Department of Electrical and Electronics Engineering

B.Tech. Electrical and Electronics Engineering
Curriculum and Syllabus

(Applicable to the students admitted during AY: 2022-23)

School of Engineering and Sciences
SRM University *AP*, Andhra Pradesh

Department Vision

To produce professionally competent graduates in the domain of power and energy by addressing the technical challenges. through unique learning experiences to serve society.

Department Mission

1. Impart standard and equitable education through academic rigor to produce real-world electrical and electronics engineers.
2. Bring on board academia and industry for collaborative research, product development, and building entrepreneurship proficiency among students and faculty.
3. To incorporate multi-disciplinary activities and ethical practices at different stages of learning.

Program Educational Objectives (PEO)

1. Develop the ability to apply concepts from the diverse areas of electrical and electronics engineering to understand and arrive at solutions.
2. Utilise interdisciplinary ideas for societal development.
3. Use domain knowledge to develop novel products, technologies, and services.
4. Effectively work as an individual/team, involved in research, development of green technologies, and creating future entrepreneurs.

Mission of the Department to Program Educational Objectives (PEO) Mapping

	PEO 1	PEO 2	PEO 3	PEO 4
Mission Statement 1				
Mission Statement 2				
Mission Statement 3				

Program Specific Outcomes (PSO)

1. Demonstrate competence in the analysis, design and development of Electrical and Electronic systems, including advanced power systems, renewable energy systems and related control strategies.
2. Use technologies, platforms, and tools to implement and enhance understanding of electrical and electronic-based systems.
3. Implement socially relevant, sustainable, and green technical solutions to complex engineering problems in multi-disciplinary environments.

Mapping Program Educational Objectives (PEO) to Program Learning Outcomes (PLO)

Program Learning Outcomes (PLO)															
PEOs	POs												PSOs		
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and ICT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
PEO 1															
PEO 2															
PEO 3															

Category Wise Credit Distribution			
Course Sub-Category	**Sub-Category Credits**	**Category Credits**	**Learning Hours**
Ability Enhancement Courses (AEC)		0	0
University AEC			
School AEC			
Value Added Courses (VAC)		0	0
University VAC			
School VAC			
Skill Enhancement Courses (SEC)		0	0
School SEC			
Department SEC			
SEC Elective			
Foundation / Interdisciplinary Courses - FIC		0	0
School FIC			
Department FIC			
Core + Core Elective including Specialization (CC)		0	0
Core			
Core Elective (Inc Specialization)			
Minor (MC) + Open Elective (OE)		0	0
Research / Design / Internship / Project (RDIP)		0	0
Internship / Design Project / Startup / NGO			
Internship / Research / Thesis			
Total		**0**	**0**

Semester wise Course Credit Distribution Under Various Categories										
Category	**Semester**									
	I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**Total**	**%**
Ability Enhancement Courses - AEC	3	0	2	0	0	0	0	0	5	**3**
Value Added Courses - VAC	2	0	0	3	0	4	0	0	9	**5**
Skill Enhancement Courses - SEC	3	7	2	4	3	3	0	0	22	**13**
Foundation / Interdisciplinary Courses - FIC	10	11	3	0	0	0	0	0	24	**14**
CC / SE / CE / TE / DE / HSS	0	4	15	16	17	18	9	0	79	**47**
Minor / Open Elective - OE	0	0	0	3	3	3	3	0	12	**7**
(Research/ Design/ Industrial Practice/Project/Thesis/Internship) -RDIP	0	0	0	0	0	0	4	12	16	**10**
Grand Total	**18**	**22**	**22**	**26**	**23**	**28**	**16**	**12**	**167**	**100**

Note: L-T/D-P/Pr and the class allocation is as follows.

a) Learning Hours : 30 learning hours are equal to 1 credit.
b) Lecture/Tutorial : 15 contact hours (60 minutes each) per semester are equal to 1 credit.
c) Discussion : 30 contact hours (60 minutes each) per semester are equal to 1 credit.
d) Practical : 30 contact hours (60 minutes each) per semester are equal to 1 credit.
e) Project : 30 project hours (60 minutes each) per semester are equal to 1 credit.

SEMESTER - I								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	SEC	S SEC	ISES 101	Industry Specific Employability Skills - I	0	0	1	1
2	SEC	S SEC	ENTR100	Exploratory Learning and Discovery	0	0	1	1
3	SEC	S SEC	IRH 101	Orientation on Internationalization	1	0	0	1
4	FIC	S FIC	BIO 103/ ENV 111	Introductory Biology for Engineers /Environmental Science	2	0	0	2
5	FIC	S FIC	EGL 101	Communicative English	3	0	0	3
6	FIC	S FIC	PHY 101/ CHE 103	Engineering Physics/Chemistry for Engineers	2	0	0	2
7	FIC	S FIC	PHY 101L/ CHE 103L	Engineering Physics Lab/ Chemistry for Engineers Lab	0	0	1	1
8	FIC	S FIC	CSE 108	Introduction to Computer Science and Programming Using C	3	0	0	3
9	FIC	S FIC	CSE 108L	Introduction to Computer Science and Programming Using C Lab	0	0	1	1
10	FIC	S FIC	MAT 113	Calculus	3	0	0	3
				Semester Total	**14**	**0**	**4**	**18**

SEMESTER - II								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	SEC	S SEC	CSE 131	Industry standard Coding practice - I	0	0	2	2
2	SEC	S SEC	CSE 107	Data Structures	3	0	0	3
3	SEC	S SEC	CSE 107L	Data Structures Lab	0	0	2	2
4	SEC	S SEC	ISES 102	Industry specific Employability skills-II	3	0	0	1
5	FIC	S FIC	ECO 121	Principles of Economics	3	0	0	3
6	FIC	S FIC	MAT 221	Probability And Statistics for Engineers	3	0	0	3
7	FIC	S FIC	BIO 103/ ENV 111	Introductory Biology for Engineers /Environmental Science	2	0	0	2
8	FIC	S FIC	MAT 211	Linear Algebra	3	0	0	3
9	FIC	S FIC	PHY 101/ CHE 103	Engineering Physics/ Chemistry for Engineers	2	0	0	2
10	FIC	S FIC	PHY 101L/ CHE 103L	Engineering Physics Lab/ Chemistry for Engineers Lab	0	0	1	1
11	CC	Core	EEE 103	Basic electrical and Electronics engineering	3	0	0	3
12	CC	Core	EEE 103L	Basic electrical and Electronics engineering	0	0	1	1
				Semester Total	**22**	**0**	**6**	**26**

SEMESTER - III								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	AEC	S AEC	AEC 105	Analytical skills for Engineers	2	0	0	2
2	VAC	U VAC	VAC 103	Co-curricular Activities	0	0	2	2*
3	VAC	U VAC	VAC 104	Community service and Social responsibility	0	0	2	2*
4	FIC	S FIC	FIC 106	Differential Equations	3	0	0	3
5	CC	Core	EEE 202	Circuit Theory	3	0	1	4
6	CC	Core	EEE 203	Electrical Machines-1	3	0	1	4
7	CC	Core	EEE 204	Electromagnetic field Theory	3	0	0	3
8	CC	Core	EEE 205	Digital Electronics	3	0	1	4
9	CC	Core	EEE 201	Solid-State Devices and High Electron Mobility Transistors (Hemts)	2	0	0	2
10	Elective	OE		Open Elective / Minor	3	0	0	3
				Semester Total	**22**	**0**	**7**	**25**

SEMESTER - IV								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	VAC	U VAC	VAC 103	Co-curricular Activities	0	0	2	2*
2	VAC	U VAC	VAC 104	Community service and Social responsibility	0	0	2	2*
3	SEC	S SEC	EEE 210	Measurements and Instrumentation	3	0	1	4
4	CC	Core	EEE 206	Power generation, Transmission and Distribution	3	0	1	4
5	CC	Core	EEE 207	Electrical Machines-II	3	0	1	4
6	CC	Core	EEE 208	Analog Circuits	3	0	1	4
7	CC	Core	EEE 209	Linear systems and Control Design	3	0	1	4
8	Elective	OE		Open Elective / Minor	3	0	0	3
				Semester Total	**18**	**0**	**9**	**23**

SEMESTER - V								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	VAC	U VAC	VAC 107	Community service and Social Responsibility	0	0	2	2*
2	VAC	U VAC	VAC 108	Co-Curricular Activities	0	0	2	2*
3	SEC	E SEC	SEC	Career Skills - I	3	0	0	3
4	CC	Core	EEE 301	Principles Of Signal Processing	3	0	0	3
5	CC	Core	EEE 302	Power System Analysis	3	0	1	4
6	CC	Core	EEE 303	Nonlinear Systems and Control	2	0	1	3
7	CC	Core	EEE 304	Power Electronics	3	0	1	4
8	CC	Core	EEE 305	Microcontrollers and Applications	2	0	1	3
9	Elective	OE		Open Elective / Minor	3	0	0	3
				Semester Total	**19**	**0**	**8**	**23**

SEMESTER - VI								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	VAC	U VAC	VAC 103	Co-Curricular Activities	0	0	2	2
2	VAC	U VAC	VAC 104	Community service and Social responsibility	0	0	2	2
3	SEC	E SEC	SEC	Career Skills - II	3	0	0	3
4	CC	Core	EEE 307	Switchgear and Protection	3	0	1	4
5	CC	Core	EEE 306	High Voltage Engineering	3	0	1	4
6	CC	Core	EEE 308	Renewable Energy Sources	3	0	1	4
7	Elective	CE		Core Elective	3	0	0	3
8	Elective	CE		Core Elective	3	0	0	3
9	Elective	OE		Open Elective / Minor	3	0	0	3
				Semester Total	**21**	**0**	**7**	**28**

SEMESTER - VII								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	Elective	CE		Core Elective	3	0	0	3
2	Elective	CE		Core Elective	3	0	0	3
3	Elective	CE		Core Elective	3	0	0	3
4	Elective	OE		Open Elective / Minor	3	0	0	3
5	RDIP	RDIP	EEE 401	Internship	0	0	3	3
				Semester Total	**12**	**0**	**3**	**15**

SEMESTER - VIII								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	RDIP	RDIP	EEE 402	Major Project	0	0	12	12
				Semester Total	**0**	**0**	**12**	**12**

Core Electives								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	Elective	CE	EEE 427	Numerical Methods for Electrical Engineering	3	0	0	3
2	Elective	CE	EEE 428	Indian Standards for Electrical Engineering Applications	3	0	0	3
3	Elective	CE	EEE 429	Power Semiconductor Drives	3	0	0	3
4	Elective	CE	EEE 430	Computer Aided Design of Electrical Machines	3	0	0	3
5	Elective	CE	EEE 431	Power System Operation and Control	3	0	0	3
6	Elective	CE	EEE 432	Switched Mode Power Converters	3	0	0	3
7	Elective	CE	EEE 433	Control of Switched Mode Power Converters	3	0	0	3
8	Elective	CE	EEE 434	Embedded Systems for Power Applications	3	0	0	3

Specialization : Renewable Energy								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	Elective	CE		Design of Photovoltaic Systems	3	0	0	3
2	Elective	CE		Modelling and Control of Battery Energy Systems	3	0	0	3
3	Elective	CE		Power Quality Issues and Mitigation Techniques	3	0	0	3
4	Elective	CE		Renewable Energy Integration with the Grid	3	0	0	3
5	Elective	CE		Control of Power Converters	3	0	0	3
6	Elective	CE		Microgrids and Energy Management	3	0	0	3

Open Electives								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**
1	Elective	OE	EEE 244	Nuclear Power Generation	3	0	0	3
2	Elective	OE	EEE 243	Introduction to Green Energy Technologies	3	0	0	3
3	Elective	OE	EEE 255	Electric Vehicle Engineering	3	0	0	3
4	Elective	OE	EEE 256	Introduction to Electric Vehicles	3	0	0	3

Career Skill Courses								
S. No	**Category**	**Sub-Category**	**Course Code**	**Course Title**	**L**	**T/D**	**P/Pr**	**C**

1	Elective	E SEC	SEC	Design of Power Electronics Circuits	3	0	0	3
2	Elective	E SEC	SEC	Design of Industrial Drives	3	0	0	3

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Industry Specific Employability Skills - I

Course Code	ISES 101	**Course Category**	SEC		**L**	**T**	**P**	**C**
					0	0	1	1
Pre-Requisite Course(s)	-	**Co-Requisite Course(s)**	-	**Progressive Course(s)**	ISES 102			
Course Offering Department	Mathematics	**Professional / Licensing Standards**	-					

Course Objectives / Course Learning Rationales (CLRs)

- Develop interpersonal skills to become a good team player.
- Develop socialization skills, positive attitude and behavioral skills
- Eliminate their barriers of communication and take conscious efforts to improvetheir skill sets.
- Recognise practice and acquire the skills necessary to deliver effective presentation with clarity and impact.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	**Bloom's Level**	**Expected Proficiency Percentage**	**Expected Attainment Percentage**
Outcome 1	Recognize the factors which motivate him in learning.	1	70%	60%
Outcome 2	Apply the knowledge of creativity and originality.	3	80%	70%
Outcome 3	Employ lateral thinking in solving problems.	1	70%	60%
Outcome 4	Identify themselves as team player.	1	90%	80%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	**Program Learning Outcomes (PLO)**														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design, and Research	Modern Tool and ICT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life LongLearning	PSO 1	PSO 2	PSO 3
Outcome 1					1			2		2		1			
Outcome 2		2			3			3	3						
Outcome 3		3							2			2			
Outcome 4								2	3			2			
Average		**3**			**2**			**4**	**4**			**3**			

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	**Quantitative Aptitude**	**10**		
	Speed calculations	1	1,4	1,4
	Time and Distance	1	1,4	1,4
	Problems on Trains	1	1,4	1,4
	Boats and Streams	1	1,4	1,4
	Races and Games, Escalator problems	1	1,4	1,4
	Time and work, Chain rule, Pipes and Cistern	2	1,4	1,4
	Simplification, surds and indices, square roots and cube roots	2	1,4	1,4
	Functions	1	1,4	1,4
Unit No. 2	**Logical Reasoning**	**4**		
	Number Series, Alphabet series	1	1,2	1,4
	Odd Man Out, Missing number, Wrong number	1	1,2	1,4
	Analogies, Mathematical Operations	1	1,2	1,4
	Calendars, Clocks	1	1,2	1,4
Unit No. 3	**Data Interpretation**	**2**		
	Cryptarithmetics, Identification of cross variable relations	1	1,2	2,4
	SUDOKU	1	2,3	2,4
Unit No. 4	**Verbal Ability**	8	1,2	2,4
	Basic sentence structure: Nouns, Pronouns, Adjectives	1	1,2	2,4
	Parts of speech, Degree of comparison	1	1,2	2,4
	Articles, conditionals, and sentences (kinds)	**1**		
	Verb Tense	1	1,2,3	2,3
	Sentence formation, Paragraph formation	1	1,2	2,3
	Change of voice, Change of speech	1	1,2,3	2,3
	Synonyms, Antonyms	2	1,2	2,3
Unit No. 5	**Soft Skills**	6		
	Self-introduction	2	1,2	2,3
	Presentations	2	1,2,3	2,3
	Nonverbal communication	1	1,2	2,3
	E-Mail Etiquettes	1	1,2	2,3
Total Contact Hours		**30**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End SemesterExam (50%)	
		CLA-1 (10%)		Mid-1 (15%)		CLA-2 (10%)		Mid-2 (15%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	40%		50%		40%		50%		50%	
	Understand										
Level 2	Apply	60%		50%		60%		50%		50%	
	Analyse										
Level 3	Evaluate										
	Create										
Total		**100%**		**100%**		**100%**		**100%**		**100%**	

Recommended Resources

1. R.S. Agarwal, A Modern Approach to Verbal & Non-Verbal Reasoning, S. Chand Publication
2. How to prepare for Quantitative Aptitude for CAT – Arun Sharma
3. Meenakshi Upadhyay, Arun Sharma -Verbal Ability and Reading Comprehension
4. How to prepare for Logical reasoning and data interpretation for CAT – Arun Sharma.
5. Mastering Soft skills – Julian Vyner.
6. Soft skills – Key to success in workplace and life – Meenakshi Raman, Shalini Upadhyay.
7. English grammar and composition – S.C.Gupta.

Environmental Science

Course Code	ENV 111	**Course Category**	VAC		**L**	**T**	**P**	**C**
Pre-Requisite Course(s)	-	**Co-Requisite Course(s)**	-	**Progressive Course(s)**	-			
Course Offering Department	-	**Professional / Licensing Standards**	-					

Course Objectives / Course Learning Rationales (CLRs)

1. To describe the environmental concepts from ecology and earth science to address real-world problems.
2. To interpret the complex interactions within and between environmental systems and to evaluate evolving environmental problems.

Course Outcomes / Course Learning Outcomes (CLOs)

CO's	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
1	Comprehend the environmental challenges that need attention.	1	80%	70%
2	Summarize the types of environmental pollutions and possible effects to society	2	80%	70%
3	Classify the natural environmental resources, present state, rate of depletion and future perspectives	2	80%	70%
4	Articulate a project-based learning on existing local to global environmental issues	2	80%	70%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and ICT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	-	-	-	-	1	1	2	-	2	1	-	1	-	-	-
Outcome 2	-	1	-	1	1	1	2	-	2	1	-	1	-	-	-
Outcome 3	-	1	-	1	1	1	3	-	2	1	-	1	-	-	-
Outcome 4	1	1	1	2	1	2	3	2	2	2	2	2	-	-	-
Course Average	**1**	**1**	**1**	**1.33**	**1**	**1.25**	**2.5**	**2**	**2**	**1.25**	**2**	**1.25**	**-**	**-**	**-**

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	**Human, Environmental Issues, and Climate Change**	**6**	1	1,2,3
	The man-environment interaction	1	1	1,2,3
	Environmental issues and scales	1	1	1,2,3
	Land use and Land cover change	2	1	1,2,3
	Ozone layer depletion	1	1	1,2,3
	Understanding climate change and adaptation	1	1	1,2,3
Unit No. 2	**Environmental Pollution and Health**	**7**	2	1,2,3
	Understanding pollution; Definitions, sources, impacts on human health and ecosystem	2	2	1,2,3
	Air pollution	1	2	1,2,3
	Water pollution	1.5	2	1,2,3
	Soil pollution	1	2	1,2,3
	Solid waste	1.5	2	1,2,3
Unit 3	**Ecosystems, Biodiversity Conservation, and Sustainable Development**	**9**	3	1,2,3
	Ecosystems and ecosystem services	1	3	1,2,3
	Biodiversity and its distribution	1	3	1,2,3
	Threats to biodiversity and ecosystems	1	3	1,2,3
	Overview of natural resources	1	3	1,2,3
	Biotic resources	1	3	1,2,3
	Water resources; Soil and Energy resources	2	3	1,2,3
	Introduction to Sustainable Development Goals (SDGs)-targets and indicators	2	3	1,2,3
Unit 4	**Environmental Management, Treaties and Legislation**	**8**	4	1,2,3
	Introduction to environmental laws and regulation	2	4	1,2,3
	Environmental management system	2	4	1,2,3
	Pollution control and management	2	4	1,2,3
	Major International Environmental Agreements; Major Indian Environmental Legislations	2	4	1,2,3
Total Contact Hours		**30**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (70%)				End Semester Exam (30%)
		CLA-1 (15%)	Mid Term (25%)	CLA-2 (15%)	CLA-3 (15%)	
Level 1	Remember	60%	60%	60%	60%	40%
	Understand					
Level 2	Apply	40%	40%	40%	40%	60%
	Analyse					
Level 3	Evaluate	-	-	-	-	-
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Rajagopalan, R. (2016) *Environmental Studies* (3rd edition), Oxford University Press.
2. Sharma, P. D. (2018) *Ecology and environment*. Rastogi Publications.
3. Anil K. Dey. (2016). *Environmental Chemistry*. New Age Publisher International Pvt Ltd. ISBN: 9789385923890, 9385923897

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Communicative English

Course Code	EGL 101	**Course Category**	AEC	**L**	**T**	**P**	**C**
				3	0	0	3
Pre-Requisite Course(s)	-	**Co-Requisite Course(s)**	-	**Progressive Course(s)**	EGL 120		
Course Offering Department	English	**Professional / Licensing Standards**	-				

Course Objectives / Course Learning Rationales (CLRs)

- To Introduce the Principles and Practices of Effective Communication Skills in various contexts.
- To understand the purpose and differentiate various types of audience.
- To encourage self-evaluation while collaborating with peers during learning.
- To produce Language in various contexts be it Oral or Written form.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	**Bloom's Level**	**Expected Proficiency Percentage**	**Expected Attainment Percentage**
Outcome 1	Employ listening, speaking, reading and writing skills to	3	90%	90%
Outcome 2	express based on production skills (Speak and Write)	3	70%	80%
Outcome 3	Illustrate views using PowerPoint and Word.	2	60%	50%
Outcome 4	Express with proper grammar.	3	80%	80%
Outcome 5	Apply listening skills to practice.	4	60%	50%
Outcome 6	Employ reading skills to read the given text.	3	70%	70%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	**Program Learning Outcomes (PLO)**														
	Scientific andDisciplinary	Analytical Reasoningand Problem Solving	Critical and Reflective Thinking	Scientific Reasoningand Design Thinking	Research RelatedSkills	Modern Tools andICT Usage	Environment andSustainability	Moral, Multiculturaland Ethical	Individual and Teamwork Skills	CommunicationSkills	Leadership Readiness Skills	Self-Directed andLife Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3		3	3		3			2	3		2			
Outcome 2		3	2	3		3				3		3			
Outcome 3	3		3		3					3		3			
Outcome 4	3	3							3	3		3			
Outcome 5		3								3		3			
Outcome 6		3							3	3		3			
Average	**3**	**3**	**3**	**3**	**3**	**3**			**3**	**3**		**3**			

Course Unitization Plan

Unit No.	Unit Name	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1		**12**		
	Course Introduction and Overview	2	1,2,3	
	Parts of Speech	2		1,2
	Tenses	1		1,2
	Vocabulary (Etymology, Prefixes, Suffix)	3		1,2
	Capitalization & Punctuations	2		1,2
	Principles of Sentence Structure & Paragraph Writing (*S+V+O*)	2		1,2,3
Unit No. 2		**11**		
	The Fundamentals of Speech (*Ethos, Pathos & Logos*)	2	1,2	1,2
	How to give a good Speech? (*Rhetoric & Speech Delivery*)	2		1,2
	Verbal Communication (Turn taking strategies, Questioning, Types of Qs)	3		1,2
	Nonverbal Communication (Cultural Contexts, Importance and Types)	2		1,2
	Fundamentals of Personal, Informative, and Scientific Speech	2		1,2
Unit No. 3		**10**		
	Listening Skills: Definition, Barriers, Steps to Overcome	2	4	2
	Listening Comprehension	3		2
	Listening to Influence, Negotiate	2		2
	Listening to Specific Information	1		2
	Note taking & Making while Listening	2		2
Unit No. 4		**10**		
	Read to Skim, and Scan	2	5	1,2
	Read to Comprehend (Predict, Answer Questions & Summarize)	2		1,2
	Read to Appreciate, Compose and Present	3		1,2
	Read to Understand Referencing Skills for Academic Report Writing and Plagiarism (APA 6th Ed)	3		1,2
Unit No. 5		**17**		
	Write to Interpret Data (Flow charts, Bar Diagrams)	2	6	4
	Write to Inform (News, Emails, Notice, Agenda & Minutes)	4		4
	Write to Define (Definitions & Essays)	2		4
	Resume and Cover Letter	3		4
	Write an Effective Abstract and a Comprehensive Summary	3		4
	Write Project Proposal	3		4
Total Contact Hours		**60**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)				End Semester Exam (50%)
		CLA-1 (10%)	Mid-1 (15%)	CLA-2 (10%)	Mid-2 (15%)	
Level1	Remember	40%	50%	30%	40%	50%
	Understand					
Level2	Apply	60%	50%	70%	60%	50%
	Analyse					
Level3	Evaluate					
	Create					
Total		**100 %**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Shoba, Lourdes. (2017). Communicative English: A Workbook. U.K: Cambridge University Press.
2. Steven, Susan, Diana. (2015). Communication: Principles for a Life Time. U.S.A: Pearson 6th Ed.
3. Publication Manual of the American Psychological Association, (2010). 6th Ed.
4. Kosslyn, S.M. "Understanding Charts and Graphs", Applied Cognitive Psychology, vol. 3, pp. 185-226, 1989

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Chemistry for Engineers

Course Code	CHE 103	**Course Category**	FIC	**L**	**T**	**P**	**C**
				2	0	0	2
Pre-Requisite Course(s)	-	**Co-Requisite Course(s)**	-	**Progressive Course(s)**		-	
Course Offering Department	-	**Professional / Licensing Standards**	-				

Course Objectives / Course Learning Rationales (CLRs)

- To distinguish the types of bonding and can predict the structure, electronic and magnetic properties of small molecules.
- To learn the type of chemical reactions based on the reaction energetics and kinetics. Also interpret stability of the binary materials based on temperature, pressure, and concentration.
- To gain in-depth knowledge about crystalline materials.
- To understand the types of polymers and familiar with industrial applications of common synthetic and biodegradable polymers.
- To learn the formation of proper electrochemical cell. Also, can choose the appropriate indicator for a given acid base titration and may also predict the pH and pOH of the given solutions.

Course Outcomes / Course Learning Outcomes (CLOs)

CO's	At the end of the course, the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
1	Distinguish the types of bonding and also can predict the structure, electronic and magnetic properties of small molecules	2	70%	85%
2	Interpret Phase rule and Kinetics based on temperature, pressure, and concentration	2	70%	85%
3	Summarize crystalline materials.	2	70%	85%
4	Identify the types of polymers and industrial applications of common synthetic and biodegradable polymers	2	70%	85%
5	Demonstrate electrochemical cell	3	70%	85%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and ICT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1		2	1	2	1		2		2		1	2			
Outcome 2		2	3	2	2		2		2		2	1			
Outcome 3		2	3	2	2		2		2		1	2			
Outcome 4		2	2	2	2		2		2		2	2			
Outcome 5		2	2	2	2		1		1		1	2			
Course Average		**2**	**2**	**2**	**2**		**2**		**2**		**1**	**2**			

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	**CHEMICAL BONDING**	**13**		
	Ionic, covalent, and metallic bonds	1	1	1, 2, 4
	Theories of bonding: Valence bond theory, nature of covalent bond, sigma (σ) bond, Pi (π) bond.	1	1	1, 2, 4
	Hybridization: Types of hybridization, sp, sp^2, sp^3, sp^3d, d^2sp^3.	1	1	1, 2, 4
	Shapes of molecules (VSEPR Theory): $BeCl_2$, CO_2, BF_3, H_2O, NH_3, CH_4, PCl_5, XeF_2, SF_6, XeF_4.	4	1	1, 2, 4
	Molecular orbital theory: Linear combination of atomic orbitals (LCAO Method)	1	1	1, 2, 4
	Bond order, homo- nuclear diatomic Molecules (H_2, O_2, N_2)	1	1	1, 2, 4
	Hetero-nuclear diatomic Molecules (NO, CO).	1	1	1, 2, 4
	Non-covalent interactions: Van der Waals interactions	1	1	1, 2, 4
	Dipole-dipole interactions	1	1	1, 2, 4
	Hydrogen bonding	1	1	1, 2, 4
Unit No. 2	**PHASE RULE, THERMOCHEMISTRY AND KINETICS**	**9**		
	Phase rule: Introduction	1	2	1, 2, 4
	Definition of the terms used in phase rule with examples	1	2	1, 2, 4
	Application of phase rule to water system water system	1	2	1, 2, 4
	Basics of thermochemistry: Standard terms in thermochemistry and their significance.	1	2	1, 2, 4
	Heat of combustion, formation and sublimation (with examples in fuels and propellants).	2	2	1, 2, 4
	Kinetics: Order and molecularity of reactions	1	2	1, 2, 4
	Zero order and first order reactions	1	2	1, 2, 4
	Second order reactions	1	2	1, 2, 4
Unit No. 3	**CRYSTALLINE AND ELECTRONIC MATERIALS**	**10**		
	Crystal structure: crystal systems	2	3	2,4
	Properties of cubic crystals, Bragg's Law, Bravais lattices	1	3	2,4
	Miller indices	2	3	2,4
	Point defects	1	3	2,4
	Band theory: metals, insulators, and semiconductors.	2	3	2,4
	Band gaps, doping, and devices.	2	3	2,4
Unit No. 4	**MATERIALS CHEMISTRY**	**9**		
	Classification of polymers: Natural and synthetic.	1	4	1, 3
	Thermoplastic and Thermosetting polymers. Degree of polymerization.	2	4	1, 3
	Properties of polymers: Tg, Tacticity, Molecular weight, weight average.	2	4	1, 3
	Degradation of polymer	1	4	1, 3
	Common Polymers: Elastomer, Conducting polymer, biodegradable polymer.	1	4	1, 3
	Examples: PET (Polyethylene terephthalate), nylon, polystyrene.	1	4	1, 3
	Demineralization of water and Zeolite process.	1	4	1, 3

Unit No. 5	**ELECTROCHEMISTRY**	**4**		
	Electrochemical cells	1	5	1, 2, 4
	Primary and secondary cells	1	5	1, 2, 4
	Lead-acid battery	1	5	1, 2, 4
	Li+ batteries and Fuel cells	1	5	1, 2, 4
Total Contact Hours		**45**		

Learning Assessment

Bloom's Level of Cognitive Task		**Continuous Learning Assessments (50%)**				**End Semester Exam (50%)**
		CLA-1 (15%)	**Mid-1 (15%)**	**CLA-2 (10%)**	**CLA-3 (10%)**	
Level 1	Remember	60%	40%	60%	40%	30%
	Understand					
Level 2	Apply	40%	60%	40%	60%	70%
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. A. Bahl, B.S. Bahl, G.D. Tuli, Essentials of Physical Chemistry, (2016), S Chand Publishing Company
2. T. Jain, Y. Jain, Engineering Chemistry, 16th Edition (2017), Dhanpat Rai Publication Company
3. V. R. Gowariker, N. V. Viswanathan, J. Sreedhar, Polymer Science, New Age International, 1986. ISBN: 0-85226-307-4
4. B. R. Puri, L. R. Sharma & M. S. Pathania, Principles of Physical Chemistry, 46th Edition (2013), Vishal Publication Company

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Chemistry for Engineers Lab

Course Code	CHE 103L	**Course Category**	FIC		**L**	**T**	**P**	**C**
					0	0	1	1
Pre-Requisite Course(s)	-	**Co-Requisite Course(s)**	Chemistry CHE 103	**Progressive Course(s)**	-			
Course Offering Department	Chemistry	**Professional / Licensing Standards**	-					

Course Objectives / Course Learning Rationales (CLRs)

- To gain knowledge on different kinds of quantitative analyses.
- To apply various analytical titration techniques.

