronicsSystemDesign	03	---	---	03	---	---	03
ELXDLO101X	Department LevelOptionalCourse-I	03	---	---	03	---	---	03
ILO101X	Institute LevelOptionalCourse-I	03	---	---	03	---	---	03
ELXL1011	Laboratory-IPower ElectronicsSystemDesign	---	02	---	---	01	---	01
ELXL1012	Laboratory-II AdvancedVLSIDesign	---	02	---	---	01	---	01
TOTAL		15	04	---	15	02	---	17

Course Code	CourseName	EXAMINATIONSCHEME–SEMESTERI							
		THEORY					MAXIMUMMARKS		
		INTERNALASSESSMENT(IA)			EndSemester Examination (Marks)	ExamDuration(Hours)			
		Test I	Test II	Avg.			Term Work	Practical / Oral	Total
ELXC1011	Advanced DigitalCommunication	20	20	20	80	03	---	---	100
ELXC1012	AdvancedVLSIDesign	20	20	20	80	03	---	---	100
ELXC1013	Power ElectronicsSystemDesign	20	20	20	80	03	---	---	100
ELXDLO101X	Department LevelOptionalCourse-I	20	20	20	80	03	---	---	100
ILO101X	Institute LevelOptionalCourse-I	20	20	20	80	03	---	---	100
ELXL1011	Laboratory-IPower ElectronicsSystemDesign	---	---	---	---	---	25	25	50
ELXL1012	Laboratory-IIAdvanced VLSI Design	---	---	---	---	---	25	25	50
TOTAL		**100**	**100**	**100**	**400**	**---**	**50**	**50**	**600**

ProgramStructureforMEElectronicsEngineering

UNIVERSITYOFMUMBAI

(WithEffectfrom2022-2023)

SemesterII

Course Code	CourseName	Teaching Scheme(Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELXC2021	Modern IndustrialInternet Engineering	03	---	---	03	---	---	03
ELXC2022	Emerging TrendsinSOCDesign	03	---	---	03	---	---	03
ELXC2023	Advanced DigitalSignalProcessing	03	---	---	03	---	---	03
ELXDLO202X	Department LevelOptionalCourseII	03	---	---	03	---	---	03
ILO202X	Institute LevelOptionalCourse-II	03	---	---	03	---	---	03
ELXL2021	Laboratory-IIIEmergingTrendsinSOCDesign	---	02	---	---	01	---	01
ELXL2022	Laboratory-IVAdvanced DigitalSignalProcessing (ADSP)	---	02	---	---	01	---	01
TOTAL		15	04	---	15	02	---	17

Course Code	CourseName	EXAMINATIONSCHEME–SEMESTERII							
		THEORY					MAXIMUMMARKS		
		INTERNAL ASSESSMENT (IA)			EndSemesterExamination(Marks)	ExamDuration(Hours)			
		Test I	Test II	Avg.			Term Work	Practical / Oral	Total
ELXC2021	Modern IndustrialInternetEngineering	20	20	20	80	03	---	---	100
ELXC2022	Emerging TrendsinSOCDesign	20	20	20	80	03	---	---	100
ELXC2023	Advanced DigitalSignalProcessing	20	20	20	80	03	---	---	100
ELXDLO202X	Department LevelOptionalCourseII	20	20	20	80	03	---	---	100
ILO202X	Institute LevelOptionalCourse-II	20	20	20	80	03	---	---	100
ELXL2021	Laboratory-IIIEmerging TrendsinSOCDesign	---	---	---	---	---	25	25	50
ELXL2022	Laboratory-IVAdvanced DigitalSignalProcessing (ADSP)	---	---	---	---	---	25	25	50
TOTAL		**100**	**100**	**100**	**400**	**---**	**50**	**50**	**600**

Course Code	DepartmentLevelOptional Course-I(ELXDLO101X)	CourseCode	DepartmentLevelOptional Course-II(EXCDLO202X)
ELXDLO1011	AdvancedProcessorArchitecture-I	ELXDLO2021	Advanced ProcessorArchitecture-II
ELXDLO1012	NextGenerationArtificial IntelligenceandMachineLearning	ELXDLO2022	Cloud Computing
ELXDLO1013	MicroelectronicsDevices	ELXDLO2023	Nanoelectronics
ELXDLO1014	AdvancedDigitalImageProcessing	ELXDLO2024	DeepLearningandComputerVision