Course Outcomes / Course Learning Outcomes (CLOs)

CO's	At the end of the course, the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
1	Choose the appropriate indicator for a given acid base titration and may also predict the pH and pOH of the given solutions	3	70%	80%
2	Predict the pH and pOH of the given solutions	4	70%	80%
3	Explain the principles and working of electrochemistry.	3	70%	80%
4	Demonstrate the electro analytical technique in the volumetric titration.	3	70%	80%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and ICT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1		2	2	2	2		2		1			2			
Outcome 2		2	3	2	1		2		2			2			
Outcome 3		2	1	2	2		1		2			2			
Outcome 4		2	2	2	2		1		2			2			
Course Average		**2**	**2**	**2**	**2**		**2**		**2**			**2**			

Course Unitization Plan - Lab

Unit No.	Experiment Name	Required Contact Hours	CLOs Addressed	References Used
Unit No. 2,4	Volumetric titration of HCl vs NaOH	4	2,4	1,2,3
Unit No. 2,4	Standardization of potassium permanganate by Oxalic acid	4	2,4	1,2,3
Unit No. 2,4	Conduct metric titration of HCl vs NaOH	4	2,4	1,2,3
Unit No. 3,4	Determination of strength of given hydrochloric acid using pH meter	4	3,4	1,2,3
Unit No. 1,2	Determination of hardness of water by EDTA method	4	1,2	1,2,3
Unit No. 3,4	Estimation of iron content of the given solution using potentiometer	4	3,4	1,2,3
Unit No. 1,2	Iodometric Determination of Ascorbic Acid (Vitamin C)	6	1,2	1,2,3
Total Contact Hours		**30**		

Learning Assessment

Bloom's Level of Cognitive Task		**Continuous Learning Assessments (50%)**			**End Semester Exam (50%)**
		Experiments (20%)	**Record/ Observation Note (10%)**	**Viva Voce + Model examination (20%)**	
Level 1	Remember	40%	40%	60%	50%
	Understand				
Level 2	Apply	60%	60%	40%	50%
	Analyse				
Level 3	Evaluate				
	Create				
Total		**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. G.H Jeffery, J Bassett, J Mendham, R.C Denny, Vogel's Text Book of Quantitative Chemical Analysis, Longmann Scientific and Technical, John Wiley, New York.
2. J.B Yadav, Advanced Practical Physical Chemistry, Goel Publishing House, 2001.
3. A.I Vogel, A.R Tatchell, B.S Furnis, A.J Hannaford, P.W.G Smith, Vogel's Text Book of Practical Organic Chemistry, Longman and Scientific Technical, New York, 1989.

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Introduction to Computer Science and Programming Using C

Course Code	CSE 108	**Course Category**		**L**	**T**	**P**	**C**
				3	0	0	3
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	CSE	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

- Gain basic knowledge in C programming language.
- Acquire knowledge on Decision making and functions in C.
- Learn arrays, strings and pointers concept in C.
- Understand the basics concepts of Structures, Union and File handling techniques Using CProgramming

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Describe C structures, enumerators, keywords, header files and operators	2	75 %	70%
Outcome 2	Illustrate Decision-Making statementsand Functions.	3	70 %	65%
Outcome 3	Interpret arrays, strings, and pointers programming in C	3	70 %	65%
Outcome 4	Apply Structures, unions, and File handling operations on different scenarios	3	70 %	65%
Outcome 5	Solve given projects based on C concepts	4	70 %	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary	Analytical Reasoning and	Critical and Reflective	Scientific Reasoning and	Research Related Skills	Modern Toolsand ICT Usage	Environmentand	Moral, Multicultural	Individual and Teamwork	Communication Skills	Leadership Readiness Skills	Self-Directedand Life Long	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	2	1									2	2	3
Outcome 2	3	3	2	1									3	2	3
Outcome 3	3	3	2	2									3	2	3
Outcome 4	3	3	2	2									3	2	3
Outcome 5	3	3	2	2								2	3	2	2
Average	**3**	**3**	**2**	**2**								**2**	**3**	**2**	**3**

Course Unitization Plan

	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	**INTRODUCTION TO COMPUTER SCIENCE**	**9**	1	1
	Fundamentals of Computing, Historical perspective, Early computers	2	1	1,2
	Computing machine. Basic organization of a computer: ALU, input-output units, memory, program counter - variables and addresses - instructions: store, arithmetic, input and output	2	1	1,2
	Problem-solving: Algorithm / Pseudo code, flowchart, program development steps	2	1	1,2
	Computer languages: Machine, symbolic and high-level language Level languages	1	1	1,2
	Creating and Running Programs: Writing, editing (any editor), compiling (gcc)	1	1	1,2
	linking, and executing in a Linux environment	1	1	1,2
Unit No. 2	**C PROGRAMMING BASICS**	**9**		
	Structure of a C program, identifiers Basic data types and sizes. Constants, Variables	1	1	1,2
	Arithmetic, relational and logical operators, increment and decrement operator's	1	1	1,2
	Conditional operator, assignment operator, expressions Tyconversion	1	1	1,2
	Conditional Expressions Precedence and order of evaluation Sample Programs.	1	1	1,2
	SELECTION & DECISION MAKING: if-else, null else, nested i-way selection: switch, else-if, examples.	2	1	1,2
	ITERATION: Loops - while, do-while and for, break, continue	1	1	1,2
	initialization and updating, event and counter controlled loops and examples.	2	1,2	1,2
Unit No. 3	**FUNCTIONS AND ARRAYS**	**10**		
	User defined functions, standard library functions	1	2,3	1,2
	Passing 1-D arrays, 2-D arrays to functions.	1	2,3	1,2
	Recursive functions - Recursive solutions for Fibonacci series, towers of Hanoi.	2	2,3	1,2
	C Pre-processor and header files	1	2,3	1,2
	Concepts, declaration, definition, storing and accessing elements	1	2,3	1,2
	one-dimensional, two dimensional, and multidimensional arrays	2	2,3	1,2
	array operations and examples, Character arrays and string manipulations	2	2,3	1,2
Unit No, 4	**POINTERS**	**10**		
	Concepts, initialization of pointer variables	**1**	3,4	1,2
	pointers as function arguments, passing by address, dangling memory, address arithmetic	**2**	3,4	1,2
	character pointers and functions, pointers to pointers	**2**	3,4	1,2
	pointers and multi-dimensional arrays, dynamic memory management functions	**2**	3,4	1,2
	command line arguments	**1**	3,4	1,2
Unit No. 5	**ENUMERATED, STRUCTURE AND UNION TYPES**	**7**		
	Structures - Declaration, definition, and initialization of structures, accessing structures	**1**	5	2, 3, 4
	nested structures, arrays of structures, structures and functions, pointers to structures,	**1**	5	2, 3, 4

	self-referential structures. Unions, typedef, bit-fields, program applications	**2**	5	2, 3, 4
	Bit-wise operators: logical, shift, rotation, masks.	**1**	5	2, 3, 4
	FILE HANDLING: Concept of a file, text files and binary files, formatted I/O, file I/O operations and example programs.	**2**	5	2, 3, 4
Total Hours		**45**		

Learning Assessment

Bloom's Level of Cognitive Task		**Continuous Learning Assessments (50%)**								**End Semester Exam (50%)**	
		CLA-1 (10%)		**Mid-1 (20%)**		**CLA-2 (10%)**		**CLA-3(10%)**			
		Th		**Th**		**Th**		**Th**		**Th**	
	Remember	70%		60%		50%		40%		30%	
Level 1	Understand										
Level 2	Apply	30%		40%		50%		60%		70%	
	Analyse										
Level 3	Evaluate										
	Create										
Total		100%		100%		100%		100%		100%	

Recommended Resources

1. The C programming Language by Brian Kernighan and Dennis Richie.
2. Programming in C, Pradip Dey and Manas Ghosh, Second Edition, OXFORD Higher Education, 2011.
3. Problem Solving and Program Design in C, Hanly, Koffman, 7th edition, PEARSON 2013.
4. Programming with C by R S Bichkar, Universities Press, 2012.

Other Resources

1. Programming with C", Byron Gottfried, Mcgraw hill Education, Fourteenth reprint,2016

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Introduction to Computer Science and Programming Using C

Course Code	CSE 108L	**Course Category**			**L**	**T**	**P**	**C**
					0	0	1	1
Pre-Requisite Course(s)		**Co-Requisite Course(s)**	CSC 108	**Progressive Course(s)**				
Course Offering Department	CSE	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

- Learn and understand C programming basics and paradigms.
- Acquire knowledge on decision-making and functions in C.
- Acquire knowledge on decision making, loop concept, control statements, arrays, strings and functions using C.
- Learn basics of Structures, Union, and File handling concepts in C.

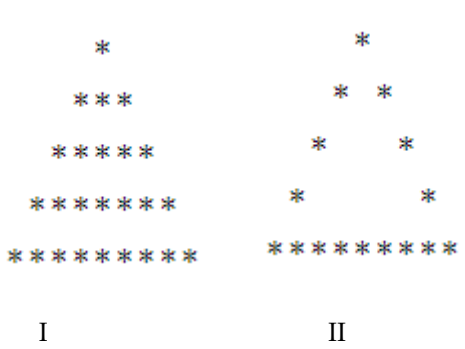
Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	**Bloom's Level**	**Expected Proficiency Percentage**	**Expected Attainment Percentage**
Outcome 1	Describe fundamentals in C, enumerators, datatypes, VA keywords, header files and operators	2	75 %	70%
Outcome 2	Illustrate Decision-Making statements and Functions.	3	70 %	65%
Outcome 3	Interpret arrays, strings, and pointers programming in C	3	70 %	65%
Outcome 4	Apply Structures, unions, File handling operations on different scenarios	3	70 %	65%
Outcome 5	Solve given projects based on C concepts	4	70 %	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	**Program Learning Outcomes (PLO)**														
	Scientific andDisciplinary	Analytical Reasoning and	Critical andReflective	Scientific Reasoning and	Research Related Skills	Modern Toolsand ICT Usage	Environmentand	Moral, Multicultural	Individual andTeamwork	Communication Skills	Leadership Readiness Skills	Self-Directedand Life Long	PSO 1	PSO 2	PSO 3
Outcome 1	2	3	3	3	2				2				3	2	
Outcome 2	2	2	3	3	2				2				2	2	
Outcome 3	2	3	3	2	2				2				2	2	
Outcome 4	3	3	3	3	2				3				2	3	
Outcome 5	2	3	3	3	3				3				2	2	
Average	**2**	**3**	**3**	**3**	**2**				**2**				**2**	**2**	

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	**Lab Experiment 1:** GCC Compiler using Linux, various Linux commands used to edit, compile and executing	2	1	1,2
Unit No. 1	**Lab Experiment 2:** a) Calculation of the area of the triangle. b) Swap two numbers without using a temporary variable. c) Find the roots of a quadratic equation	2	1	1,2
Unit No. 1,2	**Lab Experiment 3:** a) Find the sum of individual digits of a positive integer and find the reverse of the given number. b) Generate the first n terms of Fibonacci sequence. c) Generate all the prime numbers between 1 and n, where n is a value supplied by the user.	2	1,2	1,2
Unit No. 1,2	**Lab Experiment 4:** a) Print the multiplication table of a given number n up to a given value, where n is entered by the user. b) Decimal number to binary conversion. c) Check whether a given number is the Armstrong number or	2	1,2	1,2
Unit No. 1,2	**Lab Experiment 5:** Triangle star patterns  I II	2	1,2	1,2
Unit No. 2,3	**Lab Experiment 6:** **a)** (nCr) and (nPr) of the given numbers $1+x+x^2\backslash 2+x^3\backslash 3!+x^4\backslash 4!+\ldots\ldots\ldots X^n\backslash n!$	2	2,3	1,2
Unit No. 2,3	**Lab Experiment 7: a)** Interchange the largest and smallest numbers in the array. b. Searching an element in an array b. Sorting array elements.	2	2,3	1,2
Unit No. 2,3	**Lab Experiment 8:** a. Transpose of a matrix. b.Addition and multiplication of 2 matrices.	2	2,3	1,2
Unit No. 2,3	**Lab Experiment 9:** a. Function to find both the largest and smallest number of an array of integers. b. Liner search. c. Replace a character of string either from beginning or ending or at a specified location.	2	2,3	1,2
Unit No. 2,3	**Lab Experiment 10:** Pre-processor directives a. If Def b. Undef c. Pragma	1	2,3	1,2
Unit No. 3,4	**Lab Experiment 10:** a. Illustrate call by value and call by reference. b. Reverse a string using pointers Compare two arrays using pointers	2	3, 4	1,2,3
Unit No. 3,4	**Lab Experiment 11:** a. Array of Int and Char Pointers. Array with Malloc(), calloc() and realloc().	2	3, 4	1,2,3
Unit No. 3,4	**Lab Experiment 12:** a. To find the factorial of a given integer.	2	3, 4	1,2,3

	b. To find the GCD (greatest common divisor) of two given integers. c. Towers of Hanoi			
Unit No. 5	**Lab Experiment 13:** a. Reading a complex number b. Writing a complex number. c. Addition of two complex numbers Multiplication of two complex numbers	2	5	2, 3, 4
Unit No. 5	**Lab Experiment 14:** a. File copy b. Word, line and character count in a file.	2	5	2, 3, 4
Total Hours		**29**		

Learning Assessment

Bloom's Level of Cognitive Task		**Continuous Learning Assessments (50%)**		**End Semester Exam (50%)**	
		Lab Record (20%)	**Projects Presentations (30%)**	**Lab Record (20%)**	**Projects Presentations (30%)**
		Practical	Practical	Practical	Practical
Level 1	Remember	70%	60%	30%	40%
	Understand				
Level 2	Apply	30%	40%	70%	60%
	Analyse				
Level 3	Evaluate				
	Create				
Total		**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. The C programming Language by Brian Kernighan and Dennis Richie.
2. Programming in C, Pradip Dey and Manas Ghosh, Second Edition, OXFORD Higher Education, 2011.
3. Problem Solving and Program Design in C, Hanly, Koffman, 7th edition, PEARSON 2013.
4. Programming with C by R S Bichkar, Universities Press, 2012.

Other Resources

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Calculus

Course Code	MAT 113	**Course Category**	Foundation Course (FIC)	**L**	**T**	**P**	**C**
				3	0	0	3
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Mathematics	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

- Develop a comprehensive understanding of the fundamental concepts of calculus, including limits, derivatives, and integrals. Apply calculus techniques to solve a wide range of mathematical problems.
- Utilize calculus to find extreme values of functions and understand the Mean Value Theorem. Apply calculus to analyze monotonic functions, identify inflection points, and sketch curves.
- Apply Lagrange multipliers to solve optimization problems with single constraints.
- Calculate double and iterated integrals over various regions and in polar form. Utilize triple integrals in rectangular coordinates and apply them to real-world scenarios to find volumes, masses, and more.

Course Outcomes / Course Learning Outcomes (CLOs)

CO's	At the end of the course, the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
1	Describe functions and their graphs to identify key characteristics such as domain, range, and behavior.	2	75%	80%
2	Compute derivatives of single-variable functions at specific points and apply various differentiation rules.	3	70%	75%
3	Determine definite and indefinite integrals of functions and their applications.	3	75%	80%
4	Apply calculus techniques to solve practical problems, including finding extreme values of functions. Utilize the Mean Value Theorem to understand the rate of change in real-world applications.	4	72%	75%
5	Analyze double and triple integrals over various regions and apply calculus to real-world problems such as finding volumes, masses, and areas.	4	70%	75%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and	Modern Tool and	Society and Multicultural	Environment nt and	Moral, and Ethical	Individual and	Communication Skills	Project Management	Self- Directed	PSO 1	PSO 2	PSO 3
Outcome 1	2	3		2					3						
Outcome 2	3	2		1					3						
Outcome 3	2	3		1					2						
Outcome 4	3	3		2					3						
Outcome 5	3	2		2					3						
Outcome 6	3	2		2					2						
Course Average	**3**	**3**		**2**					**3**						

Course Unitization Plan

Unit No.	Syllabus Topics	Contact Hours Required	CLOs Addressed	References Used
Unit No. 1	**Unit I: Limit, Continuity, Derivative, and Integrals of Single Variable**	10		
	Functions and Their Graphs,	1	1	1
	Limit of a function at a point and limit laws,	2	1	1
	Continuity of a function,	1	1	1
	Derivative of a function at a point,	2	2	1
	Various rules of Derivative,	1	2	1
	Definite and indefinite integral,	2	3	1
	Fundamental Theorem of Calculus.	1	3	1
Unit No. 2	**Unit II: Applications of Calculus (Single Variable)**	9		
	Extreme Values of Functions	2	4	1
	The Mean Value Theorem, Monotonic Functions	2	4	1
	Concavity and curve sketching	2	4	1
	Newton's Method to find roots	1	4	1
	Area between curves	1	4	1
	Arc length.	1	4	1
Unit No. 3	**Unit III: Limit, Continuity, Partial Derivatives of Multi-Variables Function**	10		
	Three-dimensional rectangular coordinate systems	1	1	1
	Functions of several variables	2	1	1
	Limits and continuity	2	5	1
	Partial Derivatives	1	5	1
	The Chain Rule, Directional Derivatives,	2	5	1
	Gradient.	2	5	1
Unit No. 4	**Unit IV: Extrema of Multi-Variables Function**	6		
	Extreme values	1	4	1
	Saddle points	1	4	1
	Absolute Maxima and Minima on Closed Bounded Regions,	2	4	1
	Lagrange multipliers (Single Constraints).	2	4	1
Unit No. 5	**Unit V: Multiple Integrals**	10		
	Double and Iterated Integrals over Rectangles	2	5	1
	Double Integrals over General Regions.	2	5	1
	Area by Double Integration,	1	5	1
	Double Integrals in Polar Form	1	5	1
	Triple Integrals in Rectangular Coordinates	2	5	1
	Applications.	2	5	1
Total Contact Hours		**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (60%)				End Semester Assessments (40%)
		CLA-1 (15%)	Mid-1 (25%)	CLA-2 (10%)	CLA-3 (10%)	
Level 1	Remember	50%	40%	55%	40%	50%
	Understand					
Level 2	Apply	50%	60%	45%	60%	50%
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Thomas' Calculus, 14th Edition, Joel R. Hass, Christopher E. Heil, Maurice D. Weir, 2018

Other Resources

1. Introduction to Real Analysis, 4th Edition, (2014) – R. Bartle, D. Sherbert, John Wiley and Son
2. Calculus and Analytic Geometry, 9th Edition, George B. Thomas, Jr. Ross L. Finney. 2017

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Principles of Economics

Course Code	ECO 121	**Course Category**	FIC		**L**	**T**	**P**	**C**
					3	0	0	3
Pre-Requisite Course(s)	NA	**Co-Requisite Course(s)**	NA	**Progressive Course(s)**	ECO 121			
Course Offering Department	Economics	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

- To familiarize the students with the basic concept of microeconomics.
- To understand consumer behaviour; how the demand and supply works in market.
- To understand producer behaviour. How producer will behave with limited resources. How cost can be minimised
- To help students understand and apply the various decision tools to understand the market structure.

Course Outcomes / Course Learning Outcomes (CLOs)

CO's	At the end of the course, the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
1	Explain the role of scarcity, specialization, opportunity cost and cost/benefit analysis in economic decision-making.	2	70%	65%
2	Identify the determinants of supply and demand and demonstrate the impact of shifts in both market supply and demand curves on equilibrium price and output.	2	70%	65%
3	Summarize the law of diminishing marginal utility and describe the process of utility maximization	2	70%	65%
4	Describe the production function and the Law of Diminishing Marginal Productivity and calculate and graph short-run and long-run costs of production.	3	70%	65%
5	Identify the four market structures by characteristics and calculate and graph the profit-maximizing price and quantity in the output markets by use of marginal analysis.	4	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	3	2	1							2	3	1	2
Outcome 2	3	3	3	3	2	1			2			2	3	2	2
Outcome 3	3	3	3	2	2				2			2	3	3	2
Outcome 4	3	3	2	3	2	1			3			2	3	2	2
Outcome 5	3	3	3	3	3	1			2			3	3	2	2
Course Average	**3**	**3**	**3**	**3**	**2**	**1**			**2**			**2**	**3**	**2**	**2**

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	**Introduction to Economics**	**9**		
	Introduction and Principles of Economics	2	1	1
	Basic economic problems	2	1	1
	Scope and Method of Economics: Positive and Normative Science	2	1	1
	Scarcity Problems	1		
	Production Possibility Function	1	1	1
	Opportunity Curve	1	1	1
Unit No. 2	**Concepts of Demand and Supply**	**15**		
	Demand and Supply: Determinants of Individual Demand and Supply Schedule	1	2	1
	Demand Curve: Individual and Market	1	2	1
	Shifts in the Demand/Supply Curve, Demand, and Supply Together	1	2	1
	How Prices Allocate Resources	1	2	1
	Elasticity: Meaning, Types and Determinates	2	2	1
	How Prices Allocate Resources	1	2	1
	Elasticity and its application	2	2	1
	Controls on Prices; Taxes and The Costs of Taxation	2	2	1
	Market Equilibrium and Deadweight Loss	2	2	1
	Social Surplus and Market Efficiency	2	2	1
Unit No. 3	**Theory of Consumer Behaviour**	**16**		
	The Consumption Decision	1	2,3	1, 2
	Budget Constraint	1	2,3	
	Shift in Budget Line: Consumption, Income, and Price Effect	2	2,3	1, 2
	Types of Goods: Normal, Inferior and Giffen	1	2,3	1, 2
	Demand for all other Goods and Price Changes;	1	2,3	1, 2
	Indifference Curve: Definition and Properties	2	2,3	1, 2
	Limitation of Indifference Curve	1	2,3	1, 2
	Consumer Equilibrium	1	2,3	1, 2
	Consumer Equilibrium and Change in Price	2	2,3	
	Price Effect: Income and Substitution Effect	2	2,3	1, 3
	Applying Consumer Theory: Labour	2	2,3	1, 3
Unit No. 4	**Theory of Producer Behaviour**	**10**		
	Production Function: Definition and Determinates	1	4	2, 3
	Law of Variable Proportion	1	4	2, 3
	Iso Quant and Iso cost	1	4	2, 3
	Expansion Path and MRTS	1	4	2, 3
	Laws of Return to Scale and Role of Technology.	1	4	2, 3
	Theory of Cost: Introduction	1	4	2, 3
	Types of Cost	1	4	2, 3
	Cost Function and Cost Structure of a Firm in the Short-Run	1	4	2, 3
	Long Run Cost Function and Cost Structure	1	4	2, 3
	Derivation of Long Run Cost Curve	1	4	2, 3
Unit No.	**Market Structure**	**10**		

5	Perfect Competition: Definition, Characteristics, and Examples	1	5	2,3
	Determination of Price and Quantity Under Perfect Competition	1	5	2,3
	Shut-Down and Break-Even Points.	1	5	2,3
	Long Run Equilibrium Under Perfect Competition	1	5	2,3
	Monopoly: Definition and Characteristics	1	5	2,3
	Determinants of Price and Output Under Monopoly	1	5	2,3
	Supply Curve Under Monopoly	1	5	2,3
	Price Discrimination	1	5	2,3
	Monopolistic Competition and Product Differentiation	2	5	2,3
Total Contact Hours		**60**		

Learning Assessment

Bloom's Level of Cognitive Task		**Continuous Learning Assessments (50%)**								**End Semester Exam (50%)**	
		CLA-1 (15%)		**Mid-1 (15%)**		**CLA-2 (10%)**		**CLA-3 (10%)**			
		Th	**Prac**	**Th**	**Prac**	**Th**	**Prac**	**Th**	**Prac**	**Th**	**Prac**
Level 1	Remember	40%		90%		40%		80%		70%	
	Understand										
Level 2	Apply	60%		10%		60%		20%		30%	
	Analyse										
Level 3	Evaluate										
	Create										
Total		**100%**		**100%**		**100%**		**100%**		**100%**	

Recommended Resources

1. Principles of microeconomics, N. Gregory Mankiw, Publisher: Cengage Learning fifth edition,
2. Principles of Economics, Case Karl E, Fair Ray C; Oster Sharon M , Publisher: Pearson tenth edition
3. Modern Microeconomics, Koutsoyiannis, 2nd Edition,
4. Rittenberg, Libby, and Timothy Tregarthen. Principles of Microeconomics, 2009.

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Probability and Statistics for Engineers

Course Code	MAT 221	Course Category	FIC		L	T	P	C
Pre-Requisite Course(s)	NA	Co-Requisite Course(s)	NA	Progressive Course(s)	NA			
Course Offering Department	Mathematics	Professional / Licensing Standards						

Course Objectives / Course Learning Rationales (CLRs)

- After this course, students should be able to understand the compute basic probabilities, formulate a problem using random variables, analyze sample data for possible conclusions about population.
- After taking this course, students will be able to use calculators and tables to perform simple statistical analyses for small samples and use popular statistics packages, such as SAS, SPSS, S- Plus, R or Matlab, to perform simple and sophisticated analyses for large samples.
- Students who are interested in becoming statisticians themselves can build a solid foundation in probability and statistics through this course but should plan on additional coursework for thorough and comprehensive preparation.

Course Outcomes / Course Learning Outcomes (CLOs)

CO's	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
1	Able to understand the basic knowledge on fundamental probability concepts, including random variable, probability of an event, additive rules and conditional probability Bayes' theorem S understand the basic statistical concepts and measures	Understand	70%	75%
2	Able to develop the concept of the central limit theorem understand several well-known distributions, including, Geometrical, Negative Binomial, Pascal, Normal and Exponential Distribution	Develop	70%	73%
3	Able to apply the central limit theorem to sampling distribution use estimation technique to determine point estimates confidence interval and sample size.	Apply	75%	80%
4	Able to implement the analyses in SAS, S-PLUS, R or MATLAB	Analyse	70%	70%
5	Able to appreciate the diversity of the applications of central limit theorem. Able to appreciate the diversity of the applications of hypothesis testing	Apply	70%	72%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary	Analytical Reasoning and	Critical and Reflective Thinking	Scientific Reasoning and Design	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	3	2	1							2	3	1	2
Outcome 2	3	3	3	3	2	1			2			2	3	2	2
Outcome 3	3	3	3	2	2				2			2	3	3	2
Outcome 4	3	3	2	3	2	1			3			2	3	2	2
Outcome 5	3	3	3	3	3	1			2			3	3	2	2
Course Average	**3**	**3**	**3**	**3**	**2**	**1**			**2**			**2**	**3**	**2**	**2**

Course Unitization Plan

Unit No.	Syllabus Topics	Contact hours	CLOs Addressed	Reference
Unit No. 1	**Introduction to Probability**	**7**		
	Basic principle of counting, multinomial coefficient	1	C	1
	Axioms of probability, computing probabilities - unions, intersections, and Inclusion-exclusion principle	2	C	1
	Conditional probability, Independent events	2	C	1
	Bayes' theorem, law of total probability	2	C	1
Unit No. 2	**Random variables and distributions**	**12**		
	Random variables, cumulative distribution function	1	C	1
	Discrete random variables	1	C	1
	Cumulative distribution function and its properties	1	C	1
	Expectation, variance and standard deviation of discrete random variables, conditional expectation	1	C	1
	Bernoulli and binomial distributions, their expectations and variances	1	C	1
	Poisson, geometric and negative binomial distrib their expectations and variances	1	C	1
	Continuous random variables	1	C	1
	Expectation and variance, Conditional expectation	2	C	1
	Uniform and exponential distributions	1	C	1
	Normal distribution , Student's t-distribution	2	C	1
Unit No. 3	**Joint probability distributions and CLT**	**8**		
	Joint distribution of two random variables - discrete and continuous	2	C	1
	Change of variables under integration (Determinant of Jacobian), Independent random variables and their sum,	3	C	1
	Central limit theorem	1	C	1
	Covariance and correlation between random varia	2	C	1
Unit No. 4	**Descriptive statistics and linear regression**	**8**		
	Graphical representation of data -Histograms, scatter plots & time plots	1	C	1
	Descriptive statistics	2	C	2,3
	Correlation – Pearson's correlation coefficient	2	C	2,3
	Linear regression, Goodness of fit, Normal equations for least-squares regression,	3	C	2,3
Unit No. 5	**Introduction to statistical inference**	**10**		
	Population, sample and statistics	2	C	2,3
	Point estimation of population parameters	1	C	2,3
	Confidence intervals for population mean, and population proportion	2	C	2,3
	P-values, Significance level, Tests of significance for population mean, population proportion.	3	C	2,3
	Types of errors, contingency table, sensitivity, specificity, power of a test.	2	C	2,3

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (60%)				End Semester Assessments (40%)
		CLA-1 (15%)	Mid-1 (25%)	CLA-2 (10%)	CLA-3 (10%)	
Level 1	Remember	30%	40%	40%	20%	40%
	Understand					
Level 2	Apply	40%	30%	30%	40%	30%
	Analyse					
Level 3	Evaluate	30%	30%	30%	30%	30%
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. S. Ross, A First course in probability, Pearson Education; Ninth edition (2018)
2. M. Baron, Probability and Statistics for computer scientists, Chapman and Hall/CRC; First edition (2006)
3. Douglas C. Montgomery, George C. Runger, Applied Statistics and Probability for Engineers, Wiley; Sixth edition (2016)

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Introductory Biology for Engineers

Course Code	BIO 103	**Course Category**	FIC	**L**	**T**	**P**	**C**
				2	0	0	2
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	Department of Biological Sciences	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

- To understand the importance of Biological Sciences
- To understand the biomolecules and their importance in biological systems.
- To understand the structure and function of prokaryotic and eukaryotic cells, as whole entities and in terms of their subcellular processes including the molecular biology of cells.
- To understand the importance of bioinformatics in biological sciences research

Course Outcomes / Course Learning Outcomes (CLOs)

CO's	At the end of the course, the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
1	Explain the importance of biology in everyday life.	2	80%	75%
2	Describe the evolution of life forms and the importance of biomolecules in living systems	2	80%	65%
3	Explain the structure of different types of cells and cellular respiration, photosynthesis.	2	70%	65%
4	Describe the molecular biology of cells and the process of cell division	2	70%	65%
5	Discuss the use of bioinformatics tools for analysis of DNA and proteins.	2	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and ICT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1		2	3	3	1		3	3	3	3		2			
Outcome 2		2	3	3	2		3		1			2			
Outcome 3		2	3	3	3		3		1			2			
Outcome 4		2	3	3	3		3		1			2			
Outcome 5		2	3	3	3		2		2			3			
Course Average		**2**	**3**	**3**	**2**		**3**	**3**	**2**	**3**		**2**			

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References
Unit No. 1	**Biomolecules**	**6**		
	Why study Biology?	1	1	1, 2, 3
	Evolution of complex biomolecules	1	1, 2	1, 2, 3
	Life on earth	1	1, 2	1, 2, 3
	Biomolecules - carbohydrates	1	1, 2	1, 2, 3
	Biomolecules – lipids and fats	1	1, 2	1, 2, 3
	Biomolecules – nucleic acids and proteins	1	1, 2	1, 2, 3
Unit No. 2	**Cell Biology**	**6**		
	Prokaryotic cell structure	2	1, 2, 3	1, 2, 3
	Eukaryotic cell (Animal and Plant) - structure and functions of organelles	2	1, 2, 3	1, 2, 3
	Diversity of life: virus, bacteria, archaea and eukarya	2	1,2,3	1, 2, 3
Unit No. 3	**Cell Physiology**	**6**		
	Membrane transport	1	2,3,4	1, 2, 3
	Cellular respiration and energy generation	2	2,3,4	1, 2, 3
	Brief account of Photosynthesis	1	2,3,4	1, 2, 3
	Enzymes and their kinetics	1	2,3,4	1, 2, 3
	Vitamins, Hormones	1	2,3,4	1, 2, 3
Unit No. 4	**Molecular Biology**	**6**		
	DNA and Chromosomes: structure and organization	1	2,3	1, 2, 3
	Central Dogma- DNA replication, transcription and translation	2	2,3	1, 2, 3
	Cell division – mitosis and meiosis	1	2,3	1, 2, 3
	Mutations, Cancer, and genetic diseases.	2	2,3	1, 2, 3
Unit No. 5	**Biological Sequences and Databases**	**6**		
	Concept of genomics, transcriptomics, proteomics, and metabolomics	1	2,3,5	4
	FASTA file format	1	2,3,5	4
	Biological databases – NCBI	1	2,3,5	4
	Applications of BLAST and protein/Gene ID conversion	1	2,3,5	4
	Hands on experience in analyzing biological data using above mentioned tools	2	2,3,5	4
Total Contact Hours		**30**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)				End Semester Exam (50%)
		CLA-1 (10%)	Mid-1 (15%)	CLA-2 (10%)	CLA-3 (15%)	
Level 1	Remember	100%	100%	100%	100%	100%
	Understand					
Level 2	Apply					
	Analyse					
Level 3	Evaluate					
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Thrives in Biochemistry and Molecular Biology, Edition 1, 2014, Cox, Harris, Pears, Oxford University Press.
2. Thrives in Cell Biology, Ed. 1, 2013, Qiuyu Wang, Chris Smith and Davis, Oxford University Press.
3. iGenetics: A Molecular Approach by Peter J Russell, 3rd edition, Pearson International Edition.
4. Bioinformatics Introduction – Mark Gerstein.

Other Resources

1. The Physiological Society (https://www.youtube.com/user/PhysocTV)

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Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Data Structures

Course Code	CSE 107	**Course Category**	SEC		**L**	**T**	**P**	**C**
					3	0	0	3
Pre-Requisite Course(s)		**Co-Requisite Course(s)**	CSC 107 L	**Progressive Course(s)**				
Course Offering Department	CSE	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

- To understand the basic concepts such as abstract data types, linear and non-linear data structures.
- To understand the behaviour of data structures such as arrays, linked lists, stacks, queues, trees, hash tables, search trees, graphs, and their representations.
- To provide an independent view of data structures, including its representation and operations performed on them, which are then linked to sorting, searching and indexing methods to increase the knowledge of usage of data structures in an algorithmic perspective.
- To choose an appropriate data structure for a specified application.

Course Outcomes / Course Learning Outcomes (CLOs)

CO's	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
1	Compare and contrast the algorithms for linked list, stack and queue operations.	4	77%	70%
2	Illustrate algorithms for Binary Search Trees and AVL Trees.	4	75%	70%
3	Analyze Graph traversal and minimum cost spanning tree algorithms.	4	72%	70%
4	Distinguish searching and sorting techniques.	3	78%	80%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)													
	Scientific andDisciplinary	Analytical Reasoning and	Critical andReflective	Scientific Reasoning and	Research Related Skills	Modern Toolsand ICT Usage	Environmentand	Moral, Multicultural	Individual andTeamwork	Communication Skills	Leadership Readiness Skills	Self-Directedand Life Long	PSO 1	PSO 2	PSO 3
Outcome 1	2	3	3	3	2				2				3	2	
Outcome 2	2	2	3	3	2				2				2	2	
Outcome 3	2	3	3	2	2				2				2	2	
Outcome 4	3	3	3	3	2				3				2	3	
Outcome 5	2	3	3	3	3				3				2	2	
Course Average	**2**	**3**	**3**	**3**	**2**				**2**				**2**	**2**	

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	**Introduction to Data Structures**	**9**		
	Abstract Data Type (ADT), Time and space requirements of algorithms	2	1	1
	Array ADT, Representing polynomials	1	1	1,2
	Sparse matrix using arrays and its operations	1	1	1
	Stacks: representation and application, implementation of stack operations using C.	1	1	1
	Example applications on Stacks	1	1	
	Queues: representation and application, implementation of queue operations using C.	1	1	1,2
	Example applications on Queues	2	1	1,2
Unit No. 2	**Linked lists**	**8**		
	Linked lists: Single linked lists representation	1	1	1,2
	Implementation of linked list various operation using C	3	1	1
	Doubly linked list representation and Implementation of doubly linked list various operation using C	2	1	5
	Implementation of Circular linked list various operation using C	2	1	4,5
Unit No. 3	**Trees**	**10**		
	Tree terminology	1	2	1
	Binary tree, Representation of Binary Trees using Arrays and Linked lists	1	2	1
	Binary search tree	1	2	1
	Binary Search Trees- Basic Concepts, BST Operations: Insertion, Deletion	2	2	1
	Tree Traversals, Construction of tree using traversals	2	2	
	Applications, Expression tree	1	2	1
	General tree	1	2	1
	Heap Sort, Balanced Binary Trees, AVL Trees, Insertion, Deletion and Rotations.	1	2	1
Unit No. 4	**Graphs**	**9**		
	Graph terminology, Representation of graphs, path matrix	1	3	3
	BFS (breadth first search)	1	3	3
	DFS (depth first search)	2	3	3
	Topological sorting	1	3	3
	Priority Queues: Heap structures	1	3	5
	Binomial heaps, leftist heaps	1	3	2
	Shortest path algorithms.	1	3	2
	Implementation of shortest path algorithm using C	1	3	2
Unit No. 5	**Sorting and Searching techniques**	**9**		
	Bubble sort,selection sort and their algorithm analysis	1	4	2
	Insertion sort and its algorithm analysis	1	4	2
	Quick sort and its algorithm analysis	1	4	2,3
	Merge sort and its algorithm analysis	1	4	3
	Heap sort and its algorithm analysis	1	4	3
	Radix sort and its algorithm analysis	1	4	5
	Linear and binary search methods and its algorithm analysis.	2	4	5
	Hashing techniques and hash functions	1	4	5

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)				End Semester Exam (50%)	
		Theory (30%)					
		CLA-1 (5%)	Mid-1 (20%)	CLA-2 (5%)	Mid-2 (20%)	Th	Pr
Level 1	Remember	40%	40%	40%	40%	40%	
	Understand						
Level 2	Apply	40%	40%	40%	40%	40%	
	Analyse						
Level 3	Evaluate	20%	20%	20%	20%	20%	
	Create						
Total		**100%**	**100%**	**100%**	**100%**	**100%**	

Recommended Resources

1. "Data structure using C", Aaron M. Tenenbaum, Y Langsam and Mosche J. Augenstein, Pearson publication.
2. "Data structures and Algorithm Analysis in C", Mark Allen Weiss, Pearson publications, Second Edition.
3. "Fundamentals of data structure in C" Horowitz, Sahani & Anderson Freed, Computer Science Press.
4. "Fundamental of Data Structures", (Schaums Series) Tata-McGraw-Hill.
5. "Data Structures and Algorithms: Concepts, Techniques & Algorithm" G.A.V.Pai: Tata McGraw Hill.
6. "Data Structures and Program Design in C" Robert Kruse, C L Tondo, Bruce Leung and Shashi Mogalla. For pseudocode

Other Resources

1. "Programming with C", Byron Gottfried, Mcgraw hill Education, Fourteenth reprint,2016
2. "Programming in C". P. Dey and M Ghosh, Second Edition, Oxford University Press.

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Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Data Structures Lab

Course Code	CSE 107L	**Course Category**	SEC		**L**	**T**	**P**	**C**
					0	0	2	2
Pre-Requisite Course(s)		**Co-Requisite Course(s)**	CSC 107 L	**Progressive Course(s)**				
Course Offering Department	CSE	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

- To understand the basic concepts such as abstract data types, linear and non-linear data structures.
- To understand the behaviour of data structures such as arrays, linked lists, stacks, queues, trees, hash tables, search trees, graphs, and their representations.
- To provide an independent view of data structures, including its representation and operations performed on them, which are then linked to sorting, searching and indexing methods to increase the knowledge of usage of data structures in an algorithmic perspective.
- To choose an appropriate data structure for a specified application.

Course Outcomes / Course Learning Outcomes (CLOs)

CO's	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
1	Compare and contrast the algorithms for linked list, stack and queue operations.	4	77%	70%
2	Illustrate algorithms for Binary Search Trees and AVL Trees.	4	75%	70%
3	Analyze Graph traversal and minimum cost spanning tree algorithms.	4	72%	70%
4	Distinguish searching and sorting techniques.	3	78%	80%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary	Analytical Reasoning and	Critical andReflective	Scientific Reasoning and	Research Related Skills	Modern Toolsand ICT Usage	Environmentand	Moral, Multicultural	Individual andTeamwork	Communication Skills	Leadership Readiness Skills	Self-Directedand Life Long	PSO 1	PSO 2	PSO 3
Outcome 1	2	3	3	3	2				2				3	2	
Outcome 2	2	2	3	3	2				2				2	2	
Outcome 3	2	3	3	2	2				2				2	2	
Outcome 4	3	3	3	3	2				3				2	3	
Outcome 5	2	3	3	3	3				3				2	2	
Course Average	**2**	**3**	**3**	**3**	**2**				**2**				**2**	**2**	

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Conversion of infix expression to postfix expression Evaluation of expressions.	**2**	1	1,6
Unit No. 1	Tower of Hanoi is a mathematical puzzle where we have three rods and n disks. The objective of the puzzle is to move the entire stack to another rod, obeying the following simple rules: .Only one disk can be moved at a time. .Each move consists of taking the upper disk from one of the stacks and placing it on top of another stack i.e. a disk can only be moved if it is the uppermost disk on a stack. .No disk may be placed on top of a smaller disk .You can choose to use the function ***move (4, 1, 3, 2)***, *w*here 4 represents the number of disks. 1 represents disks on source shaft, 3 represents the destination shaft which holds the disks after the move and finally 2 represents the intermediate support shaft – temporary storage. Write a C program to simulate the given problem and: Perform the algorithmic complexity analysis for the solution you propose.	2	1	1,6
Unit No. 1	Implementation the following operations: enqueue, dequeue and finding an element: .Linear Queue using arrays .Circular queue arrays .Priority queue singly linked list.	2	1	1,6
Unit No. 1	The "*4-Queens Problem*" consists of placing four queens on a 4 x 4 chessboard so that no two queens can capture each other. That is, no two queens are allowed to be placed on the same row, the same column or the same diagonal (both primary and secondary diagonals). Write a C program to simulate the given problem and perform the algorithmic complexity analysis for the solution you propose.	2	1	1,6
Unit No. 1	Create a singly linked list and perform the following operations: .Add an element at the end of the list .Delete an element from the beginning of the list .Find the middle element of the list .Search the given key form the list .Polynomial addition using linked list .Sparse matrix operations using linked list	**2**	1	1,6
Unit No. 1	Let us consider a small but busy airport with only one run-way (shown in figure). In each time unit, one plane can land or one plane can take off, but not both. Planes arrive ready to land or to take off at random times, so at any given unit of time, the runway may be idle or a plan may be landing or taking off, and there may be several planes waiting either to land or take off. We therefore need two queues, called *landing* and *takeoff*, to hold these planes. It is better to keep a plane waiting on the ground than in the air, so a small airport allows a plane to take off only if there are no planes waiting to land. Hence, after receiving requests from new planes to land or take off, our simulation will first service the head of the queue of planes waiting to land, and only if the landing queue is empty will it allow a plane to take off. We shall wish to run the simulation through many units of time, and therefore, we embed the main action of the program in a loop that runs for cur-time (denoting current time) from 1 to a variable end-time. Simulate the given scenario using and write the output for different inputs.	2	1	1,6
Unit No. 2	Develop a code to test whether the given tree is binary tree or not. . Implementation of Binary tree traversals techniques – pre-order, in-order, and post-order.	**2**	2	5

	. Implementation of AVL tree and its operations			
Unit No. 2	Given a mathematical expression, evaluate it using appropriate tree structure.	2	2	5
Unit No. 3	Write a C program for implementation of Graph traversals techniques (BFS and DFS).	2	3	1,6
Unit No. 3	The **Dijkstra's algorithm** is an algorithm that gives the shortest path between two given vertices of a graph. In this problem we are given a directed graph with each edge having a non-negative weight. Thus, a solution requires a path of many other that costs least. We can think of the problem as like this: think graph G as a map of the airline routes, each node of the graph as the cities and the weights on each edge as the cost of flying from one city to another city. The solution we have to find a routing from a city v to city w such that the total cost is minimum. Write a C program to simulate the given problem. That is find the shortest path between node A and node F in the given graph.	**2**	3	1,6
Unit No. 4	Write a C program for Linear search and Binary search algorithms. What is the best case and worst-case time complexity of those searching algorithms?	2	4	2
Unit No. 4	Write a C program for bubble sort algorithm. What is the best case and worst-case time complexity of Bubble sort algorithm? Write a C program for Selection sort algorithm. What is the worst case or average case time complexity of selection sort algorithm?	2	4	2
Unit No. 4	Write a C program for Insertion sort algorithm. What is the worst case or average case time complexity of Insertion sort algorithm?	2	4	2
Unit No. 4	Write a C program for Quick sort algorithm. What is the worst case or average case time complexity of Quick sort algorithm?	2	4	3
Unit No. 4	Write a C program for Merge sort algorithm. What is the worst case or average case time complexity of Merge sort algorithm?	2	4	3
Total Contact Hours		**30**		

Learning Assessment

Bloom's Level of Cognitive Task		**Continuous Learning Assessments (20%)**	**End Semester Exam (20%)**
Level 1	Remember	50%	60%
	Understand		
Level 2	Apply	50%	40%
	Analyse		
Level 3	Evaluate		
	Create		
Total		**100%**	**100%**

Recommended Resources

1. Tenenbaum, A. M. (1990). Data structures using C. Pearson Education India.
2. Mark, A. W. (1992). Data structures and algorithm analysis in C.
3. Anderson-Freed, S., Horowitz, E., & Sahni, S. (2007). Fundamentals of Data Structures in C.
4. Lipschutz, (2002) "Data Structures", Schaum's outline series, Tata McGraw Hill Edition
5. Pai, G. V. (2008). Data Structures and Algorithms. Tata McGraw-Hill.
6. Kruse, R., & Tondo, C. L. (2007). Data structures and program design in C. Pearson Education India.

Other Resources

1. Gottfried, B. (2016) Programming with C Mcgraw hill Education, Fourteenth reprint
2. Dey, P. and Ghosh, M. (2012) Programming in C Second Edition, Oxford University Press.

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Basic Electrical and Electronics Engineering

Course Code	EEE 103	**Course Category**	Core	**L**	**T**	**P**	**C**
				3	0	0	3
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**	Circuit Theory		
Course Offering Department	EEE	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

- To provide the basic idea of electrical and electronic circuits.
- Describe the laws and concepts of electrical circuits.
- Discuss the network theorems under DC Excitation
- Conduct Steady State Analysis of Pure R, L, C Circuits, RL, RC and RLC circuits under single-phase AC Excitation.
- Understand the basic semiconductor devices, analog circuits and applications.

Course Outcomes / Course Learning Outcomes (CLOs)

CO's	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
1	Describe the application of electrical engineering in daily life	2	70%	70%
2	Discuss the laws and concepts of electrical circuits.	2	70%	70%
3	Apply the network theorems under DC Excitation	3	70%	70%
4	Conduct Steady State Analysis of Pure R, L, C Circuits, RL, RC and RLC circuits under single-phase AC Excitation.	2	70%	70%
5	Describe the basic semiconductor devices and applications.	2	60%	60%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and ICT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3		1		2				1	1		2	2	1	
Outcome 2	3	3	1		2				1	1		2	2	1	
Outcome 3	3	3	1		2				1	1		2	2	1	
Outcome 4	3	3	1		2				1	1		2	1	1	
Outcome 5	3	3	1		2				1	1		2	2	1	
Course Average	**3**	**2**	**1**		**2**				**1**	**1**		**2**	**2**	**1**	

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	**Basic Circuit Analysis**	**8**		
	Ohm's law, Kirchhoff's laws, Concept of Node, Path, Loop, Branch, Mesh	2	1, 2	1, 2
	Voltage and Current Division, Ideal and Practical Voltage and Current Source, Source transformations	2	1, 2	1, 2
	Nodal Analysis and Super node - Presence of independent voltage and current sources.	2	1, 2	1, 2
	Mesh Analysis and Super mesh - Presence of independent voltage and current sources. Illustrative examples.	2	1, 2	1, 2
Unit No. 2	**Network Theorems with DC Source**	**6**		
	Introduction to Network Theorems and Techniques, Superposition Theorem	1	1, 3	1, 2
	Thevenin's Theorem	2	1, 3	1, 2
	Norton's Theorem	1	1, 3	1, 2
	Maximum Power Transfer Theorem, Illustrative examples.	2	1, 3	1, 2
Unit No. 3	**Single-Phase AC Circuits**	**11**		
	Basic Concepts Related to Generation of Sinusoidal AC Voltage. Definition and Numerical values of Average Value, Root Mean Square Value, Form Factor and Peak Factor for sinusoidal varying quantities	2	1, 4	1, 2
	Steady State Analysis of Pure R, L, C Circuits.	2	1, 4	1, 2
	Steady State Analysis of RL, RC and RLC Series Circuits with Phasor Diagrams	5	1, 4	1, 2
	Definitions of Real Power, Reactive Power, Apparent Power, and Power Factor. Concepts of Resonance Illustrative examples.	2	1, 4	1, 2
Unit No. 4	**Semiconductor Devices and Circuits**	**12**		
	PN junction diode structure	1	1, 5	1, 2
	Forward and reverse bias operation and characteristics of PN junction diode	1	1, 5	1, 2
	Half-wave, full wave, bridge rectifiers, clipping circuits using PN junction diode	2	1, 5	1, 2
	Bipolar junction transistors (BJTs) structure and operation	2	1, 5	1, 2
	common-base, common-collector, and common- emitter configurations using BJTs	6	1, 5	1,2
Unit No. 5	**Basic Analog Circuits and Applications**	**8**		
	Characteristics of an operational amplifier and Definitions of characteristics	3	1, 5	1, 2
	Inverting and non-inverting op-amps, summing amplifier, Difference amplifier, Integrator and differentiator design using op-amp	3	1, 5	1, 2
	Op Amp Applications as Voltage to Current Converter and Current to Voltage converters, filters	2	1, 5	1, 2
Total Contact Hours		**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)					End Semester Exam (50%)	
		Theory (30%)				Practical (20%)		
		CLA-1 (5%)	Mid-1 (10%)	CLA-2 (5%)	Mid-2 (10%)	Internal	Th	Prac
Level 1	Remember	70%	60%	50%	40%	50%	30%	30%
	Understand							
Level 2	Apply	30%	40%	50%	60%	50%	70%	70%
	Analyse							
Level 3	Evaluate							
	Create							
Total		**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. William H Hayt, J E Kemmerly and Steven M Durbin, "Engineering Circuit Analysis", McGraw Hill, 8th Edition, 2011.
2. Abhijit Chakrabarti, "Circuit Theory Analysis and Synthesis", Dhanpat Rai & Co. 7th Edition, 2017.

Other Resources

1. Electrical Engineering Fundamentals, Vincent Del Toro, Second Edition, PHI
2. Fundamentals of Electrical Engineering, Second edition, Leonard S. Bobrow, Oxford University press, 2011
3. Introduction to Electric Circuits, Richard C. Dorf and James A. Svoboda, Wiley India Private Limited, Sixth Edition, 2007
4. Fundamentals of Electric Circuits, Charles K. Alexander and Matthew N.O. Sadiku, McGraw Hill Higher Education, Third Edition, 2005
5. Introductory Circuit Analysis, Robert L. Boylestad, Twelfth edition, Pearson, 2012.
6. Charles K. Alexander and Matthew N.O. Sadiku, "Fundamentals of Electric Circuits", McGraw Hill Higher Education, Third Edition, 2005.

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Basic Electrical and Electronics Engineering

Course Code	EEE 103L	**Course Category**	Core		**L**	**T**	**P**	**C**
					0	0	1	1
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**	Circuit Theory			
Course Offering Department	EEE	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

- To provide the basic idea of electrical and electronic circuits.
- Describe the laws and concepts of electrical circuits.
- Discuss the network theorems under DC Excitation
- Conduct Steady State Analysis of Pure R, L, C Circuits, RL, RC and RLC circuits under single-phase AC Excitation.
- Understand the basic semiconductor devices, analogue circuits and applications.

Course Outcomes / Course Learning Outcomes (CLOs)

CO's	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
1	Describe the application of electrical engineering in daily life	2	70%	70%
2	Discuss the laws and concepts of electrical circuits.	2	70%	70%
3	Apply the network theorems under DC Excitation	3	70%	70%
4	Conduct Steady State Analysis of Pure R, L, C Circuits, RL, RC and RLC circuits under single-phase AC Excitation.	2	70%	70%
5	Describe the basic semiconductor devices and applications.	2	60%	60%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and ICT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3		1		2				1	1		2	2	1	
Outcome 2	3	3	1		2				1	1		2	2	1	
Outcome 3	3	3	1		2				1	1		2	2	1	
Outcome 4	3	3	1		2				1	1		2	1	1	
Outcome 5	3	3	1		2				1	1		2	2	1	
Course Average	**3**	**2**	**1**		**2**				**1**	**1**		**2**	**2**	**1**	

Course Unitization Plan - Laboratory

Unit No.	Name of Experiment	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1, 2	Verification of Ohm's Law	3	1,2	1, 2
Unit No. 1, 2	Verification of Kirchoff's Law	3	1,2	1, 2
Unit No. 1,3	Verification of Superposition theorem	3	1,3	1, 2
Unit No. 1,3	Verification of Thevenin's and Norton's theorem	3	1,3	1, 2
Unit No. 1,3	Verification of Maximum Power transfer theorem.	3	1,3	1, 2
Unit No. 1,5	P-N junction diode I-V characteristics	3	1,5	1, 2
Unit No. 1,5	Application of P-N junction diode	3	1,5	1, 2
Unit No. 1,5	BJT I-V characteristics (I/P and O/P)	3	1,5	1, 2
Unit No. 1,5	Op-Amp Inverting and Non-inverting mode - Gain verification	3	1,5	1, 2
Unit No. 1,5	Verification of truth tables of basic logic gates	3	1,5	1, 2
Total Contact Hours		**30**		

Learning Assessment

Bloom's Level of Cognitive Task		**Experiments (20%)**	**Record/ Observation Note (10%)**	**Viva Voce + Model examination (20%)**	**End Semester Exam (50%)**
Level 1	Remember	30%	60%	30%	30%
	Understand				
Level 2	Apply	70%	40%	70%	70%
	Analyse				
Level 3	Evaluate				
	Create				
Total		**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. William H Hayt, J E Kemmerly and Steven M Durbin, "Engineering Circuit Analysis", McGraw Hill, 8th Edition, 2011.
2. Abhijit Chakrabarti, "Circuit Theory Analysis and Synthesis", Dhanpat Rai & Co. 7th Edition, 2017.

Other Resources

1. Electrical Engineering Fundamentals, Vincent Del Toro, Second Edition, PHI
2. Fundamentals of Electrical Engineering, Second edition, Leonard S. Bobrow, Oxford University press, 2011
3. Introduction to Electric Circuits, Richard C. Dorf and James A. Svoboda, Wiley India Private Limited, Sixth Edition, 2007
4. Fundamentals of Electric Circuits, Charles K. Alexander and Matthew N.O. Sadiku, McGraw Hill Higher Education, Third Edition, 2005
5. Introductory Circuit Analysis, Robert L. Boylestad, Twelfth edition, Pearson, 2012.
6. Charles K. Alexander and Matthew N.O. Sadiku, "Fundamentals of Electric Circuits", McGraw Hill Higher Education, Third Edition, 2005.

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Linear Algebra

Course Code	MAT 211	**Course Category**	FIC	**L**	**T**	**P**	**C**
				3	0	0	3
Pre-Requisite Course(s)	MAT 111	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	MATHEMATICS	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

- To make students understand the central ideas of linear algebra like solving linear equations performing matrix algebra, calculating determinants, and finding eigenvalues and eigenvectors.
- Equip the student with various solution techniques and modeling of linear and non-linear first and second-order differential equations, including systems of equations.

Course Outcomes / Course Learning Outcomes (CLOs)

CO's	At the end of the course, learners will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
1	Use the systems of linear equations for solving given problems in science and engineering.	2	80%	70%
2	Demonstrate the procedures of solving linear equations.	3	80%	70%
3	Performing matrix algebra, calculating determinants, finding eigenvalues and eigenvectors.	3	80%	70%
4	Demonstrate the qualitative nature of system of differential equations using matrix algebra.	3	70%	70%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design, and Research	Modern Tool and ICT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	2	3	2	2											
Outcome 2	2	3	2	2											
Outcome 3	2	3	2	2											
Outcome 4	3	3	3	3											
Course Average	**2**	**3**	**2**	**2**											

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	**Matrices and Gaussian elimination**	**10**		
	Introduction, Geometry of Linear Equations	1	1	1
	Gaussian Elimination	2	1,2	1
	Matrix Notation and Matrix Multiplication	2	2	1
	Triangular Factors and Row Exchanges	3	1,2	1
	Inverses and Transposes	2	3, 4	1
Unit No. 2	**Vector spaces**	**9**		
	Vector spaces and Subspaces	1	1,2	1
	Solving $Ax = 0$ and $Ax = b$	2	1,2	1
	Linear Independence, Basis and Dimension	2	1,2	1
	The Four Fundamental Subspaces	2	1,2	1
	Graphs and Networks, Linear Transformations	2	2	1,2
Unit No. 3	**Orthogonality**	**8**		
	Orthogonal Vectors and Subspaces	1	1,2	1
	Cosines and Projections onto Lines	2	,2,3	1
	Projections and Least Squares	3	2	1,2
	Orthogonal Bases and Gram-Schmidt	2	1,3	1,2
Unit No. 4	**Determinants**	**8**		
	Introduction	1	3	1
	Properties of the Determinant	2	1,3	1
	Formulas for the Determinant	2	1,3	1
	Applications of Determinants	3	1,3	1,2
Unit No. 5	**Eigenvalues and eigenvectors**	**10**		
	Introduction, Diagonalization of a Matrix	3	3	1,2
	Difference Equations and Powers A^k	2	3	1,2
	Differential Equations and e^{tA} and phase portrait	3	3,4	1,2
	Complex Matrices, Similarity Transformations	2	3	1,2
Total Contact Hours		**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (50%)	
		CLA-1 (10%)		Mid-1 (15%)		CLA-2 (10%)		Mid-2 (15%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	50%		60%		40%		60%		50%	
	Understand										
Level 2	Apply	50%		40%		60%		40%		50%	
	Analyse										
Level 3	Evaluate										
	Create										
Total		**100%**		**100%**		**100%**		**100%**		**100%**	

Recommended Resources

1. Gilbert Strang, Linear Algebra and Its applications, Nelson Engineering, 4th Edn., 2007
2. S. Axler, Linear Algebra Done Right, 2nd Edn., UTM, Springer, Indian edition, 2010.

Other Resources

1. K. Hoffman and R. Kunze, Linear Algebra, Prentice Hall of India, 1996

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Industry Specific Employability Skills -II

Course Code	ISES 102	Course Category	SEC		L	T	P	C
					3	0	0	1
Pre-Requisite Course(s)	ISES 101	Co-Requisite Course(s)		Progressive Course(s)	ISES 211			
Course Offering Department	Mathematics	Professional / Licensing Standards						

Course Objectives / Course Learning Rationales (CLRs)

- To develop aptitude skills.
- Develop the ability to solve logical problems.
- To develop self-awareness and understand his emotions.
- Build vocabulary through methodical approaches and nurture a passion for learningnew words.
- Develop an ability to function on multidisciplinary teams.

Course Outcomes / Course Learning Outcomes (CLOs)

Co's	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
1	Solve the basic mathematical problems.	3	90%	80%
2	Demonstrate the ability in solving the logicalreasoning problems.	3	70%	80%
3	Analyse the given data and interpret the information.	4	70%	60%
4	Use the techniques in solving the problems related todata analysis and interpretation.	3	80%	70%
5	Use emotional intelligence in developing interpersonal relations.	3	70%	60%
6	Memorise grammatic rules for making flawless useof language.	1	80%	90%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and ICT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1												2			
Outcome 2		2		1											
Outcome 3		3		2	2										
Outcome 4			2	3	1							2			
Outcome 5								2	3	2		2			
Outcome 6										3					
Course Average		**3**	**1**	**3**				**1**	**2**	**3**		**2**			

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	**Quantitative Aptitude**	**9**		
	Average	1	1,2	2,4
	Alligation or Mixture	1	1,2	2,4
	Ratio and Proportion	1	1,2	2,4
	Percentage	1	1,2	2,4
	Profit and Loss	1	1,2	2.4
	True Discount	1	1,2	2,4
	Partnership	1	1,2	2,4
	Height and Distance	1	1,2	2,4
	Algebra	1	1,2	2,4
Unit No. 2	**Logical reasoning**	**7**		
	Logical deductions	1	1,2	1,4
	Syllogism	1	1,2	1,4
	Image based problems	1	1,2	1,4
	Coding and Decoding	1	1,2	1,4
	Cubes and cuboids	1	1,2	1,4
	Inequalities	1	1,2	1,4
	Input output tracing	1	1,2	1,4
Unit No. 3	**Verbal Ability**	**10**		
	Ordering of sentences	1	3,4	2,4
	Comprehension	1	3,4	2,4
	Verbal Analogies	1	3,4	2,4
	Letter and Symbol series	1	3,4	2,4
	One word substitutes	1	3,4	2,4
	Cause and Effect	1	3,4	2,4
	Syllogism	1	3,4	2,4
	Synonyms and Antonyms	2	3,4	2,4
	Idioms and Idiomatic expressions	1	3,4	2,4
Unit No. 4	**Soft skills**	**5**		
	Critical thinking topics	1	5	5,6
	Team activity	2	5	5,6
	Problem-solving/ Out of the box thinking	2	5	5,6
Unit No. 5	**Soft skills**	**6**		
	Sentence formation (Practical)	1	6	3,7
	Word group categorization	1	6	3,7
	Casual conversation (Practical)	2	6	3,7
	Formal conversation (interpersonal, Meeting)	2		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End SemesterExam (50%)	
		CLA-1 (10%)		Mid-1 (15%)		CLA-2 (10%)		Mid-2 (15%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	40%		40%		40%		40%		40%	
	Understand										
Level 2	Apply	60%		60%		60%		60%		60%	
	Analyse										
Level 3	Evaluate										
	Create										
Total		**100%**		**100%**		**100%**		**100%**		**100%**	

Recommended Resources

1. R.S. Agarwal, A Modern Approach to Verbal & Non-Verbal Reasoning, S. Chand Publication
2. How to prepare for Quantitative Aptitude for CAT – Arun Sharma
3. Meenakshi Upadhyay, Arun Sharma -Verbal Ability and Reading Comprehension
4. How to prepare for Logical reasoning and data interpretation for CAT – Arun Sharma.
5. Mastering Soft skills – Julian Vyner.
6. Soft skills – Key to success in workplace and life – Meenakshi Raman, Shalini Upadhyay.
7. English grammar and composition – S.C. Gupta.

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Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Engineering Physics

Course Code	PHY 101	**Course Category**	FIC		**L**	**T**	**P**	**C**
					2	0	0	2
Pre-Requisite Course(s)		**Co-Requisite Course(s)**	PHY101L	**Progressive Course(s)**				
Course Offering Department	Physics	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

- To understand fundamental concepts of classical mechanics and elastic properties of solids.
- To understand laws of Geometrical and Wave Optics and waves properties of light.
- To learn fundamentals of Electromagnetism and Maxwell's equation as the foundation of Maxwell's Equation.
- To familiarize about particle properties of waves and related fundamentals.