SEMESTER–III

Course Code	CourseName	TeachingScheme(Hours)			CreditsAssigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELXS3031	Seminar	---	06	---	---	03	---	03
ELXD3031	Dissertation-I	---	24	---	---	12	---	12
TOTAL		---	30	---	---	15	---	15

Course Code	CourseName	ExaminationScheme							
		TheoryMarks				Term Work	Practical	Oral	Total
		InternalAssessment			End Sem Exam				
		Test 1	Test 2	Average					
ELXS3031	Seminar	---	---	---	---	50	---	50	100
ELXD3031	Dissertation-I	---	---	---	---	100	---	---	100
TOTAL						150		50	200

SEMESTER–IV

Course Code	CourseName	TeachingScheme(Hours)			CreditsAssigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELXD4041	Dissertation-II	---	30	---	---	15	---	15
TOTAL		---	30	---	---	15	---	15

Course Code	CourseName	ExaminationScheme							
		TheoryMarks				Term Work	Practical	Oral	Total
		InternalAssessment			End Sem Exam				
		Test1	Test2	Average					
ELXD4041	Dissertation-II	---	---	---	---	100	---	100	200
TOTAL						100		100	200

Note:

- In case of Seminar (ELXS3031), 01 Hour / week / student should be considered forthecalculation ofload ofateacher
- In case of Dissertation I (ELXD3032) and Dissertation II (ETXD4041), 02Hour/week/studentshouldbeconsidered forthe calculationofloadofateacher

Course Code	Course Name	TeachingScheme(Hours)			CreditsAssigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELXC1012	Advanced VLSI Design	03	---	---	03	---	---	03

Course Code	Course Name	ExaminationScheme							
		TheoryMarks				Term Work	Practical	Oral	Total
		InternalAssessment			End SemExam				
		Test 1	Test 2	Avg					
ELXC1012	Advanced VLSI Design	20	20	20	80	---	---	---	100

CoursePre-requisites:-

1. VLSIDesign
2. ICTechnology
3. AnalogandMixedSignalVLSIDesign

CourseObjectives:-

1. To make students understand &appreciate analytical approach for design of analog VLSIDesign
2. Tomakestudents readyfordesign ofcoexistenceof analogand digital circuit andthesystemlevel issues

CourseOutcomes:-

1. TacklewiththesystemlevelissuesformixedVLSIdesign
2. Explainworkingofcertain basicanalogbuilding blocks
3. Designdifferentdata converters
4. Implement andcommentonperformanceofMemorydevices.
5. Statethesignificanceof PLLinmixed VLSIdesign.

Module No.	Topics	Hrs.
01	**Analoganddiscrete-timesignalprocessing**	03
	Mixed-Signal Layout Issues, *Floor-planning, Power Supply andGroundingIssues, GuardRings*	
02	**Analogintegratedcontinuous-timeanddiscrete-timefilters**	08
	MOSFETs as switches, Speed considerations, Precision Considerations,Charge injection cancellation, Unity gain buffer, Non-inverting amplifierandintegrator,Analogmultipliers,LoopFilters,SwitchedCapacitor filter	
03	**Special-purposeCMOScircuits.**	08
	Schmitt trigger, Multi-vibrator Circuits, Ring oscillators, VCO , VoltageGenerators	
04	**DataConverters**	08
	Basics of Analog to digital converters (ADC) Basics of Digital to analogconverters(DAC)DACsSuccessiveapproximationADCsDualslopeADCsHigh-speedADCs(e.g.flashADC,pipelineADCandrelatedarchitectures)High-resolutionADCs(e.g.delta-sigmaconverters)	
05	**Memory**	06
	ROM,EPROM,F-Nmodel,RAMMemorystructureArrayDesign,sensingand operation ofmemorycell.	
06	**PhaseLockLoop**	06
	Mixed-SignallayoutInterconnectsPhaselockedloopsDelaylockedloops. Simple PLL,Charge pump PLL, Non ideal effects in PLL, Delaylockedloops andapplications of PLLin integratedcircuits	
TOTAL		39

ReferenceBooks:-

1. CMOSmixed-signalcircuitdesignbyR.JacobBaker,WileyIndia,IEEEpress,reprint2008.
2. DesignofanalogCMOSintegratedcircuitsby BehzadRazavi,McGraw-Hill,2003.
3. CMOScircuitdesign,layoutandsimulationby R.JacobBaker,Revisedsecondedition,IEEEpress, 2008.
4. CMOSIntegratedADCsandDACsby RudyV.dePlassche,Springer,Indianedition, 2005.
5. ElectronicFilterDesignHandbookbyArthur B.Williams,McGraw-Hill,1981.
6. DesignofanalogfiltersbyR.Schauman,Prentice-Hall 1990(ornewer additions)
7. AnintroductiontomixedsignalICtestandmeasurementbyM.Burnsetal., Oxford universitypress,firstIndianedition, 2008.