Course Outcomes / Course Learning Outcomes (CLOs)

CO's	At the end of the course, the learner will be able to	Bloom' s Level	Expected Proficiency Percentage	Expected Attainment Percentage
1	Discuss the concepts of classical mechanics	2	70%	65%
2	Explain Electromagnetic Equations and its applications	2	70%	65%
3	Illustrate Laws of Optics and waves properties of light	3	70%	65%
4	Demonstrate particle properties of waves and related fundamentals	3	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and ICT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1					1				2			2			
Outcome 2					2				2			2			
Outcome 3		2			2				2			2			
Outcome 4		2			2				3			2			
Course Average		**2**			**3**				**2**			**2**			

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	**CLASSICAL PHYSICS**	**8**		
	Introduction	1	1	1, 2
	Newton's laws of mechanics, Free body force diagram	1	1	1, 2
	Momentum and Impulse, Conservation of linear momentum	1	1	1, 2
	Work-Kinetic Energy Theorem and related problems	1	1	1,2
	Conservation of mechanical energy: Workedout problems	1	1	1, 2
	Elastic properties of solids, Stress-strain relationship, elastic constants, and their significance	1	1	1, 2
	Lab experiment: Hooke's law and determine spring constant for a given spring	2	1	4
Unit No. 2	**OPTICS**	**12**		
	Concept of Electromagnetic waves & EMW Spectra	1	3	1,2
	Geometrical & Wave Optics: Laws of reflection and refraction	1	3	1,2
	Concept of Interference	1	3	1,2
	Phase Difference and Path Difference	1	3	1,2
	Double-Slit Interference	1	3	1,2
	Diffraction: types and single slit	1	3	1,2
Unit No. 3	**MODERN PHYSICS**	**8**		
	Black Body Radiation; Wien's displacement law	1	4	1,2,3
	Discussion on failure of classical laws to explain Black Body Radiation, and concept of Planck's Hypothesis	1	4	1,2,3
	What is Light? Photon and Overview on Planck Constant	1	4	1,2,3
	Photoelectric effect – Concept and Experimental Setup	1	4	1,2,3
	Photoelectric effect – Intensity vs Current, Frequency vs Kinetic Energy, the drawback of Wave theory to explain Photoelectric effect	1	4	1,2,3
	Wave properties of particle: De Broglie wave	1	4	1,2,3
Unit No. 4	**ELECTRO-MAGNETISM – I**	**8**		
	Focus on Maxwell's Equation I: Discuss lines of force and Electrostatic flux, Introduce Gauss's law (differential and integral form)	1	2	1, 2, 5
	Application of Gauss Law: ES field due to infinite wire and sheet.	1	2	1, 2, 5
	Electrostatic field due to conducting and insulating sphere.	1	2	1, 2, 5
	Concept of Electrostatic Potential and Potential Energy Inter-relation with electrostatic field.	1	2	1, 2, 5
	Capacitor and Capacitance:	1	2	1, 2, 5
	Capacitance of a parallel plate capacitor.	1	2	1, 2, 5
Unit No. 5	**ELECTRO-MAGNETISM - II**	**10**		
	Introduce Biot-Savart Law as an alternative approach to calculate magnetic field.	1	2	1, 2, 5
	Calculate Magnetic field due to finite current element using Biot Savart Law.	1	2	1, 2, 5
	Focus on Maxwell's Equation IV: Discuss Ampere's circuital law.	1	2	1, 2, 5

	Calculate Magnetic field due to Infinite wire and Solenoid using Ampere's Law.	1	2	1, 2, 5
	Focus on Maxwell's Equation III: Lenz's Law and Faraday's law: Induced EMF and Current	1	2	1, 2, 5
	Describe Maxwell Equations as the foundation of electro-magnetism. Derive differential forms starting from Integral forms. Discuss Physical Significance.	1	2	1, 2, 5

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)					End Semester Exam (50%)	
		Theory (30%)				Practical (20%)		
		CLA-1 (5%)	Mid-1 (10%)	CLA-2 (5%)	Mid-2 (10%)	Internal	Th	Prac
Level 1	Remember	70%	60%	50%	40%	50%	30%	30%
	Understand							
Level 2	Apply	30%	40%	50%	60%	50%	70%	70%
	Analyse							
Level 3	Evaluate							
	Create							
Total		**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Physics for Scientist and Engineers - Raymond A. Serway, John W. Jewett, XIX Edition (2017), Publisher - Cengage India Private Limited
2. University Physics with Modern Physics with Mastering Physics - D Young, Roger A Freedman and Lewis Ford, XII Edition (2018), Publisher – PEARSON
3. Concept of Modern Physics - Arthur Beiser, Shobhit Mahajan, S Rai, 2017 Edition, Publisher - Tata McGraw Hill
4. Laboratory manuals, SRM University-AP

Other Resources

1. Introduction to Electrodynamics – David J. Griffiths. 4th Edition (2012), Publisher - PHI Eastern Economy Editions
2. Electricity and Magnetism - A S Mahajan and A A Rangwala, Revised of 1 Edition (2001), Publisher - McGraw-Hill.

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Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Engineering Physics Lab

Course Code	PHY 101L	**Course Category**	FIC		**L**	**T**	**P**	**C**
					0	0	1	1
Pre-Requisite Course(s)		**Co-Requisite Course(s)**	PHY 101	**Progressive Course(s)**				
Course Offering Department	Physics	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

- Operate physics equipment and measurement tools experience.
- Determine physical parameters of mechanics, thermodynamics, electromagnetism, and optics.
- To collect experimental data, analyse and graph plot.

Course Outcomes / Course Learning Outcomes (CLOs)

CO's	At the end of the course, the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
1	Illustrate equipment operation and analysis	2	70%	65%
2	Compute time period, acceleration due to gravity, viscosity and spring constant	3	70%	65%
3	Explain working principle of compound pendulum, spring and thermodynamic laws	2	70%	65%
4	Verify the laws of electromagnetism and optics using experimental results	5	70%	65%
5	Plot graphs and analyse the experimental results	5	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and ICT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1		3	2	3	3				3						
Outcome 2		3	2	3	3				3						
Outcome 3	2	3	3	3	3				2			1			
Outcome 4	2	3	2	3	3				3						
Outcome 5		3	2	3	3				3			2			
Course Average	**2**	**3**	**2**	**3**	**3**				**3**			**2**			

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1,2,5	Moment of inertia of a flywheel	2	1,2,5	1,2
Unit No. 1,2,5	Hooke's law and determine spring constant for a given spring	2	1,2,5	1,2
Unit No. 1,2,5	Compound Pendulum: Acceleration due to gravity and radius of gyration of the given pendulum	4	1,2,5	1,2
	To determine the rigidity modulus of steel wire by torsional Pendulum **[Optional]**			
	To calculate Young's modulus of a given material by deflection method **[Optional]**			
Unit No. 1,4,5	Faraday law & Induced E.M.F: Measurement of the induced voltage and calculation of the magnetic flux induced by a falling magnet	2	1,4,5	1,2
	To study the B-H curve of the given material and the permeability curve of the given material. [**Optional**]			
Unit No. 1,4,5	Biot-savart law: To study the dependence of magnetic field on the current and magnetic field along the axis of a current carrying circular loop	4		
	Hall Effect: Determination of type of semiconductor and carrier concentration in a given semiconductor **[optional]**		1,4,5	1,2
	Magnetic field in Helmholtz coil [**Optional**] a. To investigate the spatial distribution of magnetic field between coils and determine the spacing for uniform magnetic field. b. To demonstrate the superposition of the magnetic fields of the two individual coils.		1,4,5	1,2
Unit No. 1,4,5	To determine the dielectric constant of air using dielectric constant kit.	4	1,4,5	1,2
	Measurement of Resistivity of a semiconductor using Four probes [**Optional**]		1,4,5	1,2
Unit No. 1,4,5	Michelson interferometer kit with diode laser	4	1,4,5	1,2
	Resolving power of A Telescope **[Optional]**			
	Balmer Series and Rydberg constant **[Optional]**			
Unit No. 1,4,5	He-Ne laser kit: Optical Interference and Diffraction	2	1,4,5	1,2
	Solar cell characteristics**[Optional]**			
	Frank Hertz Experiment **[Optional]**			
Unit No. 1,4,5	Particle size measurement	4	1,4,5	1,2
Unit No. 1,3,5	Verification of Stefan's Law	2	1,3,5	1,2
	Measurement of specific heat capacity of any given material **[optional]**		1,3,5	1,2

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)						End Semester Exam (50%)	
		Experiments (20%)		Record/ Observation Note (10%)		Viva Voce + Model examination (20%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember				40%		30%		
	Understand								
Level 2	Apply		40%		60%		30%		50%
	Analyse								
Level 3	Evaluate		60%				40%		50%
	Create								
Total		**100%**		**100%**		**100%**		**100%**	

Recommended Resources

1. Laboratory manuals, SRM University – AP
2. R.K. Shukla and Anchal Srivastava, "Practical Physics" New Age International (P) limited Publishers, 2006 [ISBN(13) – 978-81-224-2482-9]

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Circuit Theory

Course Code	EEE 202	**Course Category**	Core	**L**	**T**	**P**	**C**
				3	0	1	4
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	EEE	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

- To provide the comprehensive idea of star delta networks, network theorems.
- To provide working application knowledge of two-port networks, and concepts of three phase AC circuits.

Course Outcomes / Course Learning Outcomes (CLOs)

CO's	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
1	Describe the star delta network and three phase electrical circuits.	3	70%	70%
2	Discuss the solution of complex DC circuits using network theorems.	3	70%	60%
3	Apply the solution methods of two-port networks	3	70%	60%
4	Illustrate the transient behaviour of RL, RC, and RLC circuits under DC and AC excitation.	3	60%	50%
5	Apply mathematical techniques to electrical circuits and understand concept of filters.	3	60%	50%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and ICT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	2	3	2				2	1		2	3	1	1
Outcome 2	3	3	3	3	2				2	1		2	3	1	1
Outcome 3	3	3	3	3	2				2	1		2	3	1	1
Outcome 4	3	3	3	3	3				2	1		2	3	1	1
Outcome 5	3	3	3	3	3				2	1		2	3	1	1
Course Average	**3**	**3**	**3**	**3**	**2**				**2**	**1**		**2**	**3**	**1**	**1**

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	**Basic Circuit Analysis and Three Phase AC Circuits**	**11**		
	Network Reduction Technique using Star–Delta Transformation	2	1	1, 2
	Analysis of electric circuits with voltage dependent voltage source and current source	2	1	1, 2
	Analysis of electric circuits with current dependent current source and voltage source	1	1	1, 2
	Necessity and advantages of three phase systems, generation of three phase power	2	1	1, 2
	Definition of Phase sequence, balanced supply, and balanced load	2	1	1, 2
	Relationship between line and phase values of balanced star and delta connections.	2	1	1, 2
Unit No. 2	**Network Theorems**	**7**		
	Superposition Theorem	1	1, 2, 3	1-3
	Thevenin's Theorem	1	1, 2, 3	1-3
	Norton's Theorem	1	1, 2, 3	1-3
	Maximum Power Transfer Theorem	2	1, 2, 3	1-3
	Reciprocity Theorem	1	1, 2, 3	1-3
	Milliman's Theorems	1	1, 2, 3	1-3
Unit No. 3	**Two Port Network**	**9**		
	Introduction to Two Port Networks	1	1, 2, 3	1-3
	Impedance Parameters	2	1, 2, 3	1-3
	Admittance Parameters	1	1, 2, 3	1-3
	Hybrid Parameters	1	1, 2, 3	1-3
	Transmission Parameters	2	1, 2, 3	1-3
	Inter-relationship between parameters of a two-port network	2	1, 2, 3	1-3
Unit No. 4	**Transient Analysis of Circuits**	**9**		
	Introduction to Transient analysis, Step Response of a Series RL circuit under DC Source Excitation	2	1, 2, 4	1-5
	Step Response of a Series RC circuit under DC Source Excitation	1	1, 2, 4	1-5
	Step Response of a Series RLC circuit under DC Source Excitation- Time Constant, Rise Time, Peak Time, Peak Overshoot/Undershoot and Settling Time	2	1, 2, 4	1-5
	Principle of Duality. Transient Response Analysis of Series RL, RC and RLC Circuits with AC Source Excitation.	4	1, 2, 4	1-5
Unit No. 5	**Graph Theory and Filter Circuits**	**9**		
	Graph theory**-** Concept of Tree, Branch, Tree link, Incidence matrix,	2	1, 5	1-5
	Tie-set matrix and loop currents, Cut set matrix and node pair potentials	2	1, 5	1-5
	Principle of Duality,	1	1,5	1-5
	Passive filters-Concept-Ideal and practical, properties and uses and classification of filter	2	1, 5	1-5
	Concept of low pass and high pass filter using reactive elements	2	1, 5	1-5
Total Contact Hours		**45**		

Course Utilization Plan – Laboratory

Unit No.	Experiment Name	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Study Of Balanced Three-Phase System For Star & Delta Connected Loads	3	1	2, 4, 5
Unit No. 1	To study Effect of Power Factor Using R And R, L Loads.	3	1	2, 4, 5
Unit No. 1	To study Power Factor Correction Using Static Capacitor	3	1	2, 4, 5
Unit No. 1	To study V-I Characteristics of Tungsten Filament Lamp	3	1	2, 4, 5
Unit No. 2	To verify Superposition 's theorem using MATLAB	3	2	2, 4, 5
Unit No. 2	To verify Thevenin's theorem using MATLAB	3	2	2, 4, 5
Unit No. 3	To calculate Z-Parameters [Open Circuit Impedance Parameter] For a 2-Port Network.	3	3	2, 4, 5
Unit No. 3	To calculate Y-Parameters [Open Circuit Impedance Parameter] For a 2-Port Network.	3	3	2, 4, 5
Unit No. 4	To simulate and draw locus diagrams Of Series R-L Circuit Using MATLAB	3	4	2, 4, 5
Unit No. 4	To simulate and draw locus diagrams Of Series R-C Circuit Using MATLAB	3	4	2, 4, 5
Total Contact Hours		**30**		

Learning Assessment

Bloom's Level of Cognitive Task		**Continuous Learning Assessments (50%)**								**End Semester Exam (50%)**	
		CLA-1 (5%)		**CLA-2 (5%)**		**CLA-3 (5%)**		**Mid Term (15% +10%=25%)**			
		Th	**Prac**	**Th**	**Prac**	**Th**	**Prac**	**Th**	**Prac**	**Th**	**Prac**
Level 1	Remember	40%	-	40%	-	40%	-	40%	30%	60%	30%
	Understand										
Level 2	Apply	60%	-	60%	-	60%	-	60%	70%	40%	70%
	Analyse										
Level 3	Evaluate										
	Create										
Total		**100%**	-	**100%**	-	**100%**	-	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Electrical Engineering Fundamentals, Vincent Del Toro, Pearson, 2016.
2. Circuit Theory Analysis and Synthesis, Abhijit Chakrabarti, Dhanpat Rai & Co. 7th Edition, 2017.
3. Fundamentals of Electric Circuits, Charles K. Alexander and Matthew N.O. Sadiku, McGraw Hill Higher Education, Third Edition, 2005
4. Sudhakar, Shyammohan, S. Pillai, Network Theory, 2/e, Tata McGraw Hill Publications, 2012.
5. Introductory Circuit Analysis, Robert L. Boylestad, Twelfth edition, Pearson, 2012.

SRM University *AP*, Andhra Pradesh
Neerukonda, Mangalagiri Mandal,
Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Electrical Machines - I

					L	T	P	C
Course Code	EEE 203	**Course Category**	Core		3	0	1	4
Pre-Requisite Course(s)	Basic Electrical and Electronics Engg.,	**Co-Requisite Course(s)**	Circuit Theory	**Progressive Course(s)**	Electrical Machines-II			
Course Offering Department	EEE	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

- Study the construction and working principle of DC machines.
- Understand the armature reaction and commutation in DC machines.
- Learn the characteristics, performance, speed control and testing methods of DC motors.
- Study the operation and performance of single phase and three phase transformers.

Course Outcomes / Course Learning Outcomes (CLOs)

CO's	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
1	Explain the basic operating principle of DC machines.	2	70%	65%
2	Interpret the performance characteristics of different types of DC generators and motors for its application.	3	70%	65%
3	Analyse the speed control and testing methods of DC machines.	4	70%	65%
4	Understand the operation and performance of single phase and three phase transformers.	2	70%	60%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and ICT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	2	2	1	2							1	3	1	
Outcome 2	3	3	3	3	3							2	3	1	
Outcome 3	3	3	3	3	3							2	3	1	1
Outcome 4	3	3	2	2	3							2	3	1	1
Course Average	**3**	**3**	**3**	**3**	**3**							**2**	**3**	**1**	**1**

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	**Construction and Operation of DC Machines**	**9**		
	D.C. Machines - Constructional details, Principle of operation	2	1	1, 2 & 3
	Action of commutator;	1	1	1, 2 & 3
	E.M.F equation of DC generator - Problems;	2	1	1, 2 & 3
	Methods of excitation of generators - Separately excited and self-excited; Causes of failure to self-excitation and remedial measures.	2	1	1, 2 & 3
	Build-up of E.M.F under no load, Critical field resistance and critical speed,	2	1	1, 2 & 3
Unit No. 2	**DC Generators**	**9**		
	Characteristics of DC generators - Internal and external characteristics of shunt, series, and compound generators	2	2	1, 2 & 3
	Armature reaction - Effect of armature reaction, Cross magnetizing, and demagnetizing AT/pole	3	2	1, 2 & 3
	Compensating winding, Interpoles;	2	2	1, 2 & 3
	Commutation process, Methods to improve commutation.	2	2	1, 2 & 3
Unit No. 3	**DC Motors**	**8**		
	Principle of operation DC Motor, Back E.M.F, Torque equation.	**2**	2, 3	1, 2 & 3
	Types of DC motors and Characteristics of DC machines	**2**	2, 3	1, 2 & 3
	Speed control of D.C. Motors: Armature voltage and field flux control methods.	**2**	2, 3	1, 2 & 3
	Starting of DC motors - Necessity and types of starters, 3 point and 4-point starters;	**2**	2, 3	1, 2 & 3
Unit No. 4	**Efficiency and Testing of DC Machines**	**8**		
	Types of losses - Constant and Variable losses;	**1**	3	1, 2 & 3
	Calculation of efficiency - Condition for maximum efficiency and example problems	**1**	3	1, 2 & 3
	Swinburne's test and example problems	**2**	3	1, 2 & 3
	Hopkinson's test and example problems	**2**	3	1, 2 & 3
	Field's test and example problems	**2**	3	1, 2 & 3
Unit No. 5	**Transformers**	**11**		
	Overview of Single-phase Transformer and emf equation	**1**	4	1, 2 & 3
	Phasor diagram on no-load and load – equivalent circuit,	**2**	4	1, 2 & 3
	Losses and efficiency of transformer - regulation of transformer	**2**	4	1, 2 & 3
	Tests on single phase transformers – open circuit and short circuit tests – Sumpner's test – separation of losses	**2**	4	1, 2 & 3
	Auto - transformer and Parallel operation of single-phase transformer	**2**	4	1, 2 & 3
	3-Phase Transformers Polyphase connections - Y/Y, Y/Δ, Δ/Y, Δ/Δ	**2**	4	1, 2 & 3
Total Contact Hours		**45**		

Course Utilization Plan - Laboratory

Unit No.	Experiment Name	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1, 2	Magnetization characteristics of DC shunt generator	3	1, 2	1, 2 & 3
Unit No. 2	Internal and External Characteristics of separately excited DC generator	3	2	1, 2 & 3
Unit No. 2	To study the characteristics of a dc shunt motor	3	2	1, 2 & 3
Unit No. 3	Speed Control of DC Motor: Field control, Armature control	3	3	1, 2 & 3
Unit No. 2, 3	Swinburne's test and separation of losses in DC Machine	3	2, 3	1, 2 & 3
Unit No. 2, 3	Brake test on DC shunt motor. Determination of performance curves	3	2, 3	1, 2 & 3
Unit No. 2, 3	Hopkinson's test on DC shunt machines	3	2, 3	1, 2 & 3
Unit No. 4	OC & SC test on single phase transformer	3	4	1, 2 & 3
Unit No. 4	Sumner's test on single phase transformer	3	4	1, 2 & 3
Unit No. 4	Load test on single-phase transformers	3	4	1, 2 & 3
Total Contact Hours		**30**		

Learning Assessment

Bloom's Level of Cognitive Task		**Continuous Learning Assessments (50%)**								**End Semester Exam (50%)**	
		CLA-1 (5%)		**CLA-2 (5%)**		**CLA-3 (5%)**		**Mid Term (15% + 20% = 35%)**			
		Th	**Prac**	**Th**	**Prac**	**Th**	**Prac**	**Th**	**Prac**	**Th**	**Prac**
Level 1	Remember	70%	-	40%	-	40%	-	40%	30%	40%	30%
	Understand										
Level 2	Apply	30%	-	60%	-	60%	-	60%	70%	60%	70%
	Analyse										
Level 3	Evaluate										
	Create										
Total		**100%**	-	**100%**	-	**100%**	-	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. P. S. Bimbhra, "Electrical Machinery", Khanna Publishers, 2011.
2. I. J. Nagrath and D. P. Kothari, "Electric Machines", McGraw Hill Education, 2010.
3. A. E. Fitzgerald and C. Kingsley, "Electric Machinery", New York, McGraw Hill Education, 2013.

Other Resources

1. A. E. Clayton and N. N. Hancock, "Performance and design of DC machines", CBS Publishers, 2004.
2. M. G. Say, "Performance and design of AC machines", CBS Publishers, 2002.

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Electromagnetic Field Theory

Course Code	EEE 204	**Course Category**	Core		**L**	**T**	**P**	**C**
					3	0	0	3
Pre-Requisite Course(s)	Power Generation, Transmission and Distribution	**Co-Requisite Course(s)**		**Progressive Course(s)**				
Course Offering Department	EEE	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

- To outline and discuss the basic mathematical tools to deal with electromagnetic fields
- To discuss the characteristics of materials and explain their interactions with electromagnetic fields.
- To analyse electromagnetic wave propagation in transmission lines and to acquire problem solving skills related to electromagnetic fields.

Course Outcomes / Course Learning Outcomes (CLOs)

CO's	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
1	Identify and designate different co-ordinate systems to describe the spatial variations of physical quantities	**2**	70%	65%
2	Clearly explain the synthesis and working electromagnetic energy storage devices like capacitor and inductor.	**2**	70%	65%
3	Justify the process of electromagnetic wave propagation and energy transfer with perturbing factors in unguided medium and analyse the interactions of materials with electromagnetic fields.	**3**	70%	65%
4	Apply the concepts of guided structures such as transmission line to show how energy is transported	**3**	60%	60%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and ICT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	2	2	1	2							1	1	2	1
Outcome 2	3	3	3	3	3							2	2	2	3
Outcome 3	3	3	3	3	3							2	3	1	2
Outcome 4	3	3	2	2	3							2	3	1	3
Outcome 5	3	3	3	3	3							2	2	2	3
Course Average	**3**	**2**	**2**	**1**	**2**							**1**	**1**	**2**	**1**

Course Unitization Plan - Theory

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Review of Electromagnetism: Del operator, Gradient, Divergence, Curl	1	1	1,2,3&4
	Geometric meaning of Gradient, Divergence and curl, Laplacian of a scalar	3	1	1,2,3&4
	Cartesian, Cylindrical and Spherical coordinate system	1	1	1,2,3&4
	General Curvilinear coordinate system	1	1	1,2,3&4
	Transformation of coordinate systems	1	1	1,2,3&4
	Gradient, Divergence and Curl in cylindrical and spherical coordinate systems	2	1	1,2,3&4
Unit No. 2	Static electric and magnetic fields: Electric and Magnetic flux density and Gauss's Law	1	2,3	1,2,3&4
	Electrostatic boundary conditions and problems	3	2,3	1,2,3&4
	Magnetic field intensity and Ampere's circuital law	1	2,3	1,2,3&4
	Magnetic scalar potential	1	2,3	1,2,3&4
	Magnetic boundary conditions and cases/problems	3	2,3	1,2,3&4
Unit No. 3	Time-varying electromagnetic fields: Motional electromotive forces	1	3	1,2,3&4
	Faraday's law of induction	1	3	1,2,3&4
	displacement current, Maxwell's equations	1	3	1,2,3&4
	Maxwell's equations from Ampere's and Gauss's law, their physical significance	2	3	1,2,3&4
	Maxwell's equations and boundary conditions	1	3	1,2,3&4
	Poynting theorem	1	3,4	1,2,3&4
	Wave power and Poynting vector	1	3,4	1,2,3&4
	Problems on average wave power calculations from Poynting vector	1	3,4	1,2,3&4
Unit No. 4	Plane wave propagation: General wave equations	2	3	1,2,3&4
	Plane wave in free space and dielectric medium	1	3	1,2,3&4
	Plane wave in a conducting medium	1	3	1,2,3&4
	Plane wave in a good conductor and dielectric	2	3	1,2,3&4
	Skin effect and skin depth	1	3	1,2,3&4
	Reflection/Refraction of uniform plane waves	2	3	1,2,3&4
Unit No. 5	Transmission lines: Concept of lump and distributed parameters, Transmission line equations	2	4	1,2,3&4
	Lossless propagation, Examples of transmission lines -, characteristic impedance	2	4	1,2,3&4
	Lossless propagation of sinusoidal voltages - complex analysis	1	4	1,2,3&4
	Transmission line equations and their solutions in phasor form, input impedance	2	4	1,2,3&4
	Reflection of waves at discontinuous points	1	4	1,2,3&4
	Standing waves in transmission lines - Voltage standing wave ratio	1	4	1,2,3&4

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (50%)	
		CLA-1 (10%)		CLA-2 (10%)		CLA-3 (10%)		Mid Term (20%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	40%	-	20%	-	40%	-	40%	-	40%	-
	Understand										
Level 2	Apply	60%	-	80%	-	60%	-	60%	-	60%	-
	Analyse										
Level 3	Evaluate										
	Create										
Total		**100**%	-	**100**%	-	**100**%	-	**100**%	-	**100**%	-

Recommended Resources

1. Element of Electromagnetic - Mathew N.O. Sadiku, IV Edition (2006), Publisher - Oxford University Press
2. Electromagnetic Field Theory Fundamentals - B S Guru & H R Hizirogul, II Edition (2017), Publisher – Cambridge university press
3. Engineering Electromagnetic - W.H. Hyat & J.A. Buck, XIII Edition (2010), Publisher - McGraw-Hill
4. Electromagnetic Field Theory- K.A.Gangadhar and P.M.Ramnathan .Khanna Publishers (1997)

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Digital Electronics

Course Code	EEE 205	**Course Category**	Core		**L**	**T**	**P**	**C**
					3	0	1	4
Pre-Requisite Course(s)	-	**Co-Requisite Course(s)**	-	**Progressive Course(s)**	-			
Course Offering Department	EEE	**Professional / Licensing Standards**	-					

Course Objectives / Course Learning Rationales (CLRs)

- To acquire the basic knowledge of digital logic levels and application of the fundamentals to understand digital electronic circuits.
- To impart how to design Digital Circuits both theoretically and practically.

Course Outcomes / Course Learning Outcomes (CLOs)

CO's	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
1	Employ the codes and number systems converting circuits and compare types of logic families.	**2**	**75%**	**65%**
2	Apply mapping, mathematical methods and logical tools to design circuits.	**3**	**75%**	**65%**
3	Discuss combinational, asynchronous sequential, and synchronous sequential digital logic circuits.	**2**	**75%**	**65%**
4	Apply the concepts of memory devices in given problems.	**3**	**75%**	**65%**

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and ICT Usage	Society and Multicultural	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and	Self-Directed and Life Long	PSO 1	PSO 2	PSO 3
Outcome 1	3	2	3	3	2	-	-	-	-	-	3	3	2	1	1
Outcome 2	3	3	3	3	2	3	1	-	3	2	3	3	3	3	3
Outcome 3	3	2	1	1	1	-	-	-	1	-	2	3	1	1	1
Outcome 4	3	2	1	2	2	-	-	-	1	-	2	3	1	1	3
Course Average	**3**	**2**	**3**	**2**	**2**	**3**	**1**	**-**	**3**	**2**	**3**	**3**	**2**	**2**	**2**

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	4 and 5 variable K-maps	2	1,2	1, 2
	1's and 2's complements	2	1	1
	Codes – Binary, BCD, Excess 3, Gray, Alphanumeric codes (Active Learning)	2	1,2	1
	Sum of products and product of sums, Minterms and Maxterms	1	1	1
	Quine-McCluskey method of minimization	2	1,2	1, 3
Unit No. 2	4 bit Adder and Subtractor	1	1	1, 2 & 3
	Binary Parallel Adder – Carry look ahead adder, BCD Adder	2	1, 2	2,3
	Multiplexer, Demultiplexer	2	1, 2	1
	Magnitude Comparator	1	1, 2	1, 3
	Decoder, Encoder, Priority Encoder (Active Learning)	2	1, 2	2,3
Unit No. 3	Flip flops – SR, JK, T, D, Master/Slave FF – operation and excitation tables, Triggering of FF	2	1,2	3,4
	Analysis and design of clocked sequential circuits – Design – Moore/Mealy models	2	1	4
	State minimization, State assignment	1	1	4
	Circuit implementation – Design of Counters – Ripple Counters, Ring Counters	2	1,2	4
	Shift Registers, Universal Shift Register	2	1,2	3,4
Unit No. 4	Stable and unstable states, output specifications	3	1,2.3	2,3
	Cycles and races, state reduction, race free assignments	2	3	1,3
	Hazards, Essential Hazards	2	2,3	1,3
	Pulse mode sequential circuits, Design of Hazard free circuits	2	1,2,3	1, 3
Unit No. 5	Classification of memories – ROM – ROM organization – PROM – EPROM – EEPROM – EAPROM	2	4	1,4
	RAM – RAM organization – Write operation – Read operation	1	4	2,4
	Programmable Logic Devices – Programmable Logic Array (PLA) – Programmable Array Logic (PAL)	2	4	4
	Field Programmable Gate Arrays (FPGA)	1	4	4
	Implementation of combinational logic circuits using ROM, PLA, PAL.	3	4	3,4

Course Unitization Plan – Laboratory

Unit No.	Experiment Name	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Realization of Basic Logic Gates.	2	2	1,2
	Design of Code Converters (Binary to Gray) & (Gray to Binary).	2	2	1
Unit No. 2	Design of Half-Adder/Subtractor, Full-Adder/Subtractor, Multiplexers/De Multiplexers.	2	3	1,2
	Design of Decoder and Encoder/ BCD 7SSD.	2	3	2, 3
	Design of Magnitude Comparator (2-bit).	2	3	1,3
Unit No. 3	Design and Verification of Flip- Flops using IC.	2	3	3, 4
	Design of Asynchronous Counter (Any Mod, Up and Down, Jhonson and Ring).	2	3	4
	Design of Synchronous Counter (Any Mod, Decade counter 74ls90).	2	3	4
	Design of Universal Shift Register (Serial to Parallel, Parallel to Serial, Serial to Serial and Parallel to Parallel Converters).	2	3	3, 4
Unit No. 4	Design & Verification of Memory (SRAM).	2	4	2, 4

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (50%)	
		CLA-1 (5%)		CLA-2 (5%)		CLA-3 (10%)		Mid Term (10% + 20% = 30%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	60%	-	40%	-	40%	-	40%	30%	40%	30%
	Understand										
Level 2	Apply	40%	-	60%	-	60%	-	60%	70%	60%	70%
	Analyse										
Level 3	Evaluate										
	Create										
Total		**100%**	-	**100%**	-	**100%**	-	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. M. Morris Mano. (2018), *Digital Design* (5th ed.). Pearson Education.
2. John F.Wakerly (2005) ,Digital Design (4th ed.). Pearson/PHI.
3. John. M Yarbrough. (2006), *Digital Logic Applications and Design* (1st ed.). Thomson Learning.
4. Charles H. Roth. (2015), *Fundamentals of Logic Design* (7th ed.). Thomson Learning.

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Solid State Devices (SSDs) and High Electron Mobility Transistors (HEMTs)

Course Code	EEE 201	**Course Category**	SEC		**L**	**T**	**P**	**C**
					2	0	0	2
Pre-Requisite Course(s)	Engineering Physics, Single Variable Calculus, Linear Algebra	**Co-Requisite Course(s)**	Differential Equations	**Progressive Course(s)**	Power Electronics			
Course Offering Department	EEE	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

- Understanding the fundamental principles of semiconductor physics (e.g. energy bands, charge carriers, doping, conductivity, and mobility).
- Applying the semiconductor physics knowledge to understand the operational principles of essential semiconductor devices (e.g. p-n junction diode, transistor).
- Utilizing the knowledge of semiconductor devices for the purpose of choosing appropriate switches in the development of power electronic converters (e.g. inverters, rectifiers, and converters).

Course Outcomes / Course Learning Outcomes (CLOs)

CO's	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
1	Summarize the concept of quantum theory and describe the behaviour of a semiconductor material at equilibrium.	2	70%	65%
2	Interpret the behaviour of the charges in a semiconductor and predict the change in carrier concentration at non-equilibrium condition.	3	70%	65%
3	Illustrate the behaviour of a semiconductor pn junction with different biasing and infer the working of a diode at with forward biasing.	2	70%	65%
4	Discover the concepts of BJT, MOScap, MOSFET, and HEMT working and interpret their potential applications.	3	70%	60%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and ICT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	2		2						1		2	2	1	
Outcome 2	3	2		2						1		2	2	1	
Outcome 3	3	3	1	2			1			1		3	3	1	2
Outcome 4	3	3	1	2			1			1		3	3	2	2
Course Average	**3**	**3**	**1**	**2**			**1**			**1**		**3**	**3**	**1**	**1**

Course Unitization Plan

Unit No.	Syllabus Topics		Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	**Introduction to Quantum Theory and Semiconductors**: Introduction to Quantum (wave) Mechanics		1	1	1-2
	Allowed and Forbidden Energy Bands		1	1	1-2
	Density of States Function		1	1	1-2
	Equilibrium Distribution of Electrons and Holes, n0 and p0 Equations		1	1	1-2
	Intrinsic Carrier Concentration and Intrinsic Fermi-level Position		1	1	1-2
	Equilibrium Distribution of Electrons and Holes in Extrinsic Semiconductors, n0 and p0 Product in Extrinsic Semiconductors		1	1	1-2
	Fermi–Dirac Integral		1	1	1-2
	Degenerate and Nondegenerate Semiconductors and Charge Neutrality		1	1	1-2
Unit No. 2	**Carrier Transport Phenomena and Nonequilibrium Excess Carriers in Semiconductors** : Drift Current Density		1	2	1-2
	Mobility Effects		1	2	1-2
	Conductivity Velocity Saturation		1	2	1-2
	Diffusion Current Density		1	2	1-2
	Total Current Density		1	2	1-2
	Excess Carrier Generation and Recombination		1	2	1-2
	Continuity Equations and Ambipolar Transport		1	2	1-2
Unit No. 3	**The pn Junction and Diode:** Basic Structure of the pn Junction		1	3	1-2
	Zero Applied Bias	Built-in Potential Barrier, Electric Field	1	1-2	1-2
		Space Charge Width	1	1-2	1-2
	Reverse Applied Bias	Space Charge Width and Electric Field	1	1-2	1-2
		Junction Capacitance	1	1-2	1-2
	Junction Breakdown		1	3	1-2
	Poynting theorem	Boundary Conditions, Minority Carrier Distribution	1	1-2	1-2
		Ideal pn Junction Current, Generation Current, Recombination Current	1	1-2	1-2
Unit No. 4	**Semiconductor Switch Fundamentals:** Bipolar Junction Transistor (BJT) Principles		1	4	1-2
	Overview of Amplification and Switching in BJT and Current Gain		1	4	1-2
	Metal-Oxide Semiconductor Capacitor (MOScaps)		1	4	1-2
	Metal-Oxide-Semiconductor Field Effect Transistor (MOSFET) and Deviations from the Ideal MOSFET Case		1	4	1-2
	Heterojunctions		1	4	1
	High Electron Mobility Transistors (HEMTs)		2	4	1,3

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (50%)	
		CLA-1 (10%)		CLA-2 (10%)		CLA-3 (10%)		Mid Term (20%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	60%	-	40%	-	60%	-	40%	-	40%	-
	Understand										
Level 2	Apply	40%	-	60%	-	40%	-	60%	-	60%	-
	Analyse										
Level 3	Evaluate	-	-	-	-	-	-	-	-	-	-
	Create	-	-	-	-	-	-	-	-	-	-
Total		**100**%	-	**100**%	-	**100**%	-	**100**%	-	**100**%	-

Recommended Resources

1. Neamen, D.A. (2021). *Semiconductor Physics and Devices* (4th ed.). McGraw-Hill.
2. Streetman, B.G., Banerjee, S.K. (2016). *Solid State Electronic Devices* (7th ed.). Pearson.
3. Tripathi, S.L., Alvi, P.A., Subramaniam, U., (2021). *Electrical and Electronic Devices, Circuits, and Materials: Technological Challenges and Solutions* (1st ed.). Wiley.

Other Resources

1. Nath, Digbijoy N. (2021). *Fundamentals of semiconductor devices.* NPTEL Course IISc Bangalore. URL: https://onlinecourses.nptel.ac.in/noc20_bt17/preview

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Differential Equations

Course Code	FIC 106	**Course Category**	FIC		**L**	**T**	**P**	**C**
					3	0	0	3
Pre-Requisite Course(s)	Analysis and Linear Algebra	**Co-Requisite Course(s)**	NA	**Progressive Course(s)**	NA			
Course Offering Department	Mathematics	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

- Develop a comprehensive set of skills and knowledge to solve complex differential equations and utilize derivative functions by introducing integration, vector spaces, and their applications in real-world scenarios.
- To gain proficiency in understanding and manipulating linear differential operators, function spaces, and non-linear differential equations, enabling them to analyse and interpret diverse mathematical models.
- To analyze techniques for solving first and higher-order differential equations, employing methods like reduction of order and variation of parameters to tackle real-world problems involving dynamic systems.

Course Outcomes / Course Learning Outcomes (CLOs)

CO's	At the end of the course, the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
1	Formation of differential equations, Order and degree of differential equations, Classification of ordinary and partial differential equations, Discuss of linear and non-linear differential equations, Solution of differential equations, Initial value problems	2	75%	80%
2	Illustrate the geometrical meaning of first-order differential equations. Applications of differential equations of first order and first degree. Solve first-order differential equations by a few analytical methods.	3	70%	65%
3	Establish the existence, uniqueness, and classification of solutions. Solve various types of first-order differential equations.	3	75%	70%
4	Explore homogeneous equations with constant coefficients and Euler-Cauchy equations with solution methods like undetermined coefficients and variation of parameters. Find general solutions of non-homogeneous equations with initial data.	3	70%	65%
5	Transform higher-order equations into systems of differential equations. Compute the solution of a system of differential equations. Emphasizing critical points and stability. Solve nonhomogeneous linear systems using methods like undetermined coefficients and variation of parameters.	4	70%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Scientific and Disciplinary	Analytical Reasoning and Problem Solving	Critical and Reflective Thinking	Scientific Reasoning and Design Thinking	Research Related Skills	Modern Tools and ICT Usage	Environment and Sustainability	Moral, Multicultural and Ethical	Individual and Teamwork Skills	Communication Skills	Leadership Readiness Skills	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	2	2		2								3	1	1
Outcome 2	3	3	3		3								3	2	3
Outcome 3	3	3	3		3								3	2	3
Outcome 4	3	3	2		2								2	3	3
Outcome 5	2	2	1		2								3	2	1
Course Average	**3**	**3**	**2**		**2**								**3**	**2**	**3**

Course Unitization Plan

Unit No.	Syllabus Topics	Contact Hours Required	CLOs Addressed	References Used
Unit No. 1	**Formation and classification of differential equations**	**12 Hours**		
	Differential equations, their formation and solutions Introduction to differential equation.	2	1	1,3
	Ordinary and partial differential equations.	1	1	1,3
	Order and degree of linear and nonlinear differential equations.	1	1	1,3
	Solution of a differential equation, general, particular and singular solution of a differential equation.	1	1	1,3
	Existence and uniqueness theorem.	2	1	1,3
	Initial value Problems.	1	1	1,3
	Applications of differential equations.	2	1	1,3
	Analytical methods for solving differential equations.	1	1	1,3
	Quiz	1	1	1,3
Unit No. 2	**Geometrical meaning of differential equations with classification of solutions**	**12 Hours**		
	Equations of first order and first-degree Introduction, Geometrical meaning of y′=f(x, y).	1	2	1,3
	Separation of variables, Homogeneous, Equations reducible to homogeneous form.	2	2	1,3
	Exact, Necessary and sufficient conditions for exactness, Integrating Factor, Linear differential equation	2	2	1,3
	Equations reducible to linear form, Bernoulli's form.	1	2	1,3
	Trajectory, Orthogonal trajectory in cartesian and polar coordinates, Self-orthogonal, Oblique trajectory.	3	2	1,3
	Applications of equations of first order and first degree.	2	2	1,3
	Class Assessment	1	2	1,3
Unit No. 3	**First order differential equations**	**12 Hours**		
	Equations of the first order but not of the first degree.	1	3	2,3
	Existence and uniqueness of solution.	1	3	2
	Different methods of finding the general solutions (Equations solvable for p, x, y and Clairaut's form)	3	3	2,4,3

	Singular solutions.	2	3	2
	Extraneous Loci (Tac, Node and Cusp)	3	3	2
	Bernoulli differential equations, Initial value problems.	2	3	2,3
Unit No. 4	**Second or higher order linear differential equations**	**12 Hours**		
	Second or Higher order differential equations	1	4	2
	Linear and non-linear differential equations	1	4	2
	General solution of differential equations.	2	4	2,4
	Homogeneous and non-homogeneous equations	1	4	2
	Homogeneous Euler-Cauchy differential equations	1	4	2
	Method of undetermined coefficients	2	4	2
	Method of variation of parameters.	2	4	2
	Operator methods for finding particular solution.	2	4	2,4
Unit No. 5	**System of first order differential equations**	**12 Hours**		
	Solution of homogeneous constant coefficient system of differential equations	2	5	2,3
	Converting higher order differential equations into system of equations	1	5	2,3
	Tutorial	1	5	2,4
	Critical points and stability	1	5	2,3
	Nonhomogeneous Linear Systems of ODEs.	1	5	2,3
	Method of undetermined coefficients	1	5	2,4
	Tutorial	1	5	2.3
	Method of variation of parameters	2	5	2,3
	Linearization of Nonlinear Systems.	1	5	2,4
	Quiz	1	5	2,4
Total Contact Hours		**60**		

Learning Assessment

Bloom's Level of Cognitive Task		**Continuous Learning Assessments (50%)**				**End Semester Assessments (50%)**
		CLA-1 (15%)	**Mid-1 (20%)**	**CLA-2 (15%)**	**CLA-3 (NA)**	
Level 1	Remember	60%	50%	40%	NA	45%
	Understand					
Level 2	Apply	40%	50%	60%	NA	55%
	Analyse					
Level 3	Evaluate				NA	
	Create					
Total		**100%**	**100%**	**100%**	**NA**	**100%**

Recommended Resources

1. William Boyce and Richard DiPrima, Elementary Differential Equations and Boundary Value Problems, 11th Edition, Wiley-I
2. Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, Wiley-India.

Other Resources

1. G. F. Simmons, Differential Equations with Applications and Historical Notes, Tata McGraw-Hill Edition, Delhi (2003).

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Power Generation, Transmission and Distribution

Course Code	EEE 206	**Course Category**	Core		**L**	**T**	**P**	**C**
					3	0	1	4
Pre-Requisite Course(s)	Circuit Theory, Electromagnetic Field Theory	**Co-Requisite Course(s)**	Electrical Machine-II	**Progressive Course(s)**	Power System Analysis			
Course Offering Department	EEE	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

- To study the principle of operation and working of different electrical power generation sources.
- To recognize the constructional features of different types of overhead lines and insulators.
- To comprehend the constructional features of different types of underground cables.
- To realize the computation of transmission line resistance, inductance, and capacitance.
- To learn about the DC and AC distribution systems.

Course Outcomes / Course Learning Outcomes (CLOs)

CO's	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
1	Explain the operation of conventional generating stations and renewable sources of electrical power.	**2**	70%	70%
2	Explain the constructional features of different types of overhead lines and insulators	**2**	70%	60%
3	Illustrate the constructional features of different types of underground cables	**3**	70%	60%
4	Compute transmission line resistance, inductance, and capacitance	**3**	60%	50%
5	Discuss about the DC and AC distribution systems	**2**	60%	50%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and ICT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	2	3	2				2	1		2	2	1	1
Outcome 2	3	3	3	3	2				2	1		2	2	2	2
Outcome 3	3	3	3	3	2				2	1		2	2	2	2
Outcome 4	3	3	3	3	3				2	1		2	2	2	2
Outcome 5	3	3	3	3	3				2	1		2	2	2	2
Course Average	**3**	**3**	**3**	**3**	**2**				**2**	**1**		**2**	**2**	**2**	**2**

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	**Generation of Electric Power:** Typical layout of power system network, present power scenario in India	1	1	3
	General layout, working of thermal power plant with a brief description of components, site selection	2	1	3
	General layout, working of hydro power plant with a brief description of components, site selection.	2	1	3
	Nuclear power plant, Gas turbine power plant: general layout, working of nuclear and gas power plant with a brief description of components, site selection.	2	1	3
	Renewable energy sources (block diagram and brief description only): Solar energy, wind energy, tidal energy, and Fuel cells	2	1	3
Unit No. 2	**Mechanical Design of Overhead Lines:** Main components of overhead lines, Conductor materials, Line supports	2	2	2,3&4
	Insulators, Types of insulators, Potential distribution over suspension insulators	2	2	2,3&4
	String efficiency, Methods of improving string efficiency, Sag in overhead lines, Calculation of sag	2	2	2,3&4
	Corona, Factors affecting corona, Advantages and disadvantages of corona	2	2	2,3&4
	Methods of reducing corona effect	1	2	2,3&4
Unit No. 3	**Underground cables:** Underground cables, Construction of cables, Insulating materials for cables, Classification of cables	2	3	3&4
	Cables for three-phase service, Laying of underground cables, Insulation resistance of a single-core cable	2	3	3&4
	Capacitance of a single-core cable, Dielectric stresses in a single-core cable	2	3	3&4
	Most economical conductor size in a cable, Grading of cables, Capacitance grading, Intersheath grading	2	3	3&4
	Capacitance of 3-core cables, Measurements of core-to-core capacitance (Cc) and core to earth capacitance (Ce)	1	3	3&4
Unit No. 4	**Computation of Line parameters:** Different types of line conductors, Computation of line resistance, Effect of temperature and skin effect on the line resistance	1	4	1,2,3&4
	Inductance due to internal flux linkage, Inductance due to external flux linkage, Computation of inductance of single-phase lines, Flux linkages of one conductor in a group	2	4	1,2,3&4
	Inductance of composite conductor lines, Computation of inductance of three-phase lines with symmetrical and asymmetrical spacings	1	4	1,2,3&4
	Inductance of transposed lines, Computation of inductance for bundled conductors, Inductance of three-phase double circuit lines	1	4	1,2,3&4
	Electric field of a long straight conductor, Potential difference between two points due to a charge	1	4	1,2,3&4
	Computation of line capacitance of single-phase lines, Potential difference in a multi-conductor configuration	1	4	1,2,3&4

	Capacitance of three-phase lines with symmetrical and asymmetrical spacings	1	4	1,2,3&4
	Effect of earth on the capacitance, Computation of capacitance for bundled conductors	1	4	1,2,3&4
Unit No. 5	**Distribution Systems- DC and AC distribution:** Distribution system, Classification of distribution systems, AC distribution, DC distribution, Connection schemes of distribution system	2	5	3&4
	Types of DC distributors, DC distribution calculations, DC distributor fed at one end-concentrated loading, Uniformly loaded distributor fed at one end	2	5	3&4
	Distributor fed at both ends- concentrated loading, Uniformly loaded distributor fed at both ends, Distributor with both concentrated and uniform loading, Ring distributor, Ring main distributors with interconnector	2	5	3&4
	AC distribution calculations, Methods of solving AC distribution problems	2	5	3&4
	3-phase unbalanced loads, Four-wire star-connected unbalanced loads, Ground detectors	1	5	3&4

Course Unitization Plan – Laboratory

Unit No.	Experiment Name	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Solar power generation by using MATLAB.	3	1	1, 2 ,3&4
Unit No. 1	AC Voltage Generation by wind turbine using MATLAB	3	1	1, 2 ,3&4
Unit No. 1	AC -DC Voltage Converter for wind turbine using MATLAB	3	1	1, 2 ,3&4
Unit No. 2	String efficiency calculations for string insulator	3	2	1, 2 ,3&4
Unit No. 3&4	ABCD parameters of short Transmission line	3	3&4	1, 2 ,3&4
Unit No. 3&4	ABCD parameters of medium Transmission line	3	3&4	1, 2,3&4
Unit No. 3&4	ABCD parameters of long Transmission line	3	3&4	1, 2,3&4
Unit No. 5	DC Distribution system fed from one end.	3	5	1, 2 ,3&4
Unit No. 5	DC Distribution system fed from both ends.	3	5	1, 2 ,3&4
Unit No. 5	DC Distribution system fed by Ring main.	3	5	1, 2 ,3&4

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (50%)	
		CLA-1 (5%)		CLA-2 (5%)		CLA-3 (5%)		Mid Term (15% +10%=25%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	70%	-	40%	-	40%	-	40%	30%	40%	30%
	Understand										
Level 2	Apply	30%	-	60%	-	60%	-	60%	70%	60%	70%
	Analyse										
Level 3	Evaluate										
	Create										
Total		**100**%	-	**100**%	-	**100**%	-	**100**%	**100**%	**100**%	**100**%

Recommended Resources

1. Power Systems Analysis: John J. Grainger and W. D. Stevenson, Jr., McGraw-Hill, Inc., 1994.
2. Electrical Power systems: C. L. Wadhwa, 6th Edition, New Age International Publishers.
3. Principles of Power System: V.K. Mehta and Rohit Mehta, 4th Revised Edition, S. Chand.
4. Power System Engineering: D.P. Kothari and I.J. Nagrath, Second Edition, McGraw-Hill.

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Electrical Machine - II

Course Code	EEE 207	**Course Category**	Core		**L**	**T**	**P**	**C**
					3	0	1	4
Pre-Requisite Course(s)	Electrical Machine - I	**Co-Requisite Course(s)**		**Progressive Course(s)**	Power System Analysis			
Course Offering Department	EEE	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

- To introduce the concepts of three-phase induction motors and their testing.
- To deal with the detailed analysis of poly-phase induction motors and alternators.
- To understand the operation, construction and types of single-phase motors and their applications in household appliances and control systems.
- To learn and analyse the concept of parallel operation of alternators.
- To study the essential concepts of synchronous motors.

Course Outcomes / Course Learning Outcomes (CLOs)

CO's	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
1	Understand the concepts of rotating magnetic fields.	2	70%	70%
2	Analyse the three-phase induction motor.	3	70%	60%
3	Examine the operation of AC machines.	3	70%	60%
4	Analyse performance characteristics of AC machines.	3	60%	50%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and ICT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	2	3	2				2	1		2	1	1	
Outcome 2	3	3	3	3	2				2	1		2	2	2	1
Outcome 3	3	3	3	3	2				2	1		2	1	1	
Outcome 4	3	3	3	3	3				2	1		2	2	2	1
Outcome 5	3	3	3	3	3				2	1		2	2	2	
Course Average	**3**	**3**	**3**	**3**	**2**				**2**	**1**		**2**	**2**	**2**	**1**

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Constructional details, Types of rotors, Principle of operation	1	1,2	1 & 2
	Slip, cogging and crawling, Equivalent circuit	2	1,2	1 & 2
	Torque - Slip characteristics, Condition for maximum torque	3	1,2	1 & 2
	Losses and efficiency, Load test, No load, blocked rotor tests, Circle diagram, Separation of losses	3	1,2	1 & 2
Unit No. 2	Need for starting, Types of starters, DOL, Rotor resistance, Autotransformer and Star - delta starters	2	2,3	1 & 2
	Speed control, Voltage control, Frequency control and pole-changing	2	2,3	1 & 2
	Cascaded connection, V/f control, Slip power recovery scheme	2	2,3	1 & 2
	Braking of three-phase induction motor: Plugging, dynamic braking and regenerative braking.	2	2,3	1 & 2
Unit No. 3	Constructional features, double-revolving field theory	2	3	1 & 2
	Equivalent circuit, determination of parameters	2	3	1 & 2
	Split-phase starting methods and applications	4	3	1 & 2
Unit No. 4	Types of rotors, winding factors, EMF equation, Synchronous reactance	**2**	4,5	1 & 2
	Armature reaction, phasor diagrams of non-salient, pole synchronous generator connected to infinite bus	**2**	4,5	1 & 2
	Synchronizing and parallel operation, synchronizing torque, Change of excitation and mechanical input	**2**	4,5	1 & 2
	Voltage regulation – EMF, MMF, ZPF and A.S.A methods	**5**	4,5	1 & 2
	steady state power, angle characteristics, two reaction theory, slip test, short circuit transients, Capability Curves	**1**	4,5	1 & 2
Unit No. 5	Principle of operation, torque equation, operation on infinite bus bars	1	4,5	1 & 2
	V and Inverted V curves, power input and power developed equations	2	4,5	1 & 2
	Starting methods, current loci for constant power input, constant excitation and constant power developed	2	4,5	1 & 2
	Hunting, natural frequency of oscillations, damper windings, synchronous condenser	1	4,5	1 & 2
	Special machines: SRM, BLDC, PMSM	2	4,5	1 & 2
Total Contact Hours		**45**		

Course Unitization Plan - Laboratory

Unit No.	Experiment Name	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	No load and blocked rotor test on a 3- ϕ induction motor	3	1,2,3	1 & 2
Unit No. 1	Brake test on 3- ϕ squirrel cage induction motor	3	1,2,3	1 & 2
Unit No. 2	VFD drive based speed control of 3 phase ac motor	3	1,2,3	1 & 2
	3 phase ac induction generator	3	1,2,3	1 & 2
Unit No. 3	Load test on 1-phase induction motor	3	1,2,3	1 & 2
	Equivalent circuit of a sigle phase induction motor	3	1,2,3	1 & 2
Unit No. 4	Regulation of alternator using synchronous impedance method and mmf method	3	4,5	1 & 2
	Parallel operation of 3 phase alternator	3	4,5	1 & 2
Unit No. 5	Determination of x_d and x_q of salient pole synchronous motor	3	4,5	1 & 2
	'V' and 'inverted V' curves of synchronous motor	3	4,5	1 & 2

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (50%)	
		CLA-1 (5%)		CLA-2 (5%)		CLA-3 (10%)		Mid Term (10% + 20% = 30%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	60%	-	40%	-	20%	-	40%	30%	40%	30%
	Understand										
Level 2	Apply	40%	-	60%	-	80%	-	60%	70%	60%	70%
	Analyse										
Level 3	Evaluate										
	Create										
Total		**100%**	-	**100%**	-	**100%**	-	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Rashid, M.H. (2015). *Microelectronic Circuits: Analysis and Design* (3rd ed.). Cengage.
2. Bimbhra, P.S. (2021). *Electrical Machinery* (Fully Revised ed.). Khanna Publishers.
3. Nagrath, I. J., Kothari, D. P. (2017). Electric Machines (5th ed.). McGraw Hill Education.
4. Fitzgerald, A. E., Kingsley, C. (2017). Electric Machinery (6th ed.) McGraw Hill Education.
5. Langsdorf, A. S. (1984). Theory of Alternating current machines. McGraw Hill Education.

Other Resources

1. Prof. Bhuvaneshwari (2024). Electrical Machines. NPTEL Course IIT Delhi. URL: https://archive.nptel.ac.in/courses/108/102/108102146/

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Analog Circuits

Course Code	EEE 208	**Course Category**	Core		**L**	**T**	**P**	**C**
					3	0	1	4
Pre-Requisite Course(s)	Circuit Theory	**Co-Requisite Course(s)**	Linear Systems and Control Design	**Progressive Course(s)**	Power Electronics			
Course Offering Department	EEE	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

- To introduce characteristics, biasing techniques and circuit models of semiconductor devices.
- To provide analog electronic circuits design techniques and analytical skills using diodes, op-amps, MOSFETs and BJTs.
- To introduce students to the various elements of engineering design process, including formulation of specifications, analyses of alternate solutions, synthesis, decision making, iterations, consideration of cost factors, and simulation. Thereafter, design electronic circuits as per the specifications.

Course Outcomes / Course Learning Outcomes (CLOs)

CO's	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
1	Outline the basic electronic circuit design techniques and analytical skills using diodes, op-amps, MOSFETs and BJTs	**2**	**70%**	**65%**
2	Describe the characteristics, biasing techniques and circuit models of semiconductor devices.	**2**	**70%**	**65%**
3	Apply basic engineering methods to design, analyses and operation of electronic devices and circuits.	**3**	**70%**	**65%**
4	Develop problem solving skills of electronic circuits and design of circuits to meet desired specifications.	**3**	**70%**	**60%**

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and ICT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	2	2	1	2							1	2	3	1
Outcome 2	3	3	3	3	3							2	2	2	3
Outcome 3	3	3	3	3	3							2	2	2	3
Outcome 4	3	3	2	2	3							2	2	3	1
Course Average	**3**	**3**	**3**	**3**	**3**							**2**	**2**	**3**	**2**

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Importance of electronics; examples of analog circuits; Specifications of Electronic systems; Design of Electronic Circuits: Analysis vs design; Circuit level Design procedure	1	1	1, 2 & 4
	Amplifier characteristics; Amplifier types: Voltage, current, transconductance and transimpedance amplifiers	1	1, 3	1, 2 & 4
	Frequency response of amplifiers: Low pass, high pass, band-pass; gain and bandwidth relation	1	1, 3	1, 2 & 4
	Miller's theorem and frequency response methods	1	1, 3	1, 2 & 4
	Feedback Amplifiers: Topologies; Harmonic distortion	1	1, 3	1, 2 & 4
	Feedback amplifiers: Input and output resistance	1	1, 3	1, 2 & 4
Unit No. 2	Circuit design using Operational Amplifiers (Op-Amps)	1	1, 3	1, 2 & 4
	DC, AC and macro-model of Op-Amps	1	1, 2, 3	1, 2 & 4
	Analysis of Ideal op-amp circuits: Non-inverting/inverting amplifiers	1	1, 3	1, 2 & 4
	Op-Amp applications – I: Voltage follower; Summing Amplifier; The Differential Amplifier; Integrator; Differentiator; Transimpedance Amplifier; Transconductance Amplifier; The Instrumentation Amplifier	2	1, 2, 3	1, 2 & 4
	Op-Amp Applications – II: Optocoupler drivers; negative impedance converters; constant current sources; noninverting integrators; inductance simulators; AC-coupled bootstrapped voltage followers	3	1, 2, 3	1, 2 & 4
	Op-Amp Circuit Design: realistic op-amp; frequency effects; non-ideal effects	1	1, 3, 4	1, 2 & 4
Unit No. 3	Circuit design using Semiconductor diodes: Ideal diodes, transfer characteristics of diode circuits; determination of diode constants	2	2, 3	1, 2 & 4
	Modelling of practical diodes; Analysis of practical diode circuits; Zener diodes and design of Zener regulators	2	2, 3	1, 2 & 4
	Power rating; Diode data sheets	1	2, 3	1, 2 & 4
	Diode rectifiers (using only diode using opamp and diode); output filters for rectifiers	2	2, 3	1, 2 & 4
	Diode peak detectors; clippers and clampers	2	2,3	1, 2 & 4
	Diode function generators	2	2,3	1, 2 & 4
	Nonlinear amplifiers using op-amps and diodes	1	2, 3	1, 2 & 4
	Small signal model of BJT/MOSFETs and small signal analysis	2	1,2.3	1, 2 & 3

Unit No. 4	DC biasing of BJTs: Fixed Bias, Emitter resistance-feedback biasing, emitter follower biasing, two-base resistor biasing; Design of biasing circuits	3	1,2,3	1, 2 & 3
	CE, CC, CB amplifier analysis and design	2	1,3	1, 2 & 4
	Frequency response of BJT amplifiers	1	1,3	1, 2 & 4
	CS, CD and CG MOSFET amplifiers: analysis and design	2	2, 3	1, 2 & 4
	Cascade, current mirror and Darlington pair: motivation and analysis	1	1, 2, 3	1, 2 & 4
Unit No. 5	Waveform Generators: RC oscillators; Comparator, Schmitt Trigger	2	3, 4	1, 2 & 4
	Square-Wave generation; Sine Wave Generation from a Square-Wave Input	1	4	1, 2 & 4
	Triangular Wave Generation; Duty Cycle Modulation; Sawtooth Generation and circuit design	2	4	1, 2 & 4
	Multivibrators design with op-Amps and 555 timers	2	1, 4	1, 2 & 4

Course Unitization Plan – Laboratory

Unit No.	Experiment Name	Required Contact Hours	CLOs Addressed	References Used
Unit No.1	Familiarization with the laboratory equipment	2	1	2, 4
Unit No.2	Inverting amplifier and non-inverting amplifier	2	1, 2, 3	2, 4
	Integrator and differentiator using IC 741 op-amp	2	1, 2, 3	2, 4
Unit No.3	Design and analysis of half wave rectifier and clipping circuits, waveform generation using diodes	2	2, 3, 4	2, 4
	Design and analysis of full-wave rectifier and Zener regulator	2	2, 3, 4	2, 4
	Design of Voltage Clamping Circuits	2	2, 3	2, 4
Unit No.4	Study of BJT characteristics and BJT amplifier design	2	2, 3	2, 4
	Study of MOSFET characteristics and MOSFET amplifier design	2	2, 3	2, 4
Unit No.5	Half Wave Precision Rectifier design	2	3, 4	2, 4
	Log and Antilog amplifier for small ac signal	2	3, 4	2, 4
	Summing and Difference Amplifier	2	3, 4	2, 4
	Low pass and High Pass filter	2	3, 4	2, 4
	Comparator and Schmitt Trigger design	2	3, 4	2, 4
	Astable Multivibrator Design	2	3, 4	2, 4
	Monostable Multivibrator Design	2	3, 4	2, 4

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (50%)	
		CLA-1 (5%)		CLA-2 (5%)		CLA-3 (10%)		Mid Term (10% + 20% = 30%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	60%	-	40%	-	20%	-	40%	30%	40%	30%
	Understand										
Level 2	Apply	40%	-	60%	-	80%	-	60%	70%	60%	70%
	Analyse										
Level 3	Evaluate										
	Create										
Total		**100%**	-	**100%**	-	**100%**	-	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Rashid, M.H. (2015). *Microelectronic Circuits: Analysis and Design* (3rd ed.). Cengage.
2. Sedra, A.S., Smith, K.C., Carusone, T.C., Gaudet, V. (2020). *Microelectronic Circuits* (8th International ed.). Oxford University Press (OUP).
3. Razavi, B. (2021). *Fundamentals of Microelectronics* (3rd ed.). Wiley.
4. Neamen, Donald A. (2021). *Microelectronics: Circuit Analysis and Design* (4th ed.). Mc Graw Hill.

Other Resources

1. Rao, Radhakrishna K. (2024). *Analog Circuits and Systems.* NPTEL Course IIT Madras. URL: https://onlinecourses.nptel.ac.in/noc24_ee81/preview

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Linear Systems and Control Design

Course Code	EEE 209	**Course Category**	Core		**L**	**T**	**P**	**C**
					3	0	1	4
Pre-Requisite Course(s)	Circuit Theory	**Co-Requisite Course(s)**	Linear Systems and Control Design	**Progressive Course(s)**	Power Electronics			
Course Offering Department	EEE	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

- To introduce characteristics, biasing techniques and circuit models of semiconductor devices.
- To provide analog electronic circuits design techniques and analytical skills using diodes, op-amps, MOSFETs and BJTs.
- To introduce students to the various elements of engineering design process, including formulation of specifications, analyses of alternate solutions, synthesis, decision making, iterations, consideration of cost factors, and simulation. Thereafter, design electronic circuits as per the specifications.