ResearchPublication:-

1. Lanny L. Lewyn, Trond Ytterda, Carsten Wulff, and Kenneth Martin,"Analog circuit Design in Nanoscale Technologies", Proceedings of theIEEEVol.97, No.10, October 2009
2. Chi-Sheng Lin, Bin-Da Liu, "A new successive approximation architecturefor low-power low-cost CMOS A/D converter," IEEE Journal of Solid StateCircuits,Vol.30,Issue. 1,Pages:54-62, 2003.

InternalAssessment(IA):

Two tests must be conducted which should cover at least 80% of the syllabus. The average marks ofboththetestwillbe consideredasfinalIA marks

EndSemesterExamination:

1. Questionpaperwill comprise6questions,eachof20marks.
2. Total4questionsneedtobesolved.
3. Question No.1willbecompulsoryandbasedonentiresyllabuswhereinsubquestionsof2to5marks willbeasked.
4. Remainingquestionswill beselectedfromall themodules

Course Code	Course Name	TeachingScheme			CreditsAssigned			
		Theory	Practical andOral	Tutorial	Theory	TW/Practical andOral	Tutorial	Total
ELXC1013	PowerElectronics System Design	03	--	--	03	--	--	03

Subject Code	Subject Name	ExaminationScheme							
		TheoryMarks					Term Work	Practical andOral	Total
		Internalassessment			End Sem. Exam	ExamdurationHours			
		Test 1	Test 2	Avg					
ELXC1013	PowerElectronicsSystem Design	20	20	20	80	3	--	--	100

CourseObjectives:

1. To make the students understand and appreciate the analytical approach for design ofpowerelectronicsystems.
2. To make the students ready for research &development oriented jobs in academia andindustry by introducing recent research advancements in power electronic converters andtheirapplications in distributedgeneration andsmart grids.

CourseOutcomes:

Aftersuccessfulcompletion of thecoursestudentswillbeableto:

1. **Understand**powersemiconductordevicestructuresforadjustablespeedmotorcontrolapplications.
2. **Apply**theconceptsofmathematicalmodellingandcomputersimulationstopowerelectronicsystems.
3. **Design** thenewtopologiesofDC-ACinverterslikemulti-leveland4-leginverters.
4. **Interpret**variousissuesinvolvedintheparalleloperationofinvertersasapartofdistributedgeneration system.
5. **Select**appropriatethree phaseACvoltagecontrollersdependingonthe application.
6. **Analyze**vitalroleplayedbypowerelectronicconvertersindistributedgenerationandsmartgrids.

Note: Theaction verbsaccordingtoBloom'staxonomyarehighlighted inbold.

Module No.	Unit No.	Contents	Hrs.
1		**AnalysisofPowerDevices**	**05**
	1.1	PowerMOSFET,SCR,IGBT,selectioncriteriaforswitching devices	
	1.2	EMI-EMCissues,protectioncircuits:Antisaturationprotectionfor IGBTandpowerMOSFET,overloadprotection, thermalprotection.	
2		**SimulationofPowerElectronicConvertersandSystems**	**6**
	2.1	IntroductiontocircuitorientedsimulatorslikeSPICE,MATLAB, SCILAB,comparison ofthesesimulators	
	2.2	Studyoftransformationsfrom3-phasetostationaryreferenceframe(Clarketransform)androtatingreferenceframe,decoupledclosed-loopcontrolstrategiesforconvertersbasedonthesetransformations.	
3		**Modellingand ControlofPowerElectronicSystems**	**08**
	3.1	Conceptofzero-orderhold(ZOH),first-orderhold(FOH)andsecond-order hold (SOH) elements, energy factor, models of AC-DC,DC-AC,AC-ACandDC-DCconvertersassimpleZOH,FOHand SOH	
	3.2	PIcontrolforAC-DCconverters,PIcontrolforDC-ACconverters andAC-AC(AC-DC-AC)converters,PIDcontrolforDC-DCconverters,closed-loop stabilityanalysis.	
4		**Inverters(DC-ACConverters)**	**10**
	4.1	Multilevelinverterstopologiesandswitching,introductionto4-leg inverters(basicworkingwithoutSVMtechniques)	
	4.2	Studyofinvertertopologies:online,line-interactive,stand-by,methodsofparalleloperationofinverters:droop,andmaster&slave control.	
5	**5.1**	**ThreephaseACVoltageControllers**	**4**
		Three-phasefullwavecontrollerwithR,RL-load,Inputpower factor,staticswitches.	
6		**GridInterfaceofRenewableEnergySources**	**6**
	6.1	Inverterinterfacingcontrolstrategiesfortransferringwindandsolar energytogrid, synchronizationwith grid usingphase-locked loop	
	6.2	Conceptofdistributedgenerationsystems,microgrids,smartgrids.	
Total			**39**