Course Outcomes / Course Learning Outcomes (CLOs)

CO's	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
1	Outline the basic electronic circuit design techniques and analytical skills using diodes, op-amps, MOSFETs and BJTs	**2**	**70%**	**65%**
2	Describe the characteristics, biasing techniques and circuit models of semiconductor devices.	**2**	**70%**	**65%**
3	Apply basic engineering methods to design, analyses and operation of electronic devices and circuits.	**3**	**70%**	**65%**
4	Develop problem solving skills of electronic circuits and design of circuits to meet desired specifications.	**3**	**70%**	**60%**

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and ICT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	2	2	1	2							1	2	3	1
Outcome 2	3	3	3	3	3							2	2	2	3
Outcome 3	3	3	3	3	3							2	2	2	3

Outcome 4	3	3	2	2	3							2	2	3	1
Course Average	**3**	**3**	**3**	**3**	**3**							**2**	**2**	**3**	**2**

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Open loop-and closed loop control systems and examples	1	1	1 & 2
	Differential Equations, Laplace Transforms, Transfer Function	1	1	1 & 2
	Modelling Electrical, Mechanical, and Electro-mechanical Systems – Force/Torque-voltage and force/torque-current analogy	2	1	1 & 2
	Block diagram representation - block diagram reduction - signal flow graph - Mason's gain formula	2	1	1 & 2
	Characteristic equation, Concept, and significance of Pole & Zeros	1	1	1 & 2
	Control system components: DC and AC servo motors – synchro -gyroscope - stepper motor - Tacho generator.	2	1	1 & 2
Unit No. 2	Transient and steady state response characterisation, time domain specifications	2	2	1 & 2
	First and second order systems, Standard test input signals & Their application	2	2	1 & 2
	Time domain specifications for step input	2	2	1 & 2
	Steady state error analysis - static error coefficient of type 0,1, 2 systems - Dynamic error coefficients.	3	2	1 & 2
	Numerical Examples	1	2	1 & 2
Unit No. 3	Concept of stability: Time response for various pole locations - stability of feedback system - Routh's stability criterion	2	3	1, 2 & 3
	Root Locus (RL): Qualitative Sketching Rules and Inverse RL	2	3	1, 2 & 3
	Stability from root loci - effect of addition of poles and zeros.	1	3	1, 2 & 3
	Controller design through RL	2	3	1, 2 & 3
	Sensitivity Analysis	1	3	1, 2 & 3
Unit No. 4	Frequency domain specifications- Analysis based on Bode plot (BP) - Log magnitude vs. phase plot	2	4	1, 2 & 3
	Polar plot, Nyquist Plot (NP) mapping & Nyquist stability criterion	3	4	1, 2 & 3
	Non-minimum phase system - transportation lag	1	4	1, 2 & 3
	Analysis of nonminimum system with NP & RL	2	4	1, 2 & 3
	Gain Margin and Phase Margin with BP & NP	1	4	1, 2 & 3
	Loop shaping	1	4	1, 2 & 3
Unit No. 5	Design Using Frequency Response	1	4	1, 2 & 3
	Lag-lead controller design	2	4	1, 2 & 3
	Industrial Controllers, P, PI & PID	2	4	1, 2 & 3
	Controller optimization error performance specification (ISE, IAE & ITASE)	2	4	1, 2 & 3

Course Unitization Plan - Laboratory

Unit No.	Experiment Name	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Realization of Open loop and closed loop DC motor Speed control system	2	1	2, 4
Unit No. 2	First order control system and its transient response analysis	1	1, 2, 3	2, 4
	Second order control system and its transient response analysis	1		
	Type zero control systems and its steady state analysis	1		
	Type one control systems and its steady state analysis	1		
	Type two control systems and its steady state analysis	1	1, 2, 3	2, 4
Unit No. 3	Time domain response analysis using root locus technique	2	2, 3, 4	2, 4
Unit No. 4	Frequency domain response analysis using Bode plot technique	2	2, 3	2, 4
	Frequency domain response analysis using Nyquist plot technique	2	2, 3	2, 4
Unit No. 5	Lead compensator design using root locus technique	1	3, 4	2, 4
	Lag compensator design using root locus technique	1	3, 4	2, 4
	Lag-lead compensator design using root locus technique	1	3, 4	2, 4
	Lead compensator design using Bode plot technique	1	3, 4	2, 4
	Lag compensator design using Bode plot technique	1	3, 4	2, 4
	Lag-lead compensator design using Bode plot technique	1	3, 4	2, 4
	Design of P, PI, PID Controller	2	3, 4	2, 4

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (50%)	
		CLA-1 (5%)		CLA-2 (5%)		CLA-3 (10%)		Mid Term (10% + 20% = 30%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	60%	-	40%	-	20%	-	40%	30%	40%	30%
	Understand										
Level 2	Apply	40%	-	60%	-	80%	-	60%	70%	60%	70%
	Analyse										
Level 3	Evaluate										
	Create										
Total		**100%**	-	**100%**	-	**100%**	-	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Rashid, M.H. (2015). *Microelectronic Circuits: Analysis and Design* (3rd ed.). Cengage.
2. Sedra, A.S., Smith, K.C., Carusone, T.C., Gaudet, V. (2020). *Microelectronic Circuits* (8th International ed.). Oxford University Press (OUP).
3. Razavi, B. (2021). *Fundamentals of Microelectronics* (3rd ed.). Wiley.
4. Neamen, Donald A. (2021). *Microelectronics: Circuit Analysis and Design* (4th ed.). Mc Graw Hill.

Other Resources

1. Rao, Radhakrishna K. (2024). *Analog Circuits and Systems.* NPTEL Course IIT Madras. URL: https://onlinecourses.nptel.ac.in/noc24_ee81/preview

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Measurements and Instrumentation

Course Code	EEE 210	**Course Category**	SEC	**L**	**T**	**P**	**C**
				3	0	1	4
Pre-Requisite Course(s)		**Co-Requisite Course(s)**	Basic Electrical and Electronics Engineering	**Progressive Course(s)**			
Course Offering Department	EEE	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

- Study the principle of operation and working of different types of instruments. Measurement of voltage and current.
- Understand the working principle of operation of different types of instruments for measurement of power and energy.
- Learn the principle of operation and working of dc and ac potentiometers, instrumentation transformers.
- Apply AC and DC bridges for measurement of electrical parameters like resistance, inductance, and capacitance.
- Understand the basic concepts of digital metering and transducers.

Course Outcomes / Course Learning Outcomes (CLOs)

CO's	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
1	Identify the right type of instrument for measurement of voltage and current for ac and dc.	**2**	**70%**	**65%**
2	Identify the right type of instrument for measurement of power and energy.	**2**	**70%**	**65%**
3	Illustrate the calibration of various measuring meters with help of potentiometer.	**3**	**70%**	**65%**
4	Apply the solution for measurement of electrical parameters like resistance, inductance and capacitance.	**3**	**70%**	**60%**
5	Describe the basic operation of transducers, building blocks of digital systems, recording and display units.	**2**	**70%**	**60%**

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and ICT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	2	3	1	2							1	1		
Outcome 2	3	2	3	1	2							1	1		
Outcome 3	3	3	3	2	2							2	1		
Outcome 4	3	3	3	2	2							2	1		
Course Average	**3**	**2**	**3**	**2**	**2**							**2**	**1**		

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Measuring Instruments and Classifications	1	1	1, 2 & 3
	Errors in Measurements	1	1	1, 2 & 3
	Classification of operating torques – deflecting, control and damping torques	1	1	1, 2 & 3
	Measurement of voltage & current- Permanent Magnet Moving Coil (PMMC) type	2	1	1, 2 & 3
	Measurement of voltage & current- Moving Iron type	2	1	1, 2 & 3
	Electrodynamometer-Type Instruments	1	1	1, 2 & 3
Unit No. 2	Power Measurement in DC and AC Circuits	1	2	1, 2 & 3
	Electrodynamometer and Induction-type Wattmeter	2	2	1, 2 & 3
	Measurement of active and reactive powers in balanced and unbalanced systems.	2	2	1, 2 & 3
	Single-Phase Induction-type Energy Meter	2	2	1, 2 & 3
	Errors in Induction-type Energy Meters and			
	Their Compensation	2	2	1, 2 & 3
Unit No. 3	Principle and operation of D.C. Crompton's potentiometer – standardization	2	3	1, 2 & 3
	Measurement of unknown resistance, current, voltage	1	3, 4	1, 2 & 3
	AC Potentiometers – classifications, applications, advantages and disadvantages	2	3	1, 2 & 3
	Instrument transformers – Current and Potential transformers	2	3	1, 2 & 3
	Ratio and phase angle errors	2	3	1, 2 & 3
Unit No. 4	Method of measuring low, medium and high resistance, Wheat-stone's bridge – Carey Foster's bridge	2	4	1, 2 & 3
	Measurement of low resistance - Kelvin's double bridge	1		
	Measurement of high resistance – loss of charge method	1	4	1, 2 & 3
	Measurement of inductance-Maxwell's bridge, Hay bridge, Anderson's bridge	2	4	1, 2 & 3
	Measurement of capacitance and loss angle - De Sauty's bridge, Schering bridge	2	4	1, 2 & 3
	Frequency measurement and Wagner Earthing Device	1	4	1, 2 & 3
Unit No. 5	Block diagram of and working principle of Digital Storage Oscilloscope (DSO)	2	5	1, 2 & 3
	Measurement of Electrical Quantities, Voltage, Current and phase using DSO	1	5	1, 2 & 3
	Electronic Voltmeters (DVMs)	1	5	1, 2 & 3
	Digital Frequency Meter	1	5	1, 2 & 3
	Electrical Transducers	1	5	1, 2 & 3
	Linear Variable differential Transformer (LVDT)	1	5	1, 2 & 3
	Strain Gauges and Electromagnetic Flow Meter	1	5	1, 2 & 3
	Temperature Transducers Pressure Measurement	1	5	1, 2 & 3

Course Unitization Plan – Laboratory

Unit No.	Experiment Name	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Measurement of medium resistance by using the voltmeter and ammeter method.	2	1,4 1,4	1,3
	Conduct clamp-on meter for measurement of AC current.	2	1,4	1,3
	Measurement of resistance and inductance of a choke coil using a three-voltmeter method	2	1,4	1,3
	Measurement of resistance and inductance of a choke coil using a three-ammeter method	2	1,4	1,3
Unit No. 2	Calibration & testing of single-phase energy meter	2	1, 2, 3	2, 3
	Study the three phase power and reactive power measurement by using two wattmeter method balanced load	2	2, 3, 4	2, 3
	Measurement of 3-phase reactive power with single wattmeter for balanced loading	2	2, 3	2, 3
	Measurement of 3-phase active power by using a single watt-meter method	2	2, 3	2, 3
Unit No. 3	CT error ratio	2		2, 3
Unit No. 4	Measurement of resistance by using Wheatstone's bridge	2	3, 4	2, 3

Learning Assessment

Bloom's Level of Cognitive Task		CLA-1 (5%)		CLA-2 (5%)		CLA-3 (10%)		Mid Term (10% + 20% = 30%)		End Semester Exam (50%)	
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	70%	-	40%	-	40%	-	40%	30%	40%	30%
	Understand										
Level 2	Apply	30%	-	60%	-	60%	-	60%	70%	60%	70%
	Analyse										
Level 3	Evaluate										
	Create										
Total		**100**%	-	**100**%	-	**100**%	-	**100**%	**100**%	**100**%	**100**%

Recommended Resources

1. A.K. Sawhney. (2015), *A Course in Electrical and Electronic Measurements and Instrumentation* (19th ed.). Dhanpat Rai & Co (P).
2. E.W. Golding and F.C. Widdis. (2019), *Electrical Measurements and Measuring Instruments* (6th ed.). Medtech.
3. R.K. Rajput. (2020), *Electrical and Electronic Measurement* ***and Instrumentation,*** **(4th ed.). S. Chand**

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Guntur District, Mangalagiri, Andhra Pradesh – 522240.

Principles of Signal Processing

Course Code	EEE 301	**Course Category**	Core		**L**	**T**	**P**	**C**
					3	0	0	3
Pre-Requisite Course(s)	Circuit Theory	**Co-Requisite Course(s)**	Nonlinear Systems and Control, Power Electronics	**Progressive Course(s)**				
Course Offering Department	EEE	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

- Outline and discuss the mathematical representation of continuous and discrete time signals and their further classification; develop input/output relationship for systems and their classification.
- Perform frequency-domain analysis of systems and periodic signals using Fourier series and aperiodic signals through Fourier transforms.
- Identify the limitations of Fourier transform and the necessity of Laplace and Z transform; their areas of application; striking a balance between theory and practice so that the theory discussed can be realized in simulations and easily compared with the analytically predicted results.

Course Outcomes / Course Learning Outcomes (CLOs)

CO's	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
1	Discuss fundamental principles of signals and systems which would allow them to analyse and apply to any physical system in time and frequency domain	**3**	**70%**	**65%**
2	Convert a signal/system from continuous time domain to a discrete-time domain and reconstruct it	**2**	**70%**	**65%**
3	Analyse the pros and cons of discretization of continuous time systems and apply the techniques as per the application requirement	**3**	**70%**	**60%**
4	To clearly apply the course knowledge to modern digital signal processing, control systems, signals and harmonic analysis in power electronics and power system analysis/stability.	**2**	**70%**	**60%**

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and ICT Usage	Society and Multicultural	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	2	2	1	2							1	3	2	3
Outcome 2	3	3	3	3	3							2	1	2	2
Outcome 3	3	3	3	3	3							2	2	2	1
Outcome 4	3	3	2	2	3							2	3	2	3
Course Average	**3**	**3**	**3**	**3**	**3**							**2**	**3**	**2**	**3**

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Classification of signals: continuous-time (CT)/discrete-time (DT), Even and odd, symmetry of signals	2	1,4	1, 2
	Periodic and aperiodic, energy and power signals, random, and deterministic signals	1	1,4	1, 2
	Standard signals: impulse, step, ramp, exponential, signum and sinusoids: definition and properties	1	1,4	1, 2
	Operations on signals: Amplitude scaling, addition, multiplication, differentiation, integration and their effects on energy and power signals.	2	1,4	1, 2
	Operations on signals: Time scaling, shifting, and folding and effect on energy/power signals	1	1,4	1, 2
	Analogy between vectors and signals, orthogonal signal space, signal approximation using orthogonal functions	2	1,4	1, 2
Unit No. 2	System: definition, Continuous-time/discrete-time LTI System	1	1,4	1, 2
	Classification of systems: linear and nonlinear, time-invariant/time-variant systems, static and dynamic, causal and non-causal, stable and unstable	2	1,4	1, 2
	Continuous-time/discrete-time LTI System properties: causality, memory, Stability (BIBO stability), and feedback system	2	1,4	1, 2
	Unit impulse response and convolution integral	1	1,4	1, 2
	Convolution: properties, response using convolution sum, and solution approach	3	1,4	1, 2
Unit No. 3	Definition and necessity of continuous and discrete-time Fourier series, Fourier series representation of periodic signals	1	1,3,4	1, 2, 3
	Properties and representation of Fourier series, Dirichlet's conditions for the existence of Fourier series	2	1,3,4	1, 2, 3
	Periodicity of DT signal, DT signal representation Fourier series	1	1,3,4	1, 2, 3
	Properties of DT Fourier series, Parseval power theorem	2	1,3,4	1, 2, 3
	Fourier Transform: Motivation, representation of an aperiodic signal	1	1,3,4	1, 2, 3
	Fourier Transforms of some useful signals	2	1,3,4	1, 2, 3
	Properties of Fourier transform and Parseval's theorem	2	1,3,4	1, 2, 3
	CTFT of periodic signals, amplitude and phase spectra, Discrete-time Fourier transform (DTFT) and its properties.	3	1,3,4	1, 2, 3
	Connection between Fourier transform with Laplace and Z-transform	1	1,3,4	1, 2, 3
Unit No. 4	Laplace Transform: Definition, derivation, necessity, existence conditions and region of convergence (ROC)	2	1,4	1, 2
	Properties of Laplace transform	1	1,4	1, 2
	Laplace transform of periodic signals, Use of Laplace Transforms to find response of an LTI system	2	1,4	1, 2
	Differential equation solution	1	1,4	1, 2
	Inverse Laplace transform	1	1,4	1, 2
	Initial and final value theorems; causality and stability from Laplace Transforms	2	1,4	1, 2

	Laplace Transform: Definition, derivation, necessity, existence conditions and region of convergence (ROC)	2	1,4	1, 2
Unit No. 5	Z-Transform: Definition, derivation, necessity, existence conditions and region of convergence (ROC)	2	2,3,4	1, 2
	Properties of Z-transform	1	2,3,4	1, 2
	Inverse Z-transform	1	2,3,4	1, 2
	Z-transform solution of linear difference equations	2	2,3,4	1, 2
	DT system realization	2	2,3,4	1, 2

Learning Assessment

Bloom's Level of Cognitive Task		**Continuous Learning Assessments (50%)**								**End Semester Exam (50%)**	
		CLA-1 (10%)		**CLA-2 (10%)**		**CLA-3 (10%)**		**Mid Term (20%)**			
		Th	**Prac**	**Th**	**Prac**	**Th**	**Prac**	**Th**	**Prac**	**Th**	**Prac**
Level 1	Remember	40%	-	40%	-	20%	-	40%	-	40%	-
	Understand										
Level 2	Apply	60%	-	60%	-	80%	-	60%	-	60%	-
	Analyse										
Level 3	Evaluate	-	-	-	-	-	-	-	-	-	-
	Create	-	-	-	-	-	-	-	-	-	-
Total		**100**%	-	**100**%	-	**100**%	-	**100**%	-	**100**%	-

Recommended Resources

1. Oppenheim, A.V., Willsky, A.S., and Nawab, S. *Signals and Systems* (2nd ed.). Prentice Hall.
2. Haykin, S., Veen, B.V., (2021). *Signals and Systems* (2nd ed.). Wiley.
3. Lathi, B.P. (2009). *Principles of Signal Processing and Linear Systems* (2nd ed.). Oxford.

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Power System Analysis

Course Code	EEE 302	**Course Category**	Core		**L**	**T**	**P**	**C**
					3	0	1	4
Pre-Requisite Course(s)	Power Generation, Transmission and Distribution	**Co-Requisite Course(s)**	-	**Progressive Course(s)**	Switchgear and Protection			
Course Offering Department	EEE	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

- To develop the impedance diagram (p.u), formation of Ybus, and study the concept of the Zbus building algorithm.
- To analyse power system performance during steady state and fault conditions.
- To analyse the stability status of power systems.

Course Outcomes / Course Learning Outcomes (CLOs)

CO's	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
1	Interpret the impedance diagram (p.u), formation of Ybus,and building of Zbus.	**3**	**70%**	**65%**
2	Use numerical methods concepts to analyse the steady-state operation of power systems.	**4**	**60%**	**55%**
3	Analyse the behaviour of power systems under symmetrical and unsymmetrical fault conditions.	**4**	**60%**	**55%**
4	Analyse the stability status of power systems under given conditions.	**4**	**65%**	**55%**

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and ICT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	2	1	1				1	2		1	2	1	1
Outcome 2	3	3	3	3	3				2	2		1	2	2	2
Outcome 3	3	3	3	3	3				2	2		1	2	2	2
Outcome 4	3	3	3	3	3				2	2		1	2	2	2
Course Average	**3**	**3**	**3**	**3**	**3**				**2**	**2**		**1**	**2**	**2**	**2**

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	**Per Unit Representation & Topology:** Per Unit Representation –Single line diagram	1	1	1, 2 & 3
	Impedance diagram of a power system	2	1	1, 2 & 3
	Formation of element node incidence and bus incidence matrices	2	1	1, 2 & 3
	Formation of Y–bus matrix by singular transformation and direct inspection methods	3	1	1, 2 & 3
	Formation of Z–Bus: Partial network– Algorithm for the Modification of Zbus Matrix for addition elements	3	1	1, 2 & 3
Unit No. 2	**Power Flow Analysis:** Necessity of power flow studies – Derivation of static power flow equations	2	2	1, 2 & 3
	Solution of Power Flow Equations by Gauss-Seidel Method	2	2	1, 2 & 3
	Solution of Power Flow Equations by Newton Raphson Method	2	2	1, 2 & 3
	Fast Decoupled Power Flow Solution, Comparison of Power Flow Methods	2	2	1, 2 & 3
Unit No. 3	**Symmetrical Fault Analysis:** Introduction to Symmetrical Fault Analysis	1	3	1, 2 & 3
	Symmetrical Fault Analysis using Thevenin's Method	3	3	1, 2 & 3
	Symmetrical Fault Analysis using Bus Impedance Matrix	2	3	1, 2 & 3
	Short Circuit Capacity and Example problems	2	3	1, 2 & 3
Unit No. 4	**Unsymmetrical Fault Analysis:** Fundamentals of Symmetrical Components	1	3	1, 2 & 3
	Sequence Impedances for: Transmission Lines, Star Connected Loads, Synchronous Machines, Transformers	1	3	1, 2 & 3
	Sequence Networks of a Loaded Generator	2	3	1, 2 & 3
	Unsymmetrical Fault Analysis: Single Line-to-Ground Fault, Line-to-Line Fault, Double Line-to-Ground Fault	3	3	1, 2 & 3
	Unsymmetrical Fault Analysis using Bus Impedance Matrix	2	3	1, 2 & 3
Unit No. 5	**Power System Stability:** Introduction to Power System Stability Problems, Swing Equation	2	4	1, 2 & 3
	Synchronous Machine Models for Stability Studies	1	4	1, 2 & 3
	Steady State Stability Analysis	2	4	1, 2 & 3
	Transient Stability Analysis- Equal Area Criterion	1	4	1, 2 & 3
	Applications of Equal Area Criterion to Sudden Increase in Power Input and Three Phase Fault	3	4	1, 2 & 3

Course Unitization Plan – Laboratory

Unit No.	Experiment Name	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Formation of bus admittance matrix by using MATLAB	3	1	1, 2 & 3
Unit No. 1	Formation of bus impedance matrix by using MATLAB	3	1	1, 2 & 3
Unit No. 1	Sequence impedance of three phase transformer	3	1	1, 2 & 3
Unit No. 2	Load flow study using Gauss-Seidel method by using MATLAB	3	2	1, 2 & 3
Unit No. 2	Load flow study using Newton Raphson method by using MATLAB	3	2	1, 2 & 3
Unit No. 3	L-G Fault analysis for 3-phase transformer	3	3	1, 2 & 3
Unit No. 3	L-L Fault analysis for 3-phase transformer	3	3	1, 2 & 3
Unit No. 3	L-G Fault analysis for 3-phase alternator	3	3	1, 2 & 3
Unit No. 3	LLLG Fault analysis for 3-phase alternator	3	3	1, 2 & 3
Unit No. 4	Power angle characteristics of alternator	3	4	1, 2 & 3

Learning Assessment

Bloom's Level of Cognitive Task		**Continuous Learning Assessments (50%)**								**End Semester Exam (50%)**	
		CLA-1 (5%)		**CLA-2 (5%)**		**CLA-3 (5%)**		**Mid Term (15% + 20% = 35%)**			
		Th	**Prac**	**Th**	**Prac**	**Th**	**Prac**	**Th**	**Prac**	**Th**	**Prac**
Level 1	Remember	70%	-	40%	-	40%	-	40%	30%	40%	30%
	Understand										
Level 2	Apply	30%	-	60%	-	60%	-	60%	70%	60%	70%
	Analyse										
Level 3	Evaluate										
	Create										
Total		**100%**	-	**100%**	-	**100%**	-	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. H. Saadat (2010). *Power System Analysis* (3rd ed.). PSA Publishing.
2. D. P. Kothari, I. J. Nagrath, and R. K. Saket (2022). *Modern Power System Analysis* (5th ed.). McGraw Hill Education.
3. V.K. Mehta and R. Mehta (2006). *Principles of Power System* (Revised ed.). S Chand & Co Ltd.

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Nonlinear Systems and Control

Course Code	EEE 303	**Course Category**	Core	**L**	**T**	**P**	**C**
				2	0	1	3
Pre-Requisite Course(s)	Linear Systems and Control Design	**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	EEE	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

- To equip the students with the necessary methods along with prerequisites for analysing the structure and behaviour of nonlinear feedback systems.
- To learn the basic design techniques including feedback linearization, Lyapunov design, backstepping, and model reference adaptive control along with suitable application.

Course Outcomes / Course Learning Outcomes (CLOs)

CO's	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
1	have insight into the basic differences between open-loop and closed-loop systems	3	70%	70%
2	have insight into the basic differences between linear and non-linear systems	3	70%	60%
3	define fundamental control-theoretical stability concepts	3	70%	60%
4	give an overview of modern directions in nonlinear control	3	60%	50%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and ICT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	2	3	2				2	1		2	1	2	3
Outcome 2	3	3	3	3	2				2	1		2	1	2	3
Outcome 3	3	3	3	3	2				2	1		2	1	2	3
Outcome 4	3	3	3	3	3				2	1		2	1	2	3
Outcome 5	3	3	3	3	3				2	1		2	1	2	3
Course Average	**3**	**3**	**3**	**3**	**2**				**2**	**1**		**2**	1	2	3

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	**Linear compensators and controllers:** Review of compensators	2	1, 2, 3	1-3
	Review of PI, PD and PID controllers	2	1, 2, 3	1-3
Unit No. 2	**State-space analysis:** State-space solutions and realization	3	1, 2, 3	1, 2
	Stability and Controllability	1	1, 2, 3	1-3
	State Feedback Controller Design	1	1	1, 2
	Observability and Observer Design	1	1	1, 2
Unit No. 3	**Nonlinear Systems Introduction:** Examples of nonlinear systems and their properties	2	1, 2, 3	1-3
	Existence and Uniqueness of Solutions	1	1, 2, 3	1-3
	Vector, Matrix, and Signal Norms	1	1, 2, 3	1-3
Unit No. 4	**Stability of nonlinear systems:** Lyapunov Stability definitions – stability, uniformity, attractivity, asymptotic stability, exponential stability	2	1, 2, 4	1-3
	Function classes; Definiteness, radial boundedness, decrescence; Lyapunov stability theorems	2	1, 2, 4	1-3
	Stability theorems – Stability in the sense of Lyapunov and Asymptotic Stability	2	1, 2, 4	1-3
	LaSalle's invariance principle, worked out examples	1	1, 2, 4	1-3
	Stability of nonautonomous systems	1	1, 2, 4	1-3
Unit No. 5	**Nonlinear control design:** Controllability and observability in non-linear systems	1	1, 2, 4	5
	Control Lyapunov Functions	1	1, 2, 4	5
	Backstepping method for control design, integrator backstepping	2	1, 2, 4	5
	Feedback linearization – motivation, Lie derivatives, relative degree results	2	1, 2, 4	5
	Feedback linearization – Zero dynamics, local Asymptotic Stability.	2	1, 2, 4	4

Course Unitization Plan - Laboratory

Unit No.	Experiment Name	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	PID Controller design for position control of DC Servo motor (Ziegler Nichols Tuning method)	2	1	1-3
Unit No. 1	PID Controller design for position control of DC Servo motor (Standard transfer function-based method)	2	1	1-3
Unit No. 1	Design of DC-DC converter and open-loop analysis (simulation)	2	1	1-3
Unit No. 1	Design of DC-DC converter and open-loop analysis (hardware)	2	1	1-3
Unit No. 2	Closed-loop PI controller design of DC-DC converter (simulation)	2	2	1-3
Unit No. 2	Closed-loop PI controller design of DC-DC converter (hardware)	2	2	1-3
Unit No. 3	Rotary inverted pendulum modeling and open-loop analysis	2	3	1-3
Unit No. 3	PI controller design for rotary inverted pendulum (Ziegler Nichols Tuning method)	2	3	1-3
Unit No. 4	PI controller design for rotary inverted pendulum (Standard transfer function-based method)	2	4	1-3
Unit No. 4	Nonlinear control design for rotary inverted pendulum	2	4	1-3
Total Contact Hours		**30**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (50%)	
		CLA-1 (5%)		CLA-2 (5%)		CLA-3 (10%)		Mid Term (10% + 20% = 30%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	60%	-	40%	-	20%	-	40%	30%	40%	30%
	Understand										
Level 2	Apply	40%	-	60%	-	80%	-	60%	70%	60%	70%
	Analyse										
Level 3	Evaluate										
	Create										
Total		**100**%	-	**100**%	-	**100**%	-	**100**%	**100**%	**100**%	**100**%

Recommended Resources

1. Thomas Kailath, Linear Systems, Pearson, 2016.
2. Gene F. Franklin, J. David Powell, Abbas Emami-Naeini, Feedback Control of Dynamic Systems, Pearson, 7th ed., 2014.
3. M. Gopal, Modern Control Systems Engineering, New Age International, 5th ed., 2008.
4. Frank L. Lewis, Darren M. Dawson, Chaouki T. Abdallah, Robot Manipulator Control, CRC Press, 2 nd ed., 2003.
5. Miroslav Krstic, Ioannis Kanellakopoulos, Petar Kokotovic, Nonlinear and Adaptive
6. Control, John Wiley & Sons, 1995.

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Power Electronics

Course Code	EEE 304	**Course Category**	Core		**L**	**T**	**P**	**C**
					3	0	1	4
Pre-Requisite Course(s)	Circuit Theory	**Co-Requisite Course(s)**	-	**Progressive Course(s)**	Renewable Energy Sources			
Course Offering Department	EEE	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

- Equip the students with a basic understanding of modern power semiconductor devices.
- Introduce the operation and working of important topologies of power converter circuits for specific types of applications.
- Equips students with an ability to understand and analyze non-linear circuits involving power electronic converters**.**

Course Outcomes / Course Learning Outcomes (CLOs)

CO's	**At the end of the course the learner will be able to**	**Bloom's Level**	**Expected Proficiency Percentage**	**Expected Attainment Percentage**
1	Choose switching devices for a given power converter.	**2**	**70**%	**65**%
2	Evaluate the performance of AC-DC converters.	**3**	**70**%	**65**%
3	Design DC-DC choppers for a given performance.	**3**	**70**%	**65**%
4	Analyze and evaluate the operation of inverters and ac-ac converters.	**4**	**70**%	**65**%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	**Program Learning Outcomes (PLO)**														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and ICT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Lifelong	PSO 1	PSO 2	PSO 3
Outcome 1	3	2	2	1	2							1	3	1	
Outcome 2	3	3	2	3	3							1	2	3	
Outcome 3	3	3	2	3	2							1	3	3	
Outcome 4	3	3	3	3	2							2	3	3	
Course Average	**3**	**3**	**2**	**3**	**2**							**1**	**3**	**3**	

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	**Power Semiconductor Devices:** Concept of power electronics, scope and applications, types of power converters.	1	1	1, 2 & 3
	Power semiconductor switches and their V-I characteristics of Diodes, SCR and TRIAC.	2	1	1, 2 & 3
	V-I characteristics of power MOSFET and IGBT.	2	1	1, 2 & 3
	Thyristor ratings and protection, methods of SCR commutation.	2	1	1, 2 & 3
	Gate drive circuits.	1	1	1, 2 & 3
	Switching and conduction losses in a generic power semiconductor device.	2	1	1, 2 & 3
	Wide bandgap switching devices.	1	1	1, 2 & 3
Unit No. 2	**AC-DC Converters:** Principles of single-phase half-controlled converter with RL and RLE load.	3	2	1, 2 & 3
	Principles of single-phase fully controlled converter with R, RL, and RLE load.	3	2	1, 2 & 3
	Principles of three- phase fully controlled converter operation with RLE load.	2	2	1, 2 & 3
	Effect of source inductance.	1	2	1, 2 & 3
	Single phase and Three phase dual converters.	2	2	1, 2 & 3
Unit No. 3	**Choppers:** Introduction, Basic principles of choppers.	1	3	1, 2 & 3
	Time ratio control.	1	3	1, 2 & 3
	Chopper classification, study of Buck regulator.	2	3	1, 2 & 3
	Study of Boost and Buck-Boost regulators.	2	3	1, 2 & 3
	Tutorial Problems.	1	3	1, 2 & 3
Unit No. 4	**DC-AC Converters:** Introduction, principle of operation, performance parameters.	1	4	1, 2 & 3
	single phase bridge inverters with R, RL and RLC loads.	2	4	1, 2 & 3
	3-phase bridge inverters- 180 degrees mode of operation.	2	4	1, 2 & 3
	3-phase bridge inverters- 120 degrees mode of operation.	1	4	1, 2 & 3
	Voltage control of single-phase inverters –single pulse width modulation and multiple pulse width modulation.	2	4	1, 2 & 3
	Voltage control of single-phase inverters sinusoidal pulse width modulation.	1	4	1, 2 & 3
Unit No. 5	**AC-AC Converters:** Introduction and Single-phase AC voltage controller with R and RL Load.	2	4	1, 2 & 3
	Single-phase AC voltage controller using TRIAC with R and RL Load.	1	4	1, 2 & 3
	Midpoint step down cyclo-converter with R load.	1	4	1, 2 & 3
	Bridge type step down cyclo-converter with R-load.	1	4	1, 2 & 3
	Midpoint step up cyclo-converter with R load.	1	4	1, 2 & 3
	Bridge type step-up cyclo converters with R load.	1	4	1, 2 & 3

Course Unitization Plan – Laboratory

Unit No.	Experiment Name	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Study V-I characteristics of SCR and MOSFET.	3	1	1, 2 & 3
Unit No. 2	Characteristics of single-phase fully controlled bridge rectifier.	3	2	1, 2 & 3
Unit No. 2	Characteristics of single-phase semi-controlled bridge rectifier.	3	2	1, 2 & 3
Unit No. 2	Characteristics of three-phase fully controlled rectifier.	3	2	1, 2 & 3
Unit No. 3	Study of characteristics of DC-DC buck chopper.	3	3	1, 2 & 3
Unit No. 3	Study of characteristics of DC-DC boost chopper.	3	3	1, 2 & 3
Unit No. 4	Study of unipolar and bi-polar PWM based single-phase inverter.	3	4	1, 2 & 3
Unit No. 4	Study of 3-Phase PWM inverter.	3	4	1, 2 & 3
Unit No. 4	Study of single-phase ac voltage controller.	3	4	1, 2 & 3
Unit No. 4	Study of step down cyclo converter.	3	4	1, 2 & 3

Learning Assessment

Bloom's Level of Cognitive Task		**Continuous Learning Assessments (50%)**								**End Semester Exam (50%)**	
		CLA-1 (5%)		**CLA-2 (5%)**		**CLA-3 (5%)**		**Mid Term (15% + 20% = 35%)**			
		Th	**Prac**	**Th**	**Prac**	**Th**	**Prac**	**Th**	**Prac**	**Th**	**Prac**
Level 1	Remember	70%	-	40%	-	40%	-	40%	30%	40%	30%
	Understand										
Level 2	Apply	30%	-	60%	-	60%	-	60%	70%	60%	70%
	Analyse										
Level 3	Evaluate										
	Create										
Total		**100%**	-	**100%**	-	**100%**	-	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. M. H. Rashid. (2018). Power Electronics: Devices, Circuits, and Applications (4th ed.). Pearson.
2. Ned Mohan, Tore M. Undeland, William P. Robbins. (2006). Power Electronics- Converters, Applications and Design (3rd ed.). John Wiley & Sons.
3. M.D. Singh and K.B.Khanchandani. (2006). Power Electronics. (2nd ed.). Tata McGraw-Hill.