TextBooks:

1. N.Mohan,T.M.Undeland,W.P.Robbins,PowerElectronics:ConvertersApplicationand Design, JohnWiley&Sons, USA, 2003.

2. M. H. Rashid, Power Electronics: Circuits, Devices, and Applications, Pearson EducationIndia,2009.

3. R.W.Erickson,D.Maksimovic,FundamentalsofPowerElectronics,SpringerUSA,2001.

4. F. L. Luo, H. Ye, M. H. Rashid, Digital Power Electronics and Applications, ElsevierAcademicPress, USA, 2005.

5. H. Akagi, E. H. Watanabe, M. Aredes,Instantaneous Power Theory and Applications toPowerConditioning,IEEE Press/JohnWiley&SonsLtd., USA, 2007.

6. B.K.Bose,Modernpowerelectronicsand ACdrives,PrenticeHallPTR,2002.

ReferenceBooks/Researchpapers:

1. Q.-C. Zhong, T. Hornik, Control of Power Inverters in Renewable Energy And Smart GridIntegration,IEEEPress/John Wiley&Sons,Ltd.,USA, 2013.

2. J.-S. Lai and F. Z. Peng, Multilevel converters – A new breed of power converters, IEEETransactionsonIndustryApplications,vol.32,no.3,pp.509-517,May/Jun1996.URL:http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=502161&isnumber=10824

3. T.KawabataandS.Higashino,Paralleloperationofvoltagesourceinverters,IEEETransactionsonIndustryApplications, vol. 24, no. 2, pp. 281–287, 1988.
URL:
http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=2868&url=http%3A%2F%2Fieeexplore.ieee.org%2Fiel1%2F28%2F164%2F00002868

4. W. C. Lee, T. K. Lee, S. H. Lee, K. H. Kim, D. S. Hyun, and I. Y. Suh, A master and slavecontrol strategy for parallel operation of three-phase UPS systems with different ratings,Proceedings of the 19th Annual IEEE Applied Power Electronics Conference & Exposition,(Anaheim,California,USA), pp. 456–462, Feb. 2004.
URL:
http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=1295848&url=http%3A%2F%2Fieeexplore.ieee.org%2Fiel5%2F9082%2F28818%2F01295848.pdf%3Farnumber%3D1295848

InternalAssessment(IA):

Twotestsmustbe conductedwhichshouldcoverat least80%ofsyllabus.Theaveragemarksofboth thetests will beconsidered as finalIA marks.

EndSemesterExamination:

1. Questionpaperwill consistof6questions,eachof 20marks.
2. Total4 questionsneed tobe solved.
3. QuestionNo.1willbecompulsoryandbasedonentiresyllabuswhereinsubQuestionsof 2 to 5 marks will beasked.
4. Remainingquestionswillbeselected fromallthe modules

CourseCode	CourseName	Teaching Scheme(Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELXDLO1013	MicroelectronicsDevices	04	---	---	04	---	---	04

Course Code	CourseName	ExaminationScheme							
		Theory Marks				Term Work	Practical	Oral	Total
		InternalAssessment			End SemExam				
		Test 1	Test 2	Average					
ELXDLO1013	Microelectronics Devices	20	20	20	80	---	---	---	100

CoursePre-requisites:-

- Electronicdevices:OperationandCharacteristics

CourseObjectives:-

- Tolearn &applybasic conceptsof semiconductorphysicsrelevanttoelectronicdevices
- Toanalyze&explainoperationofsemiconductordevicesintermsoftheirphysicalstructure
- Toestimatevarious deviceparameters &theirmeasurement
- Todescribe&usethedevice& circuitmodelsof semiconductordevicesof varyinglevelofcomplexity

CourseOutcomes:-

- Abilitytoapply&explainbasic semiconductor conceptsapplicable tothedevices
- Abilityto describetheunderlyingphysics&principles of operation ofvariousdevices
- Abilitytocreate&applylinearincrementalequivalentcircuitmodelsforBJT&MOSFET
- Ability to determine parameter values for large signal & incremental linear equivalentcircuit models for the p-n diodes, BJT & MOSFET based on knowledge of devicestructure,dimensions & bias conditions

Module No.	Unit No.	Topics	Hrs.
1	**BasicSemiconductorPhysics**		08
	1.1	Reviewofquantummechanics,	
	1.2	Electronsinperiodiclattices,Ekdiagrams,Quasi-particlesinsemiconductors, electrons,holesandphonons	
	1.3	Boltzmanntransportequationandsolutioninthepresenceoflowelectric and magneticfields-mobilityand diffusivity	
2	**SemiconductorJunction**		08
	2.1	p-njunction action, Abrupt junction, Linearly gradedjunction,StaticIV Characteristicsofp-njunction, Electricalbreakdowninp-n junctions	
	2.2	Dynamicbehaviour of p-njunction diode	
	2.3	Majoritycarrier diodes	
	2.4	Schottky,homo-andhetero-junctionbanddiagramsandI-Vcharacteristics	
3	**ModelingBipolarDevicePhenomena**		05
	3.1	InjectionandTransportModel	
	3.2	ContinuityEquation	
	3.3	TransistorModels:Ebers-Moll andGummelPoonModel	
	3.4	SPICEmodeling,temperatureandareaeffects	
4	**MOSFETModeling**		08
	4.1	Introduction,InversionLayer,	
	4.2	ThresholdVoltage	
	4.3	GradualChannelApproximation,MOSTransistorCurrent	
	4.4	Temperature,ShortchannelandNarrowWidthEffect	
	4.5	Characterizationof MOScapacitors:HFandLFCVs	
	4.6	ModelsforEnhancement,Depletion TypeMOSFET	
5	**ModelingofHeteroJunctionDevices**		06
	5.1	BandgapEngineering	
	5.2	Band gap OffsetatabruptHetero-junction	
	5.3	Modifiedcurrentcontinuityequations	
	5.4	HeteroJunctionbipolartransistors(HBTs),Si-Ge	
6	**MonteCarlo ParticleModelingofSemiconductorDevices**		04
	6.1	TheMonteCarlomethod	
	6.2	ApplicationofMonteCarlo techniques todevicemodeling	
TOTAL			**39**

ReferenceBooks:-

1. M.S.Tyagi,"IntroductiontoSemiconductorMaterialsandDevice",JohnWiley&sons, 1991
2. BenG.Streetman&S.K.Bannerjee,"SolidStateElectronicDevices"6thedition,PrenticeHa ll
3. RichardS.Muller&TheodoreI.Kummins,"DeviceElectronicsforIntegratedCircuits",Joh nWiley& Sons, 2nd edition (1986)
4. A.S.Grove,"Physics&TechnologyforSemiconductorDevices",McGrawHill,3rdedition (2007)
5. DonaldA.Neamen,"SemiconductorDevices&Physics",McGrawHill,3rdedition(2007)
6. M.H.Rashid,"SPICEforCircuits&Electronics", PrenticeHall(1995)
7. A.Vladimirescu,"TheSPICE Book",JohnWiley&Sons,NewYork(1994)

ResearchPublications:-

1. ChristopherM.Snowden,"SemiconductorDeviceModeling"Rep.Prog.Phys.Vol.48, pp.223-275

2. C.Moglestue,,,MonteCarloparticlemodelingofsmallsemiconductordevices"Computer Methods in Applied Mechanics & Engineering Vol. 30 (1982) pp. 173-208;North–Holland Publishing

InternalAssessment(IA):

Two tests must be conducted which should cover at least 80% of the syllabus. The average marks ofboththetestwillbe consideredasfinalIA marks

EndSemesterExamination:

1. Questionpaperwill comprise6questions,eachof20marks.
2. Total4questions needtobesolved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to5marks willbeasked.
4. Remainingquestionswill beselectedfromall themodules

Subject Code	Subject Name	TeachingScheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELXL1011	PowerElectronicsSystemDesign Lab	--	02	--	--	01	--	01

Subject Code	Subject Name	ExaminationScheme							
		Theory Marks					Term Work	Practical AndOral	Total
		Internalassessment			End Sem. Exam	ExamdurationHours			
		Test 1	Test 2	Avg ofTest 1and Test 2					
ELXL1011	PowerElectronicsSystem DesignLab	-	-	-	-	-	25	25	50

TermWork:

At least10 experimentscovering the entire syllabus of ELXC1013 (**Power ElectronicsSystemDesign**)shouldbesettohavewellpredefinedinferenceandconclusion.Theexperiments should be student centric and attempt should be made to make experiments moremeaningful, interesting. Simulation experiments are also encouraged. Experiments must begraded from time to time. The grades should be converted into marks as per the Credit andGrading System manual and should be added and averaged. The grading and term workassessment should be done based on this scheme. The final certification and acceptance ofterm work ensures satisfactory performance of laboratory work and minimum passing marksintermwork.PracticalandOralexamswillbebasedontheentiresyllabus.