Other Resources

1. Prof. B.G. Fernandes. *Power Electronics.* NPTEL Course IIT Bombay. URL: https://nptel.ac.in/courses/108/101/108101038/
2. Prof. Vivek Agarwal, Prof. L. Umanand. *Fundamental of Power Electronics*. NPTEL Course IIT Bombay & IISc Bengaluru. URL: https://nptel.ac.in/courses/108/101/108101126/

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Microcontrollers and Applications

Course Code	EEE 305	**Course Category**	Core		**L**	**T**	**P**	**C**
					2	0	1	3
Pre-Requisite Course(s)	-	**Co-Requisite Course(s)**	Design of Power Electronics Circuits Lab	**Progressive Course(s)**	Embedded Systems			
Course Offering Department	EEE	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

- To understand the internal architecture of 8051 Microcontrollers.
- To understand and acquire knowledge in programming 8051 Microcontroller using Embedded C.

Course Outcomes / Course Learning Outcomes (CLOs)

CO's	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
1	Describe the architecture and functional block diagram of 8051 microcontroller	**2**	**70%**	**65%**
2	Identify various applications of 8051 microcontroller	**2**	**70%**	**65%**
3	Realize various mathematical and logical operations on 8051 microcontroller using Assembly and Embedded C	**3**	**70%**	**60%**
4	Interface 8051 microcontroller with A/D and D/A converters for serial communication	**2**	**70%**	**60%**

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

COs	Program Learning Outcomes (PLO)													
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and ICT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	2	2	1	2							1	3	2	3
Outcome 2	3	3	3	3	3							2	1	2	2
Outcome 3	3	3	3	3	3							2	2	2	1
Outcome 4	3	3	2	2	3							2	3	2	3
Course Average	**3**	**3**	**3**	**3**	**3**							**2**	**3**	**2**	**3**

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	The Microcontroller 8051: Introduction and history of microcontrollers.	1	1	1, 2
	Features of 8051 microcontroller. Block diagram of 8051- program status word (PSW), accumulator, program counter	1	1	1, 2
	Memory organization – RAM & ROM, register banks and stack	1	1	1, 2
	8051 microcontrollers: Pin out diagram- description of pins, special function registers, I/O port organization, Interrupts.	1	1	1, 2
Unit No. 2	Instruction Set of 8051 & Addressing modes	2	2, 3	1, 2
	Classification of instruction set - Data transfer group, arithmetic group, logical group, single bit, branching group, CALL and RET instructions and their usage.	2	2, 3	1, 2
	Addressing modes - Immediate, register, direct, register indirect and indexed addressing modes.	2	2, 3	1, 2
	Accessing the data from internal and external memory	1	2, 3	1, 2
	Signed number concepts, generating relative address for loops	1	2, 3	1, 2
Unit No. 3	Introduction to 8051 assembly language programming	1	2, 3	1, 2
	Data types & directives, Simple Programs	1	2, 3	1, 2
	Programming Exercises	2	2, 3	1, 2
	Concept of subroutine and time delay programming	2	2, 3	1, 2,
Unit No. 4	Introduction to Programming 8051 Using Embedded C Language	2	2, 3	1, 2
	C vs. embedded C, compiler vs cross compiler. Storage classes – auto, register, static & extern. Data types	2	2, 3	1, 2
	Programs in embedded C: Sample programs and exercises	3	2, 3	1, 2
Unit No. 5	Serial Communication in 8051 microcontrollers: Serial communication – modes and protocols	1	2,3,4	1, 2
	RS-232 pin configuration and connection. Serial port programming (Transmitting a character, and receiving a character using serial communication) using Assembly and Embedded C	2	2,3,4	1, 2
	Interfacing Data Converters with 8051: Digital to Analog converters – DAC0808 / MC 1408 DAC.	1	2,3,4	1, 2
	Analog-to-Digital Converters - ADC0808, ADC0848, LM34/LM35 temperature measurement.	1	2,3,4	1, 2

Course Unitization Plan - Laboratory

Unit No.	Experiment Name	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Familiarization with the laboratory equipment	2	1	1
Unit No. 2	16-bit addition, subtraction and multiplication	2	2, 3	1, 2
	32- Bit Division.	1	2, 3	1, 2
Unit No. 3	Program for addition of two numbers and display it on LCD.	1	2, 3	1, 2
	Moving data form 500 memory locations to 600 memory locations	2	2, 3	1, 2
	Searching a number in given array.	2	2, 3	1, 2
	Program for comparing two strings	1	2, 3	1, 2
Unit No. 4	8051 Embedded C coding with Keil Simulator Open Source: Program to store the data in the accumulator 2.	3	2, 3	1, 2
	Write a program to load three numbers into Accumulator and send them to port 1 3.	2	2, 3	1, 2
	Write a program to send hex values for ASCII characters of 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D and E to port P1	2	2, 3	1, 2
	Program to send values 00-ff to Port 1	2	2, 3	1, 2
	Program to toggle bits of P1 with time delay, Program to read a byte from P1, wait 1/2 second and then send to P2	2	2, 3	1, 2
Unit No. 5	Write a C program for 8051 to transfer the letter "A" serially at 9600 baud continuously. Use 8-bit data and 1 stop bit.	2	2, 3, 4	1, 2
	Write an 8051 C program to transfer the message "SRMAP" serially at 9600 baud, 8-bit data, 1 stop bit. Do this continuously.	2	2, 3, 4	1, 2
	Write an 8051 C Program to send the two messages "first name" and "last name" to the serial port. If SW = 0, send first name else if SW = 1, send last name. Set the baud rate at 9600, 8-bit data, and 1 stop bit	2	2, 3, 4	1, 2
	Program 8051 in C to receive bytes of data serially and put them in P1. Set the baud rate at 9600, 8-bit data, and 1 stop bit.	2	2, 3, 4	1, 2

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (40%)								End Semester Exam (50%)	
		CLA-1 (10%)		CLA-2 (10%)		CLA-3 (10%)		Mid Term (20%)			
		Th (10%)	Prac (0%)	Th (10%)	Prac (0%)	Th (10%)	Prac (0%)	Th (10%)	Prac (10%)	Th (30%)	Prac (20%)
Level 1	Remember	40%	-	40%	-	20%	-	40%	50%	40%	40%
	Understand										
Level 2	Apply	60%	-	60%	-	80%	-	60%	50%	60%	60%
	Analyse										
Level 3	Evaluate	-	-	-	-	-	-	-	-	-	-
	Create	-	-	-	-	-	-	-	-	-	-
Total		**100**%	-	**100**%	-	**100**%	-	**100**%	**100**%	**100**%	**100**%

Recommended Resources

1. Kenneth. J. Ayala, *The 8051 Microcontroller*, Cengage Learning, 3rd Edition.
2. M. A. Mazidi, J. G. Mazidi and R. D. McKinlay (Jan. 2007), *The 8051 Microcontroller and Embedded Systems using Assembly and C*, Pearson Education India, 2nd Edition

Other Resources

1. NPTEL course on Microprocessors and Microcontrollers by Prof. Santanu Chattopadhyay, Dept. of EECE, IIT Kharagpur. Course page URL: https://archive.nptel.ac.in/courses/108/105/108105102/

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Switchgear and Protection

Course Code	EEE 307	**Course Category**	Core		**L**	**T**	**P**	**C**
					3	0	1	4
Pre-Requisite Course(s)	Electrical Machines-1&2, Power Generation, Transmission and Distribution, Power System Analysis	**Co-Requisite Course(s)**	-	**Progressive Course(s)**				
Course Offering Department	EEE	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

- Understand the operation and basic principles of various types of circuit breakers.
- Understand the operation and application of different types of electromagnetic protective relays.
- Learn the generator and transformer protection schemes.
- Study the feeder and busbar protection schemes.
- Understand the protection schemes of different types of over voltages in a power system.

Course Outcomes / Course Learning Outcomes (CLOs)

CO's	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
1	Describe the operating principles of given types of circuit breakers.	**2**	**70%**	**65%**
2	Interpret the operation and application of given types of electromagnetic protective relays.	**3**	**70%**	**65%**
3	Demonstrate the generator and transformer protection schemes.	**3**	**70%**	**65%**
4	Illustrate the feeder and busbar protection schemes.	**3**	**70%**	**60%**
5	Explain the protection schemes of different types of over voltages in a power system.	**2**	**70%**	**60%**

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and ICT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	1	1	1	2							1	3	1	1
Outcome 2	3	2	2	2	2							2	3	1	1
Outcome 3	3	2	2	2	2							2	3	2	2
Outcome 4	3	2	2	2	2							2	3	2	2
Outcome 5	3	2	2	2	2							2	3	2	2
Course Average	**3**	**2**	**2**	**2**	**2**							**2**	**3**	**2**	**2**

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	**Circuit Breakers:** Elementary principles of arc interruption– Restriking Voltage and Recovery voltages	2	1	1&2
	Restriking phenomenon - RRRV– Average and Max. RRRV and Example Problems	2	1	1&2
	Current chopping and Resistance switching– Introduction to oil circuit breakers	2	1	1&2
	Description and operation of Air Blast– Vacuum and SF6 circuit breakers	2	1	1&2
	CB ratings and specifications– Concept of Auto reclosing	1	1	1&2
Unit No. 2	**Electromagnetic Protection:** Relay connection – Balanced beam type attracted armature relay	2	2	1&2
	Induction disc and induction cup relays, Torque equation	2	2	1&2
	Relays classification–Instantaneous– DMT and IDMT types	2	2	1&2
	Applications of relays: Over current and under voltage relays– Directional relays– Differential relays and percentage differential relays	2	2	1&2
	Distance relays: Impedance– Reactance– Mho and offset mho relays– Characteristics of distance relays and comparison	2	2	1&2
Unit No. 3	**Generator and Transformer Protection:** Protection of generators against stator faults	2	3	1&2
	Rotor faults and abnormal conditions	2	3	1&2
	Restricted earth fault and inter turn fault protection– Numerical examples	2	3	1&2
	Protection of transformers: Percentage differential protection– Design of CT's ratio	2	3	1&2
	Buchholz relay protection	1	3	1&2
Unit No. 4	**Feeder and Busbar Protection:** Protection of lines, Overcurrent Protection schemes	2	4	1&2
	PSM, TMS - Numerical examples	2	4	1&2
	Carrier current and three zone distance relay using impedance relays	2	4	1&2
	Protection of busbars by using Differential protection	2	4	1&2
Unit No. 5	**Protection against over voltage and grounding:** Generation of over voltages in power systems– Protection against lightning over voltages	2	5	1&2
	Valve type and zinc oxide lightning arresters	1	5	1&2
	Grounded and ungrounded neutral systems–Effects of ungrounded neutral on system performance	3	5	1&2
	Methods of neutral grounding: Solid–resistance–Reactance–Arcing grounds and grounding Practices	3	5	1&2

Course Unitization Plan - Laboratory

Unit No.	Experiment Name	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1 & 2	Study and testing of Electromechanical type over current relay & to plot IDMT /DMT characteristics.	3	2	1&2
Unit No. 1 & 2	Study and testing of Electromechanical type Earth Fault current relay & to plot IDMT /DMT characteristics.	3	2	1&2
Unit No. 2	Study and testing of Digital type Over & under voltage relay(1Ø) & to plot IDMT /DMT characteristics.	3	2	1&2
Unit No. 2	Study and testing of Digital type over current relay (3Ø) & Negative sequence Relay to plot IDMT & DMT characteristics	3	2	1&2
Unit No. 3	Study & Testing of Generator protection simulator under various generator faults in real time (Differential, OC, OV, UV, E/F, Synchronizing etc).	3	3	1&2
Unit No. 3	Study & Testing of Transformer protection simulator under various transformer faults in real time (Differential, OC, OV, UV, E/F etc)	3	3	1&2
Unit No. 3	Study & Testing of Current and Potential Transformers.	3	3	1&2
Unit No. 3	Study and testing of Digital type Frequency relay (1Ø) to plot relay characteristics under testing of FHP Alternator set up.	3	3	1&2
Unit No. 3	Study & Testing of Bucholtz Relay.	3	3	1&2
Unit No. 4	Study & Testing of Feeder protection simulator under various faults in real time.	3	4	1&2

Learning Assessment

Bloom's Level of Cognitive Task		**Continuous Learning Assessments (50%)**								**End Semester Exam (50%)**	
		CLA-1 (5%)		**CLA-2 (5%)**		**CLA-3 (5%)**		**Mid Term (15% + 20% = 35%)**			
		Th	**Prac**	**Th**	**Prac**	**Th**	**Prac**	**Th**	**Prac**	**Th**	**Prac**
Level 1	Remember	70%	-	40%	-	40%	-	40%	30%	40%	30%
	Understand										
Level 2	Apply	30%	-	60%	-	60%	-	60%	70%	60%	70%
	Analyse										
Level 3	Evaluate										
	Create										
Total		**100%**	-	**100%**	-	**100%**	-	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. D N Vishwakarma, Badri Ram, and Soumya R Mohanty (2022). *Power System Protection and Switchgear* (3rd ed.). McGraw Hill Education.
2. Paithankar and S.R.Bhide. (2013). *Fundamentals of Power System Protection* (2nd ed.). PHI Learning.
3. T.S.Madhava Rao (1989). *Power System Protection Static Relays with Microprocessor Applications* (2nd ed.). Tata McGraw-Hill.

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High Voltage Engineering

Course Code	EEE 306	**Course Category**	Core		**L**	**T**	**P**	**C**
					3	0	1	4
Pre-Requisite Course(s)	Circuit Theory, Electromagnetic Field Theory	**Co-Requisite Course(s)**	-	**Progressive Course(s)**	-			
Course Offering Department	EEE	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

- To study the fundamentals, generation and measurement of high voltage electricity.
- To understand breakdown mechanisms.

Course Outcomes / Course Learning Outcomes (CLOs)

CO's	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
1	Describe electrical fields and breakdown concepts in gas and vacuum medium.	**2**	**70%**	**60%**
2	Describe the breakdown concepts in solid and liquid.	**2**	**70%**	**60%**
3	Explain the generation of high (dc, ac, and impulse) voltage and currents.	**2**	**70%**	**60%**
4	Apply diagnostics techniques for high voltage measurements.	**3**	**70%**	**60%**
5	Apply testing techniques on insulators, cables, transformers.	**3**	**70%**	**60%**

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and ICT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	1		2				1	1		3	3	3	3
Outcome 2	3	3	1		2				1	1		3	3	3	3
Outcome 3	3	3	3	2	2				1	1		3	3	3	3
Outcome 4	3	3	3	2	2				1	1		3	3	3	3
Outcome 5	3	3	1						1	1		3	3	3	3
Course Average	**3**	**3**	**2**	**2**	**2**				**1**	**1**		**3**	**3**	**3**	**3**

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	**Fundamentals of high voltage, vacuum, and gas breakdown:** Introduction to electric field stress	1	1	1, 2
	Vacuum, gas, liquid and solid as insulators	1	1	1, 2
	Breakdown in vacuum, non-metallic electron emission, clump mechanism	3	1	1, 2
	Breakdown in gases, Townsend's breakdown mechanism, Streamer mechanism, Paschen's law	3	1	1, 2
	Breakdown in no-uniform field	1	1	1, 2
Unit No. 2	**Breakdown mechanism in liquid and solid dielectric materials:** Breakdown in liquids, Intrinsic Break down	2	2	1, 2 & 3
	Cavitation Theory, Suspended particle Theory	2	2	1, 2 & 3
	Application of oil in power apparatus	1	2	1, 2 & 3
	Breakdown in solids Intrinsic breakdown, Electromechanical break down, Thermal breakdown, Streamer Breakdown. Electrochemical breakdown	3	2	1, 2 & 3
	Application of solid dielectrics	1	2	1, 2 & 3
Unit No. 3	**Generation of dc, ac and impulse voltage: Generation** of dc high voltage, voltage doubler circuit	2	3	1, 2 & 3
	Generation of ac high voltage, cascade transformer, resonant transformer	3	3	1, 2 & 3
	Definition of impulse voltage	1	3	1, 2 & 3
	Generation of impulse voltage	2	3	1, 2 & 3
	Multistage impulse generators	1	3	1, 2 & 3
Unit No. 4	**Measurement techniques in high voltage:** Measurement of dc voltage using resistance potential dividers	2	4	1, 2 & 3
	Measurement of high ac voltage using capacitance potential dividers	2	4	1, 2 & 3
	Measurement of currents, using resistive shunts, current transformers	3	4	1, 2 & 3
	Measurement of currents Rogowski coil and illustrative examples	2	4	1, 2 & 3
Unit No. 5	**Testing of electrical equipment:** Introduction to testing of insulators and bushings	2	5	1, 2 & 3
	Power frequency test and impulse test on insulators	2	5	1, 2 & 3
	Power frequency test and impulse test on bushings	1	5	1, 2 & 3
	Testing of transformers, impulse testing	2	5	1, 2 & 3
	Testing of cables	2	5	1, 2 & 3

Course Unitization Plan – Laboratory

Unit No.	Experiment Name	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1,2,3&4	Introduction to different equipment's, safety features and diagnostics	3	1,2,3&4	1, 2 & 3
Unit No. 1	Breakdown study in air, gases, and vacuum under different electrode arrangements.	3	1	1, 2 & 3
Unit No. 2	Liquid breakdown study.	3	2	1, 2 & 3
Unit No. 2	Breakdown study in solids	3	2	1, 2 & 3
Unit No. 3&4	Generation and measurement of dc voltage	3	3&4	1, 2 & 3
Unit No. 3&4	Generation and measurement of ac voltage.	3	3&4	1, 2 & 3
Unit No. 3&4	Generation and measurement of impulse voltage.	3	3&4	1, 2 & 3
Unit No. 3	Functioning of Cockroft Walton Voltage Multiplier.	3	3	1, 2 & 3
Unit No. 3	Functioning of Voltage Doubler.	3	3	1, 2 & 3
Unit No. 4	Measurement of capacitance and tan delta	3	4	1, 2 & 3

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (50%)	
		CLA-1 (5%)		CLA-2 (5%)		CLA-3 (5%)		Mid Term (15% +10%=25%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	60%	-	50%	-	40%	-	60%	30%	60%	30%
	Understand										
Level 2	Apply	40%	-	50%	-	60%	-	40%	70%	40%	70%
	Analyse										
Level 3	Evaluate										
	Create										
Total		**100**%	-	**100**%	-	**100**%	-	**100**%	**100**%	**100**%	**100**%

Recommended Resources

1. **E**.Kuffel, W.S.Zaengl, J.Kuffel High Voltage Engineering: Fundamentals, Elsevier, 2nd edition, 2000
2. M.S.Naidu and V. Kamaraju, "High Voltage Engineering", TMH Publications. New Delhi, 5th edition, 2017.
3. C.L.Wadhwa, "High Voltage Engineering", New Age Internationals (P) Limited,3rd edition 2012.

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Renewable Energy Sources

Course Code	EEE 308	**Course Category**	Core		**L**	**T**	**P**	**C**
					3	0	1	4
Pre-Requisite Course(s)	Power Electronics	**Co-Requisite Course(s)**	-	**Progressive Course(s)**	-			
Course Offering Department	EEE	**Professional / Licensing Standards**	-					

Course Objectives / Course Learning Rationales (CLRs)

- Realize the need of renewable energy sources and its importance.
- Study the performance of solar thermal systems and solar photovoltaic systems.
- Explore the concepts involved in wind energy conversion systems and performance.
- Study the operation of biogas generation and fuel cell systems.

Course Outcomes / Course Learning Outcomes (CLOs)

CO's	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
1	Understand the need of renewable energy sources.	2	65%	70%
2	Develop the electrical model of PV cell and study the characteristics.	3	65%	70%
3	Illustrate the various solar thermal energy conversion systems.	2	65%	70%
4	Describe the working principle of wind energy conversion systems.	3	65%	70%
5	Understand the biomass energy conversion systems and fuel cell technology.	2	65%	70%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)													
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and ICT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Lifelong	PSO 1	PSO 2	PSO 3
Outcome 1	3	2	2	2	2		3					1			3
Outcome 2	2	1	2	3	2		3					2			2
Outcome 3	3	3	3	3	2		3					2		3	3
Outcome 4	3	3	3	3	3		3					2		2	3
Outcome 5	3	1	3	2	2		3					2			2
Course Average	**3**	**2**	**3**	**3**	**2**		**3**					**2**		**3**	**3**

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	**Introduction to Energy Sources and Solar Radiation:** Introduction about the renewable energy sources and Impact of renewable energy generation on environment.	1	1	1, 2, & 4
	Solar constant, extra-terrestrial and terrestrial solar radiation.	1	1	1, 2, & 4
	Types of solar radiation - beam and diffuse radiation.	1	1	1, 2, & 4
	Sun-earth geometry, declination angle, hour angle, LAT with examples.	2	1	1, 2, & 4
	solar angles with examples.	3	1	1, 2, & 4
	Insolation on horizontal flat plate and energy on horizontal flat plate.	2	1	1, 2, & 4
	Instruments for measuring solar radiation and sunshine recorder.	1	1	1, 2, & 4
Unit No. 2	**Solar Photovoltaic Cell:** A historical perspective.	1	2	1, 2, & 4
	PV cell characteristics and equivalent circuit.	2	2	1, 2, & 4
	Model of photovoltaic cell and its parameters.	1	2	1, 2, & 4
	Effect of temperature on open circuit voltage, short circuit current and maximum power point.	1	2	1, 2, & 4
	Data sheet study, cell efficiency and fill factor.	1	2	1, 2, & 4
	Concept of load line, identical and non-identical cells connected in series	1	2	1, 2, & 4
	Identical and non-identical cells connected in Parallel.	1	2	1, 2, & 4
	Concept of maximum power point tracking, input impedance of buck converter.	1	2	1, 2, & 4
	Input impedance of boost and buck-boost converter.	2	2	1, 2, & 4
Unit No. 3	**Solar Thermal Systems:** Introduction to solar collectors and classifications.	1	3	1, 2, & 4
	Performance indices of solar collectors.	1	3	1, 2, & 4
	Non concentrated collectors and Classification of concentrated collectors	1	3	1, 2, & 4
	Modified flat plate collector and compound parabolic concentrator.	1	3	1, 2, & 4
	Applications of solar collectors.	1	3	1, 2, & 4
Unit No. 4	**Wind energy:** Introduction to wind energy, Wind energy conversion system and its merits and demerits.	1	4	1, 2, 3 & 4
	Power and energy from wind turbines with examples.	2	4	1, 2, 3 & 4
	Maximum rotor efficiency with examples.	2	4	1, 2, 3 & 4
	Effect of tower height on wind speeds with examples.	2	4	1, 2, 3 & 4
	General Classification of Wind Turbines-Rotor Turbines-Multiple-Blade Turbines.	1	4	1, 2, 3 & 4
	Downwind and upwind turbine, Pitch control and yaw control.	1	4	1, 2, 3 & 4
	Horizontal axis wind turbine and its important parts.	1	4	1, 2, 3 & 4

	vertical axis wind turbine and its important parts.	1	4	1, 2, 3 & 4
Unit No. 5	**Biomass Energy and fuel cell:** Introduction to biomass, biomass energy and its merits and demerits.	1	5	1, 2, & 4
	Principles of biomass conversion and Photosynthesis.	1	5	1, 2, & 4
	Combustion and fermentation.	1	5	1, 2, & 4
	Types of biogas digesters and its working.	2	5	1, 2, & 4
	Introduction about fuel cell and working of fuel cell.	1	5	1, 2, & 4
	Efficiency of fuel cell and concept of fuel cell technology.	1	5	1, 2, & 4

Course Unitization Plan – Laboratory

Unit No.	Experiment Name	Required Contact Hours	CLOs Addressed	References Used
Unit No. 2	Study the I-V and P-V characteristics of PV modules.	3	2	1, 2, & 4
Unit No. 2	Study the I-V and P-V characteristics of series and parallel combination of PV modules.	3	2	1, 2, & 4
Unit No. 1, 2	Study the effect of variation in tilt angle of PV modules.	3	1, 2	1, 2, & 4
Unit No. 2	Study the effect of shading on PV modules.	3	2	1, 2, & 4
Unit No. 2	Study the working of bypass diodes and blocking diodes.	3	2	1, 2, & 4
Unit No. 2	(a) Study the power flow calculations of stand-alone PV system with DC load and battery. (b) Study the power flow calculations of stand-alone PV system with AC load and battery.	3	2	1, 2, 3 & 4
Unit No. 4	Evaluation of cut-in speed of wind turbine	3	4	1, 2, 3 & 4
Unit No. 4	Characteristics of turbine (power variation) with wind speed	3	4	1, 2, 3 & 4
Unit No. 4	Power analysis at turbine output with DC and AC load	3	4	1, 2, 3 & 4
Unit No. 5	Study the I-V characteristics of a fuel cell.	3	5	1, 2, & 4

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (50%)	
		CLA-1 (5%)		CLA-2 (5%)		CLA-3 (5%)		Mid Term (15% + 20% = 35%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	70%	-	40%	-	40%	-	40%	30%	40%	30%
	Understand										
Level 2	Apply	30%	-	60%	-	60%	-	60%	70%	60%	70%
	Analyse										
Level 3	Evaluate										
	Create										
Total		**100%**	-	**100%**	-	**100%**	-	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. G. D. Roy. (1988). Non-Conventional Energy Sources (6th ed.). Khanna Publishers.
2. S. P. Sukhatme and J. K. Nayak (2017). Solar Energy (4th ed.). Tata Mc Graw Hill.
3. John Twidell and Tony Weir (2021). Renewable Energy Resources (4th ed.). Taylor & Francis.
4. Solanki, Chetan Singh (2009). Renewable Energy Technologies: Practical Guide For Beginners (2nd ed.). PHI Learning Pvt. Ltd.

Other Resources

1. Prof. R. Anandalakshmi, Prof. Vaibhav Vasant Goud. Renewable Energy Engineering: Solar, Wind and Biomass Energy Systems. NPTEL Course IIT Guwahati. URL: https://www.youtube.com/playlist?list=PLwdnzlV3ogoXUifhvYB65lLJCZ74o_fAk.

CO-CURRICULAR ACTIVITIES

Course Code	VAC 103	**Course Category**	VAC	**L**	**T**	**P**	**C**
				0	0	2	2
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	SA	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Develop essential skills, including leadership, communication, and teamwork, among students.
2. Offer opportunities for students to apply academic concepts in practical, real-world scenarios.
3. Promote self-exploration, confidence-building, and social responsibility.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	**Bloom's Level**	**Expected Proficiency Percentage**	**Expected Attainment Percentage**
Outcome 1	Demonstrate confidence in leading group activities, communicate clearly, and collaborate effectively with diverse teams.	2	80%	75%
Outcome 2	Apply theories to practical tasks by solving problems and adapting concepts to real-life situations through cocurricular activities	2	80%	70%
Outcome 3	Develop new experiences with an open approach through guided reflection to assess personal growth, skills, and learning for holistic development.	3	80%	70%

Learning Assessment

Bloom's Level of Cognitive Task		**Continuous Learning Assessments 100%**			
		CLA-1 25%	**CLA-2 25%**	**CLA-3 25%**	**CLA-4 25%**
Level 1	Remember				
	Understand				
Level 2	Apply	15%	15%	15%	15%
	Analyse				
Level 3	Evaluate	10%	10%	10%	10%
	Create				
Total		**25%**	**25%**	**25%**	**25%**

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COMMUNITY SERVICE AND SOCIAL RESPONSIBILITY

Course Code	VAC 104	**Course Category**	VAC	**L**	**T**	**P**	**C**
				0	0	2	2
Pre-Requisite Course(s)		**Co-Requisite Course(s)**		**Progressive Course(s)**			
Course Offering Department	CEL	**Professional / Licensing Standards**					

Course Objectives / Course Learning Rationales (CLRs)

1. Encourage initiatives that address local needs, foster self-sufficiency, and promote environmental sustainability within the community.
2. Equip participants with a deeper understanding of social issues and a sense of responsibility towards marginalized communities.
3. Inspire active participation in community service programs and foster a culture of giving back among individuals and organizations.
4. Develop and implement programs that contribute to skill development, economic empowerment, and equal opportunities for underprivileged sections of society.