LaboratoryOutcomes:

Aftersuccessfulcompletion of thecoursestudentswillbeableto:

1. **Analyze**selection criteriaforpower switchingdevices.
2. **Simulate**thepowerconvertersusingsimulationsoftwarelikeMATLAB,SCILABand PSPICE.
3. **Design**andsimulateclosedloopcontrolsystemforpowerconverters.
4. **Simulate**athreephasepowerconverters.
5. **Understand**theapplicationofpowerelectronicssystem.

Note: Theaction verbsaccordingtoBloom'staxonomyarehighlighted inbold.

SuggestedListofExperiments

Sr. No.	ExperimentTitle
1	Tostudyselection criteriaforpower switchingdevices.
2	TostudyPSPICEascircuitorientedsimulatorsforpower converters.
3	TostudyMATLABascircuitorientedsimulatorsforpowerconverters.
4	TostudySCILAB ascircuit orientedsimulatorsforpower converters.
5	TostudyZOH,FOH andSOHmodelofpower converters.
6	TostudyPIand PID control of powerconverters.
7	To studythreephaseinverterwith R, RLload.
8	Tostudymultilevel invertertopologies.
9	Tostudythreephase controlledrectifier with R/RLload.
10	Tostudygrid interfaceof renewable energysources.

Note: Experimentscanbeperformedonlineusingsimulationsoftwareaswellashardware.Freesimulation software SCILABcan beusedtoperformtheexperiments.

(ExpectedpercentageofH/wandsoftwareexperimentsshould be60%&40%respectively)

Note:
Suggested List of Experiments is indicative. However, flexibility lies with individual courseinstructors to design and introduce new, innovative and challenging experiments, (limitedto maximum 30% variation to the suggested list) from within the curriculum, so that thefundamentals and applications can be explored to give greater clarity to the students andtheycan bemotivated tothink differently.

Course Code	CourseName	TeachingScheme(Hrs)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELXC203	Advanced DigitalSignal Processing	3	-	-	4	-	-	4

Course Code	Course Name	ExaminationScheme							
		Theory Marks							
		Internalassessment			EndSem.Exam	Term Work	Practical	Oral	Total
		Test 1	Test 2	Avg. OfTest1& Test 2					
ELXC203	Advanced DigitalSignalProcessing	20	20	20	80	-	-	-	100

CoursePre-requisites:

SignalsandSystems,DigitalSignalProcessing,ProbabilityandRandomprocesses.

CourseObjectives:

1. TounderstandDSPtechniquesin differentfields ofmoderndayapplications.
2. Tostudymultirate**DSP**algorithmsandfilterbank analysisfor real worldapplications.
3. Todevelopasolidfoundationinlinearpredictionanalysisandoptimumfilteringconcepts.
4. TolearnthoroughlyLMSandRLSalgorithmswhichareattheheartoftheadaptivesystems.
5. Togaindeepinsightintospectrumestimationalgorithms.

CourseOutcomes:
Studentswill beable to

1. Applymultirate processingtechniquesin practical applications.
2. Designoptimumfilterssuitedfordifferentapplications.
3. Design andsimulateadaptivesystems.
4. Extractinformationfrom spectralanalysisofsignals.
5. Design andtestsignalprocessingalgorithmsforvarioustasks.

Module No.	Unit No	Topics	Hrs
01		**IntroductionandReview**	04
	1.1	BasicDSPexamplesinblockdiagrams,TypicalDSPinrealworldapplications.	02
	1.2	ReviewofFIR& IIRfilters,SamplingandReconstructionofsignals,Analogto digital and Digital to analogconversions.	02
02		**MultirateDigitalSignalProcessing**	12
	2.1	Introduction,Decimationbya factorD,Interpolationbyafactor I,Samplingrateconversionbyarational factorI/D.	03
	2.2	Implementationofsamplingrateconversion,Multistageimplementationof samplingrateconversion.	03
	2.3	Sampling rate conversion of band pass signal, sampling rateconversionbyarbitraryfactor,Applications ofmultirate signalprocessing.	03
	2.4	Digitalfilterbanks,Two channelQuadratureMirrorfilterbanks.	03
03		**LinearPredictionandOptimumfilters**	07
	3.1	Randomsignals,Correlationfunctions,PowerSpectra,Innovationsrepresentationof aStationaryrandom Process	03
	3.2	Forwardand BackwardLinearpredictions.	02
	3.3	SolutionofNormalequations.The Levinson-DurbinAlgorithm.	02
04		**AdaptiveDigital Filters**	06
	4.1	FIRadaptivefilters. Steepestdescentadaptivefilter,LMSalgorithms,NormalizedLMS,Applicationin noisecancellation.	04
	4.2	AdaptiveRecursive filters.	02
05		**PowerSpectrumEstimation**	06
	5.1	Estimationofspectrafromfinitedurationobservationsofsignals.	02
	5.2	Nonparametricmethodsforpowerspectrumestimation.	02
	5.3	Parametricmethodsforpowerspectrumestimation.	02
06		**Applicationsof DSP**	04
	6.1	Biomedical applications, ECG signal analysis, QRS template, QRSdetectionmethods etc.	02
	6.2	Speechprocessingapplications,Widebandandnarrowbandspectrograms.	02
		Total	39

ReferenceBooks:

1. DigitalSignal ProcessingPrinciples ,algorithms and applications ,John. G. Proakis ,D.G.Manolakis. 4/e,Pearson.
2. DigitalSignalProcessing,APracticalapproach.Emmanuel.C.IfeachorB.W.Jervis.Pearso n.
3. DigitalSignalProcessing.Acomputerbasedapproach,S.K.Mitra,TataMcGrawHill.
4. StatisticalDigitalSignalProcessing,Monson.H.HAYES,WileyIndia.
5. IntroductiontoDigitalSpeechProcessing, L.RRabiner&R.W Schafer, Pearson.
6. DiscretetimeSignalsProcessing,Oppenheim &Schaffer,Pearson.

RecommendedResearchPapersforReading:

1. **P.Vaidyanathan**(1990)*."Multirate Digitalfilters,Filterbanks,Polyphasenetworkand applications: Atutorial"* Proc.IEEE vol 78,No 1,pp 56-90.
2. **2SchoederM.R**(1985) *"Linearpredictivecodingofspeech:Reviewandcurrentdirections"*IEEECommun. Magvol 23 , pp 54-61
3. **Widrow.B**(1975)*"AdaptivenoisecancelIing,PrinciplesandApplications"*ProcIEEE,vol 63, pp 1692-1716
4. **WidrowB**(1976*)"StationaryandNonstationary characteristicsoftheLMSadaptivefilter"*Proc IEEE ,vol 64,pp 1151-1162
5. **ThomsonD.J**(1969)*"Spectralestimation&Harmonicanalysis"*ProcIEEEvol70, pp1055-1096

InternalAssessment(IA):

Two tests must be conducted which should cover at least 80% of the syllabus. The average marks ofboththetestwillbe consideredasfinalIAmarks

EndSemesterExamination:

1. Questionpaperwill comprise6questions,eachof20marks.
2. Total4questionsneedtobesolved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to5marks willbeasked.
4. Remainingquestionswill beselectedfromall themodules

Course Code	CourseName	TeachingScheme(Hrs)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ELXL204	LAB-1V AdvancedDigital SignalProcessingLAB	-	2	-	-	1	-	1

Course Code	Course Name	ExaminationScheme							
		Theory Marks							
		Internalassessment			EndSem.Exam	Term Work	Practical	Oral	Total
		Test 1	Test 2	Avg. OfTest1& Test 2					
ELXL204	LAB-1V AdvancedDigital signalProcessingLAB	-	-	-	-	25	-	25	50

CoursePre-Requisites:

1. BasicknowledgeofSignalsandSystems,DSP.
2. AcquaintanceofSimulationlanguagesandsoftwaretools.

CourseObjectives:

1. TodesignandsimulatebasicDSPsystemsandmultiratesystemsforpracticalapplications.
2. Todesignand simulateDSPsystemsforspectralanalysisofsignalsandoptimumfiltersfordifferentapplications
3. Todesignandsimulateadaptivefiltersforrealworldapplications

CourseOutcomes:

Studentswill beable to

1. ImplementbasicDSPalgorithmsand multiratetechniquesforvarioussituations.
2. Implementoptimumfiltersforrealworldapplicationsandextractspectralinformation.
3. Design andtestadaptivefiltersystemsforpracticalapplications.

ListofExperiments:

1. Basicfilteringoperations,likenoisereductionusingFIRfilter,enhancementofECGsignalusingnotch filteringetc.
2. IIR filter.SimulationofDigitalaudioequalizer.
3. Biomedicalsignalprocessing,ECG signalprocessing.
4. AlgorithmsinDTMFtonegeneration.
5. OversamplingandAnalogtodigital conversionresolution.
6. Samplingratereductionbyanintegerfactor,samplingrateincreasebyanintegerfactor.
7. ChangingSamplingratebyanon integerfactor L/M.
8. UpsamplingandInterpolationfilterprocessesinCDaudiosystems.
9. Noisecancellationusingadaptivefilters.
10. Systemmodelingusingadaptivefilters.
11. Lineenhancementusinglinearprediction.
12. SubbanddecompositionandtwochannelperfectreconstructionsQMFbank.

Students arerequired to perform any **six experiments** from the above listcoveringmost of the topics in Advanced Signal processingandperform **one mini project**preferablybased on anyoftheabovetopics 2,4,8,or 12.

ReferenceBooks:

1. Digital Signal Processing Fundamentals & Applications.2/eLi Tan & Jean JiangElsevier,Academicpress.
2. DigitalSignalProcessing.Acomputerbasedapproach,S.K.Mitra,TataMcGrawHill.

SEMESTERIII

CourseCode	CourseName	Credits
ELXS3031	Seminar	03

GuidelinesforSeminar

- Seminar should be based on thrust areas in Electronics and TelecommunicationEngineering
- Students should do literature survey and identify the topic of seminar and finalize inconsultationwith Guide/Supervisor.
- Students should use multiple literatures and understand the topic and compile thereport in standard format and present infront of Panel of Examiners appointed by theHeadof the Department/InstituteofrespectiveProgramme.

Seminarshould beassessed based on followingpoints

- QualityofLiteraturesurveyand Noveltyinthetopic
- Relevanceto thespecialization
- Understandingof thetopic
- QualityofWrittenandOralPresentation

IMPORTANTNOTE:

1. AssessmentofSeminarwillbecarriedoutbyapairofInternalandExternalexaminer.Theexternalexaminershouldbeselectedfromapprovedpanelofexaminersfor SeminarbyUniversity ofMumbai,ORfacultyfromPremierEducational Institutions /Research Organizations such as IIT, NIT, BARC, TIFR,DRDO, etc. OR a person having minimum Post-Graduate qualification with at leastfiveyears‟experienceinIndustries.
2. Literature survey in case of seminar is based on the broader area of interest in recentdevelopmentsand fordissertationit should befocusedmainlyonidentifiedproblem.
3. At least 4-5 hours of course on Research Methodology should be conducted whichincludes Literature Survey, Problems Identification, Analysis and Interpretation ofResultsandTechnical Paper Writingin thebeginningof3rd Semester.

SEMESTERIII

CourseCode	CourseName	Credits
ELXD3031/ELXD4041	DissertationI/ Dissertation-II	12+15

GuidelinesforDissertation

- Students should do literature survey and identify the problem for Dissertation andfinalize in consultation with Guide/Supervisor. Students should use multiple literatureand understandthe problem. Students should attempt solution to the problem byanalytical/simulation/experimental methods. The solution to be validated with properjustificationand compile thereport in standard format.

GuidelinesforAssessmentofDissertation I

- DissertationIshouldbeassessed basedon followingpoints
- QualityofLiteraturesurveyandNoveltyin theproblem
- Clarityof Problem definition and Feasibilityof problem solution
- Relevanceto thespecialization
- Clarityofobjectiveand scope
- DissertationIshouldbeassessedthroughapresentationbyapanelofInternalexaminersappointedbytheHeadoftheDepartment/InstituteofrespectiveProgramme.

GuidelinesforAssessmentofDissertation II

- DissertationIIshouldbeassessedbased onfollowingpoints
- QualityofLiteraturesurveyandNoveltyin theproblem
- Clarityof Problem definition and Feasibilityof problem solution
- RelevancetothespecializationorcurrentResearch/Industrialtrends
- Clarityofobjectiveand scope
- Qualityof workattempted
- Validationofresults
- Qualityof Writtenand OralPresentation
- DissertationIIshouldbeassessedthroughapresentationjointlybyInternal andExternal Examiners appointed bytheUniversityof Mumbai
- Students shouldpublishatleastone paper basedonthe workinreputedInternational/NationalConference(desirablyin Refereed Journal)