Course Outcomes / Course Learning Outcomes (CLOs)

	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
Outcome 1	Develop effective strategies for identifying and addressing community needs.	3	80%	80%
Outcome 2	Demonstrate empathy and cultural sensitivity when engaging with diverse community groups.	4	80%	75%
Outcome 3	Implement sustainable solutions and evaluate their impact on social well-being.	5	90%	85%
Outcome 4	Collaborate effectively within teams to design and lead community service projects.	6	90%	80%

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments 50%				End Semester Exam 50%
		CLA-1 20%	Mid-1 20%	CLA-2 20%	CLA-3 20%	
Level 1	Remember	10%	10%			20%
	Understand					
Level 2	Apply		10%	10%		20%
	Analyse					
Level 3	Evaluate				10%	10%
	Create					
Total		**10%**	**20%**	**10%**	**10%**	**50%**

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Numerical Methods for Electrical Engineering

Course Code	EEE 427	**Course Category**	Core Elective I (CE)		**L**	**T**	**P**	**C**
					3	0	0	3
Pre-Requisite Course(s)	Power System Analysis	**Co-Requisite Course(s)**	-	**Progressive Course(s)**	Power System Analysis			
Course Offering Department	EEE	**Professional / Licensing Standards**	-					

Course Objectives / Course Learning Rationales (CLRs)

- Demonstrate an understanding of computational methods to obtain approximate solutions.
- Apply computational methods to solve otherwise intractable problems.
- Implement computational methods in MATLAB.
- Find roots of equations, solve simultaneous equations and fit curves for interpolation.
- Utilize numerical integration, differentiation and solving ordinary differential equations to solve engineering problems.

Course Outcomes / Course Learning Outcomes (CLOs)

CO's	**At the end of the course, the learner will be able to**	**Bloom's Level**	**Expected Proficiency Percentage**	**Expected Attainment Percentage**
1	obtain approximate solutions of the system through different computational methods.	2	70%	65%
2	solve intractable problems with computational methods.	3	70%	65%
3	Implement computational methods in MATLAB.	3	70%	65%
4	Retrieve roots of equations, explain simultaneous equations and fit curves for interpolation.	4	70%	60%
5	Employ numerical integration, differentiation and solving ordinary differential equations to solve engineering problems.	3	70%	60%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	**Program Learning Outcomes (PLO)**														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and ICT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Lifelong	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	2	3	2				2	1		2	3	2	
Outcome 2	3	3	3	3	2				2	1		2	2	2	
Outcome 3	3	3	3	3	2				2	1		2	3	2	
Outcome 4	3	3	3	3	3				2	1		2	2	2	
Outcome 5	3	3	3	3	3				2	1		2	2	2	
Course Average	**3**	**3**	**3**	**3**	**2**				**2**	**1**		**2**	**2**	**2**	

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	**Roots of Equations:** Accuracy and precision; round-off and truncation errors;	2	1,2,3	1,2&3
	Bisection method;	2	1,2,3	1,2&3
	Newton-Raphson method,	1	1,2,3	1,2&3
	Secant method;	1	1,2,3	1,2&3
	Bairstow's method.	1	1,2,3	1,2&3
	Illustrative examples	2	1,2,3	1,2&3
Unit No. 2	**Algebraic Equations** :Gauss elimination (naïve and with pivoting),	2	1,2,3	1,2&3
	Gauss-Jordan,	2	1,2,3	1,2&3
	LU decomposition, matrix inverse;	1	1,2,3	1,2&3
	Gauss-Seidel;	2	1,2,3	1,2&3
	Extensions to nonlinear system of equations	1	1,2,3	1,2&3
	Illustrative examples	1	1,2,3	1,2&3
Unit No. 3	**Curve Fitting:** Linear and polynomial regressions;	2	1,2,3,4	1,2&3
	Linear least squares,	1	1,2,3,4	1,2&3
	Nonlinear regression,	1	1,2,3,4	1,2&3
	Newton's, Lagrange and spline interpolations.	3	1,2,3,4	1,2&3
	Illustrative examples	2	1,2,3,4	1,2&3
Unit No. 4	**Numerical Differentiation and Integration** :Integration with unequal segments	1	3,4,5	1,2,3&4
	Newton-Cotes algorithms for equations	1	3,4,5	1,2,3&4
	Romberg integration	1	3,4,5	1,2,3&4
	Adaptive and Gauss quadrature's	1	3,4,5	1,2,3&4
	Differentiation formulas	1	3,4,5	1,2,3&4
	Richardson extrapolation	1	3,4,5	1,2,3&4
	Unequally spaced data	1	3,4,5	1,2,3&4
	Illustrative examples	1	3,4,5	1,2,3&4
Unit No. 5	**Ordinary Differential Equations**: Euler's and Runge-Kutta methods;	2	3,4,5	1,2,3&4
	Systems of equations;	1	3,4,5	1,2,3&4
	Adaptive Runge-Kutta methods;	1	3,4,5	1,2,3&4
	Stiffness and multistep methods;	1	3,4,5	1,2,3&4
	Boundary-value problems;	2	3,4,5	1,2,3&4
	Eigenvalue problems.	2	3,4,5	1,2,3&4

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (50%)	
		CLA-1 (10%)		CLA-2 (10%)		CLA-3 (10%)		Mid Term (20%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	70%	-	40%	-	40%	-	40%	-	40%	30%
	Understand										
Level 2	Apply	30%	-	60%	-	60%	-	60%	-	60%	70%
	Analyse										
Level 3	Evaluate										
	Create										
Total		**100%**	-	**100%**	-	**100%**	-	**100%**	**-**	**100%**	**100%**

Recommended Resources

1. A S. C. Chapra and R. P. Canale, "Numerical Methods for Engineers," McGraw Hill, 8th edition, 2021.
2. W. Hamming, "Numerical Methods for Scientists and Engineers," Dover Publications, 2nd edition, 1986.
3. W. Y. Yang, W. Cao, J. Kim, K. W. Park. H.H. Park, J. Joung, J. S. Ro, H. L. Lee, C. H. Hong, T. Im, "Applied Numerical Methods using MATLAB", Wiley, 2nd Edition, 2020
4. B. S. Grewal, "Numerical Methods in Engineering and Science," Mercury Learning and Information, 2019.

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Indian Standards for Electrical Engineering Applications

Course Code	EEE 428	**Course Category**	Core Elective I (CE)		**L**	**T**	**P**	**C**
					3	0	0	3
Pre-Requisite Course(s)	Electrical Machines, Power Electronics	**Co-Requisite Course(s)**	-	**Progressive Course(s)**	**NA**			
Course Offering Department	EEE	**Professional / Licensing Standards**	-					

Course Objectives / Course Learning Rationales (CLRs)

- To understand the significance of Indian Standards in electrical engineering.
- To gain knowledge of various IS codes relevant to electrical design and installation.
- To apply the standards in practical electrical engineering problems and projects.
- To develop skills in using IS codes for ensuring safety and compliance in electrical installations.
- To understand the IS codes in renewable energy systems.

Course Outcomes / Course Learning Outcomes (CLOs)

CO's	**At the end of the course, the learner will be able to**	**Bloom's Level**	**Expected Proficiency Percentage**	**Expected Attainment Percentage**
1	To understand the relevance and application of IS codes in electrical engineering.	2	70%	70%
2	To develop the ability to design and evaluate electrical machines according to Indian Standards.	4	70%	60%
3	To ensure compliance with national standards in professional practice in electrical installation.	2	70%	60%
4	To enhance safety and reliability in electrical power systems through adherence to IS codes.	2	60%	50%
5	To understand the standards for energy efficiency and sustainability in renewable energy installations.	2	60%	50%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	**Program Learning Outcomes (PLO)**														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and ICT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	2	1								1		2	3	1	1
Outcome 2	3	3	3							1		2	2	1	1
Outcome 3	3	2	1							1		2	2	1	1
Outcome 4	3	2	1							1		2	2	1	1
Outcome 5	3	2								1		2	2	1	1
Course Average	**3**	**2**	**1**							**1**		**2**	**2**	**1**	**1**

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Overview of standardization bodies: BIS, IEC, IEEE	1.5	1	1,2,3
	Importance of standardization in electrical engineering	1.5	1	1,2,3
	Introduction to IS codes: History, development, and current practices	1.5	1	1,3
	Key IS codes for electrical engineering	3	1	1,3
Unit No. 2	IS 325: Three-phase induction motors	1.5	2	1,3,4
	IS 2026: Power transformers	1.5	2	2,3
	IS 996: Alternators	1.5	2	1,2,3
	IS 4722: Rotating electrical machines	1.5	2	1, 2,3
	Standards for testing and performance evaluation	1.5	2	1, 2,3
Unit No. 3	IS 732: Code of practice for electrical wiring installations	1.5	3	1, 2,3
	IS 3043: Code of practice for earthing	1.5	3	1, 2,3
	IS 3646: Interior lighting	1.5	3	1, 2,3
	IS 2309: Protection of buildings and allied structures against lightning	1.5	3	1, 2,3
	Safety standards and best practices	1.5	3	1, 2,3
Unit No. 4	IS 5561: Electric power connectors	1.5	4	2, 3
	IS 9921: Alternating current disconnectors (isolators) and earthing switches	1.5	5	1, 2,3
	IS 1646: Code of practice for fire safety in buildings (electrical aspects)	1.5	4	2, 3
	IS 1885: Electrical and electronics terminology	1.5	4	1, 3
	Standards for substation and transmission line design	3	5	1, 2,3
Unit No. 5	IS 14286: Grid-connected solar photovoltaic systems	1.5	5	1, 2,3
	IS 16159: Wind turbine generator systems	1.5	5	1, 2,3
	Role of IS codes in electrical safety audits	1.5	5	1, 2,3
	Standards for energy efficiency and sustainability in renewable energy installations	3	5	1, 2,3
	Standards for charge controller design	3	5	1, 2,3
	Standards for electric vehicle design	3	5	1, 2,3
Total Contact Hours		**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)				End Semester Exam (50%)
		CLA-1 (10%)	Mid-1 (20%)	CLA-2 (10%)	CLA-3 (10%)	
		Th	Th	Th	Th	Th
Level 1	Remember	60%	60%	60%	60%	60%
	Understand					
Level 2	Apply	40%	40%	40%	40%	40%
	Analyse					
Level 3	Evaluate	-	-	-	-	-
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. S.L. Uppal and G.C. Garg, "Electrical Wiring, Estimating and Costing," Khanna Publishers - Provides practical insights into IS codes related to wiring and installations.
2. C.L. Wadhwa, "Electrical Power Systems," New Age International Publishers - Discusses the application of IS codes in power system design.
3. Indian Electricity Rules, 1956 - A reference guide to legal aspects and safety standards in electrical engineering.
4. Bureau of Indian Standards (BIS) Publications - Official publications of various IS codes.

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Power System Operation and Control

Course Code	EEE 429	**Course Category**	Core Elective II (CE)	**L**	**T**	**P**	**C**
				3	0	0	3
Pre-Requisite Course(s)	Power System Analysis	**Co-Requisite Course(s)**	-	**Progressive Course(s)**	-		
Course Offering Department	EEE	**Professional / Licensing Standards**	-				

Course Objectives / Course Learning Rationales (CLRs)

- Understand the economics of power system operations
- Implement and control voltage and frequency of the power system.
- Compute the unit commitment problems
- Learn the power quality issues related to power system stability.
- Understand the smart grid of the power systems

Course Outcomes / Course Learning Outcomes (CLOs)

CO's	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
1	Recognize the economics of power system operation	2	70%	65%
2	Demonstrate the requirements and methods of real and reactive power control in power system	4	70%	65%
3	Contrast unit commitment problem in economic load dispatch	3	70%	65%
4	Illustrate the power quality issues and stability analysis	3	70%	65%
5	Illustrate the features of Smart Grid.	3	70%	60%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and ICT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Lifelong	PSO 1	PSO 2	PSO 3
Outcome 1	3	2	3	3	2								1	2	2
Outcome 2	3	3	3	3	2								1	3	3
Outcome 3	3	2	2	2	2								2	3	3
Outcome 4	3	3	3	2	3								2	3	3
Outcome 5	3	3	3	2	3								2	3	3
Course Average	**3**	**2**	**3**	**3**	**2**								**1**	**3**	**3**

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Nonlinear function optimization: Unconstrained parameter optimization, Constrained parameter optimization: Equality constraints, Inequality constraints	3	1	1 & 2
	Operating cost of thermal power plant	1	1, 2	1 & 2
	Economic dispatch neglecting losses and no generator limits, Economic dispatch neglecting losses and including generator limits	3	1, 2	1 & 2
	Economic dispatch including losses, derivation of loss formula	1	1, 2	1 & 2
	Numerical Problems	3	1, 2	1 & 2
Unit No. 2	Introduction, Basic generator control loop	1	1	1, 2 & 4
	Load frequency control: generator model, load model, prime mover model, governor model	2	1, 2	1, 2 & 4
	Automatic generation control (AGC): AGC in a single area system, AGC in the multi-area system	2	1, 2	1, 2 & 4
	Tie-line bias control, AGC with optimal dispatch of generation	1	1, 2	1, 2 & 4
	Numerical problems	2	1, 2	1, 2 & 4
Unit No. 3	Production and absorption of reactive power, Relation between Voltage, Power, and Reactive Power at a Node	2	3	1, 2 & 3
	Methods of voltage control: shunt reactors, shunt capacitors, series capacitors, Synchronous condensers, static var systems	2	3	1, 2 & 3
	Methods of voltage control: Tap changing transformers	2	3	1, 2 & 3
	Combined Use of Tap-Changing Transformers and Reactive-Power Injection	2	3	1, 2 & 3
	Unit commitment problems	2	3	1,2 & 3
	Numerical problems	1	3	1, 2 & 3
Unit No. 4	Reasons for sinusoidal voltage, Types of voltage variations and voltage events, Types of waveform distortions, Causes and how power flows	2	4	1 & 2
	Small Signal Stability: Analysis techniques, Linearized based and Prony analysis, Modal analysis.	3	4	1 & 2
	Participation factor, QR and Selective methods, Damping Control, PSS and its tuning, WADC	2	4	4
Unit No. 5	Need of smart grid, Motivation, why distributed generation, Concept of microgrid (MG), Typical configuration of hybrid MG.	2	5	4 &5
	Evolution of smart grid and their drivers, characterization of conventional grid versus smart grid, Benefits and application of smart grid, SCADA: functions, merits and demerits.	2	5	4 & 5
	PMU: concept and generic architecture in wide area monitoring. Features of PMU, SCADA Vs PMU	3	5	4 & 5
	Major challenges in smart grid, National initiatives in smart grid.	1	5	5

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (50%)	
		CLA-1 (10%)		CLA-2 (10%)		CLA-3 (10%)		Mid Term (20%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	70%	-	40%	-	40%	-	40%	-	40%	30%
	Understand										
Level 2	Apply	30%	-	60%	-	60%	-	60%	-	60%	70%
	Analyse										
Level 3	Evaluate										
	Create										
Total		**100%**	-	**100%**	-	**100%**	-	**100%**	**-**	**100%**	**100%**

Recommended Resources

1. Chakrabarti & Haldar, "Power System Analysis: Operation and Control", Prentice Hall of India, 2004
2. Kundur, Prabha. "Power system stability." Power system stability and control, 2007.
3. Saadat, Hadi. Power system analysis. Vol. 2. McGraw-hill, 1999.
4. Graham Rogers "Power System Oscillations" Springer-Verlag New York 2012.
5. P. Palensky and F. Kupzog, "Smart grids," Annual Reviews of Environment and Resources, vol. 38, pp. 201–226, 11 2013.

Other Resources

1. Prof. S N Singh, Power System Operation & Control. NPTEL Course IIT Kanpur. URL: https:// https://nptel.ac.in/courses/108104052
2. Prof. A M Kulkarni, Power System Dynamics & Control. NPTEL Course IIT Bombay. URL: https:// https://nptel.ac.in/courses/108101004

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Computer Aided Design of Electrical Machines

Course Code	EEE 430	**Course Category**	Core Elective II (CE)		**L**	**T**	**P**	**C**
					2	0	1	3
Pre-Requisite Course(s)	Electrical Machines, Engineering Materials, CAD	**Co-Requisite Course(s)**	-	**Progressive Course(s)**	**-**			
Course Offering Department	EEE	**Professional / Licensing Standards**						

Course Objectives / Course Learning Rationales (CLRs)

- Study computational electromagnetics understanding the mathematical formulations for magnetic field solutions.
- Understand finite element analysis and computer aided design.
- Learn electromagnetic designs of static and rotating electrical machines.
- Implement machine design optimization using CAD.

Course Outcomes / Course Learning Outcomes (CLOs)

CO's	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
1	Understand various machine design variables and their range of variations, properties of magnetic and insulating materials	2	70%	65%
2	Analyse electromagnetic mechanisms of various electromechanical devices	3	70%	65%
3	Implement machine design problems on computer added platforms applying optimization	4	70%	65%
4	Apply optimization for machine design	3	70%	60%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and ICT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Lifelong	PSO 1	PSO 2	PSO 3
Outcome 1	3	2	3	3	2							1	2	2	
Outcome 2	3	3	3	3	2							1	3	3	
Outcome 3	3	2	2	2	2							2	3	3	
Outcome 4	3	3	3	2	3							2	3	3	
Course Average	**3**	**2**	**3**	**3**	**2**							**1**	**3**	**3**	

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	**Introduction to computer aided design:** Basic principles of computer aided design of electrical machines	1	1, 2	1, 2 & 3
	Advantages and limitations of computer aided design	1	1, 2	1, 2 & 3
	Design of magnetic circuit	1	1, 2	1, 2 & 3
	CAD: Analysis method of design	1	1, 2	1, 2 & 3
	CAD: Synthesis method of design	1	1, 2	1, 2 & 3
	CAD: Hybrid method of design	1	1, 2	1, 2 & 3
	Optimization	2	1,2	1, 2 & 3
	Tutorial Problems	2	1, 2	1, 2 & 3
Unit No. 2	**Designs of single and three phase transformers:** Constructional features, Comparative characteristics of core and shell type transformers	2	1, 2	1, 2 & 3
	Output equations, window space factor, field density and linear current density	1	1, 2	1, 2 & 3
	EMF per turn and overall dimensions	1	1, 2	1, 2 & 3
	Design procedure-single phase transformer	1	1, 2	1, 2 & 3
	Design procedure-three phase transformer	1		
	Design problem with CAD	2	1, 2	1, 2 & 3
Unit No. 3	**Design of DC machines:** Types and construction of DC machines	1	3	1, 2 & 3
	Salient features of DC motors-electrical and magnetic loadings, air-gap lengths	1	3	1, 2 & 3
	Winding designs-pitches, single and double layer configurations	2	3	1, 2 & 3
	Derivation of output equation, selection of number of poles	2	1, 2	1, 2 & 3
	Design of field system	1	4	1, 2 & 3
	Design of armature circuit	1	4	1, 2 & 3
	Design problem with CAD	2	4	1, 2 & 3
Unit No. 4	**Design of three-phase alternator**: Introduction.	1	4	1, 2 & 3
	Stator and rotor constructions-types and features	1	4	1, 2 & 3
	Magnetic segments and MMF drops	1	4	1, 2 & 3
	Estimation of main dimensions	1	1, 2	1, 2 & 3
	Design of armature and field winding layouts	1	4	1, 2 & 3
	Selection and design of poles, teeth and yokes	1	4	1, 2 & 3
	Estimation and minimization of full load MMF with design tuning	1	4	1, 2 & 3
	Design problem with CAD	1	4	1, 2 & 3
Unit No. 5	**Design of three-phase induction motor:** Introduction, construction details.	1	4	1, 2 & 3
	Specific loadings and output equations	1	4	1, 2 & 3
	Design of winding layouts	1	4	1, 2 & 3
	Design of stator-number of poles, yoke, slots airgap	1	4	1, 2 & 3
	Design of rotor-yoke, slots airgap	1	4	1, 2 & 3
	Performance evaluation and design iterations	2	4	1, 2 & 3
	Design problem with CAD	2	1, 5	1, 2 & 3

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (50%)	
		CLA-1 (10%)		CLA-2 (10%)		CLA-3 (10%)		Mid Term (20%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	70%	-	40%	-	40%	-	40%	-	40%	30%
	Understand										
Level 2	Apply	30%	-	60%	-	60%	-	60%	-	60%	70%
	Analyse										
Level 3	Evaluate										
	Create										
Total		**100%**	-	**100%**	-	**100%**	-	**100%**	**-**	**100%**	**100%**

Recommended Resources

1. Thomas A. Lipo, Introduction to AC Machine Design (3rd ed.). John Wiley & Sons., IEEE Press Series on Power and Energy Systems, 2017,
2. J. Pyrhonen, T. Jokinen, and V. Hrabovcova, Design of Rotating Electrical Machines, John Wiley and Sons Inc., 2nd edition, 2013,
3. A. K. Sawhney, A Course in Electrical Machine Design", Dhanpat Rai and Co., 2016.

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Switched Mode Power Converters

Course Code	EEE 431	**Course Category**	Core Elective III (CE)		**L**	**T**	**P**	**C**
					3	0	0	3
Pre-Requisite Course(s)	Circuit Theory & Power Electronics	**Co-Requisite Course(s)**	-	**Progressive Course(s)**	-			
Course Offering Department	EEE	**Professional / Licensing Standards**	-					

Course Objectives / Course Learning Rationales (CLRs)

- Study the working principle of different power converters.
- Gain knowledge on the analysis and design of power converters.
- Know the modelling of power converters.
- Study the working and operation of resonant converters.

Course Outcomes / Course Learning Outcomes (CLOs)

CO's	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
1	Understand the DC-DC converters and their operation.	2	70%	65%
2	Estimate the critical inductance, capacitance in DC-DC converters.	3	70%	65%
3	Modelling of DC-DC converter.	3	70%	65%
4	Synthesize and design magnetic components for power converters.	4	70%	60%
5	Understand the operation of the resonant converter.	3	70%	60%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and ICT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	2	3	3	2							1	2	2	
Outcome 2	3	3	3	3	2							1	3	3	
Outcome 3	3	2	2	2	2							2	3	3	
Outcome 4	3	3	3	2	3							2	3	3	
Outcome 5	3	2	2	3	2							1	2	2	
Course Average	**3**	**2**	**3**	**3**	**2**							**1**	**3**	**3**	

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	**Non-isolated DC-DC converters:** Introduction to voltage regulators.	1	1, 2	1, 2 & 3
	Design and analysis of buck converters under continuous conduction and dis-continuous conduction mode of operation.	2	1, 2	1, 2 & 3
	Design and analysis of boost converters under continuous conduction and dis-continuous conduction mode of operation.	2	1, 2	1, 2 & 3
	Design and analysis of buck-boost converters under continuous conduction mode of operation.	2	1, 2	1, 2 & 3
	Design and analysis of CUK converter under continuous conduction.	1	1, 2	1, 2 & 3
	Tutorial Problems	2	1, 2	1, 2 & 3
Unit No. 2	**Isolated Converters:** Design and analysis of flyback converters under continuous conduction and dis-continuous conduction mode of operation.	3	1, 2	1, 2 & 3
	Design and analysis of forward converter.	1	1, 2	1, 2 & 3
	Design and analysis of push-pull converter.	1	1, 2	1, 2 & 3
	Analysis of half bridge and full-bridge converter.	1	1, 2	1, 2 & 3
	Numerical Problems.	2	1, 2	1, 2 & 3
Unit No. 3	**Modelling of Power Converters:** Steady state and small signal modelling of buck converter.	2	3	1, 2 & 3
	Steady state and small signal modelling of boost converter.	2	3	1, 2 & 3
	Steady state and small signal modelling of buck-boost converter.	2	3	1, 2 & 3
	State space modelling of buck converter.	2	3	1, 2 & 3
	Active front-end power factor correction boost converter.	2	1, 2	1, 2 & 3
Unit No. 4	**Design of Power Converters Components**: Introduction.	1	4	1, 2 & 3
	Design of magnetic components - design of inductor with examples.	2	4	1, 2 & 3
	Design of transformer, and Selection of filter capacitors, Selection of ratings for devices, input filter design.	1	4	1, 2 & 3
Unit No. 5	**Resonant Converters:** Introduction, Basic resonant circuit concepts.	1	5	1, 2 & 3
	Resonant switch converters: zero current switching buck converter with examples.	2	5	1, 2 & 3
	Resonant switch converters: zero voltage switching buck converter with examples	2	5	1, 2 & 3
	Series resonant inverter	2	5	1, 2 & 3
	Series, parallel and series-parallel resonant DC-DC converters with examples.	4	5	1, 2 & 3
	Dual active bridge converters and Introduction to high gain converters.	2	1, 5	1, 2 & 3

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (50%)	
		CLA-1 (10%)		CLA-2 (10%)		CLA-3 (10%)		Mid Term (20%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	70%	-	40%	-	40%	-	40%	-	40%	30%
	Understand										
Level 2	Apply	30%	-	60%	-	60%	-	60%	-	60%	70%
	Analyse										
Level 3	Evaluate										
	Create										
Total		**100%**	-	**100%**	-	**100%**	-	**100%**	**-**	**100%**	**100%**

Recommended Resources

1. Ned Mohan, Tore M. Undeland, William P. Robbins. (2006). Power Electronics- Converters, Applications and Design (3rd ed.). John Wiley & Sons.
2. Daniel W Hart. (2011). Power Electronics. Tata McGraw Hill,
3. L. Umanand. (2009). Power Electronics: Essentials & Applications. Wiley, Pvt. Limited.

Other Resources

1. Prof. L. Umanand. Design and Simulation of DC-DC converters using open-source tools. NPTEL Course IISC Bengaluru. URL: https://nptel.ac.in/courses/117108124

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Digital Control Systems

Course Code	EEE 432	**Course Category**	Core Elective IV (CE)		**L**	**T**	**P**	**C**
					3	0	0	3
Pre-Requisite Course(s)	Power Electronics	**Co-Requisite Course(s)**	-	**Progressive Course(s)**	**-**			
Course Offering Department	EEE	**Professional / Licensing Standards**	-					

Course Objectives / Course Learning Rationales (CLRs)

- Explain the architecture and key components of the C2xx DSP core.
- Implement basic interrupt handling routines using control registers in a C2xx DSP environment.
- Describe the operation of the ADC within the DSP and its role in event management.
- Compare the functionalities of CPLDs and FPGAs, focusing on the Xilinx XC3000 series.
- Differentiate between CPLDs and FPGAs, particularly in the context of the Xilinx XC3000 series, by providing examples.

Course Outcomes / Course Learning Outcomes (CLOs)

CO's	**At the end of the course the learner will be able to**	**Bloom's Level**	**Expected Proficiency Percentage**	**Expected Attainment Percentage**
1	Demonstrate understanding of the C2xx DSP core architecture and its components by explaining their functions.	2	70%	65%
2	Apply knowledge by writing and testing interrupt handling routines in a C2xx DSP setup.	3	70%	65%
3	Explain how the ADC operates and integrates with event management systems in DSP.	2	70%	65%
4	Differentiate between CPLDs and FPGAs, particularly in the context of the Xilinx XC3000 series, by providing examples.	2	70%	60%
5	Design and simulate a PWM inverter circuit for DC motor control.	3	70%	60%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	**Program Learning Outcomes (PLO)**														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and ICT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	2	2	1	2							2	2	3	1
Outcome 2	3	3	3	3	3							2	2	2	3
Outcome 3	3	3	3	3	3							2	2	3	3
Outcome 4	3	3	2	2	3							2	2	3	1
Course Average	**3**	**3**	**3**	**3**	**3**							**2**	**2**	**3**	**2**

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	**Overview of the C2xx DSP Core and Code Development:** **C2xx DSP Core Architecture:** Introduction to the C2xx DSP Core, Key Components: ALU, Registers, and Memory Interface	3	1	1 and 2
	Interfacing and Integration: External Device Integration with the C2xx Core, Peripherals and Their Interfaces, System Configuration Registers	2	1	1 and 2
	Memory Management and Programming: Memory Types and Addressing Schemes, Assembly Language Programming with the C2xx DSP	3	1	1 and 2
	Instruction Set and Development Tools: Instruction Set Overview, Software Development Tools	3	1	1 and 2
Unit No. 2	**Pin Multiplexing and Interrupt Management:** **Pin Multiplexing and I/O Control:** Overview of Pin Multiplexing (MUX) and General Purpose I/O, Control Registers for Multiplexing and General Purpose I/O	3	2	1 and 2
	Interrupt Architecture: Basics of Interrupts, Interrupt Hierarchy	2	2	1 and 2
	Interrupt Management and Servicing: Interrupt Control and Management Registers, Software Methods for Initializing and Handling Interrupts	3	2	1 and 2
Unit No. 3	**ADC Functionality and Event Management in DSP:** **ADC Operation in DSP:** Introduction to ADC Functionality, How the ADC Operates within the DSP	3	3	1 and 2
	Event Manager Overview: Overview of the Event Manager (EV), Handling Event Manager Interrupts	2	3	1 and 2
	Timers and Capture Units: General Purpose (GP) Timers, Compare Units and Their Functionality, Capture Units and Quadrature Encoder Pulse (QEP) Systems	3	3	1 and 2
Unit No. 4	**Introduction to Field Programmable Gate Arrays (FPGAs)** **Fundamentals of FPGAs:** Basics of Field Programmable Gate Arrays (FPGA), Comparison between CPLD and FPGA, Different Types of FPGAs	3	4	1-3
	Xilinx FPGA Architecture: Overview of the Xilinx XC3000 Series, Configurable Logic Blocks (CLB), Input/Output Block (IOB) Details, Programmable Interconnect Points (PIP), Overview of the Xilinx 4000 Series	2	4	1-3
	HDL Programming and Case Study: HDL Programming Fundamentals, Case Study: Spartan 3E and Virtex II Pro FPGA Boards	3	4	1-3
Unit No. 5	**Power Electronics and Motor Control Techniques:** **Power Conversion Techniques:** Basics of Controlled Rectifiers, Overview of Switched Mode Power Converters	4	5	4
	Motor Control Methods: Pulse Width Modulation (PWM) Inverters, Control of DC Motors, Techniques for Induction Motor Control	4	5	4

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (30%)	
		CLA-1 (10%)		CLA-2 (10%)		CLA-3 (10%)		Mid Term (20%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	60%	-	40%	-	60%	-	40%	-	40%	-
	Understand										
Level 2	Apply	40%	-	60%	-	40%	-	60%	-	60%	-
	Analyse										
Level 3	Evaluate	-	-	-	-	-	-	-	-	-	-
	Create	-	-	-	-	-	-	-	-	-	-
Total		**100**%	-	**100**%	-	**100**%	-	**100**%	-	**100**%	**100**%

Recommended Resources

1. Toliyat, H. A., & Campbell, S. G. (2003). DSP-based electromechanical motion control. CRC press.
2. Buso, S., & Mattavelli, P. (2015). Digital control in power electronics (2nd ed.). Morgan & Claypool Publishers.
3. XC 3000 series datasheets (version 3.1). Xilinx, Inc., USA, 1998.
4. XC 4000 series datasheets (version 1.6). Xilinx, Inc., USA, 1999.

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Power Semiconductor Drives

Course Code	EEE 433	**Course Category**	Core Elective IV (CE)		**L**	**T**	**P**	**C**
					3	0	0	3
Pre-Requisite Course(s)	Power Electronics & Electrical Machines	**Co-Requisite Course(s)**	-	**Progressive Course(s)**	-			
Course Offering Department	EEE	**Professional / Licensing Standards**	-					

Course Objectives / Course Learning Rationales (CLRs)

- Learn the basic concepts of power electronic drive system and control.
- Study the operation of rectifier fed dc drives system and its characteristics.
- Know the operation of chopper fed dc drives and its characteristics.
- Study the speed control concept of ac drive systems.

Course Outcomes / Course Learning Outcomes (CLOs)

CO's	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
1	Understand the principle and dynamics of electrical drive systems.	2	65%	60%
2	Apply the concept of phase-controlled rectifiers to control the speed of dc motors.	3	65%	60%
3	Analyse the speed control of chopper fed dc motors.	4	65%	60%
4	Develop the concept of speed control of VSI fed induction motor drives.	3	65%	60%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)													
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and ICT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Lifelong	PSO 1	PSO 2	PSO 3
Outcome 1	3	3	2	2	2							1	2		
Outcome 2	3	3	3	3	2							1	2	3	
Outcome 3	3	2	3	2	2							1	2	3	
Outcome 4	3	3	3	3	2							1	3	2	
Outcome 5	3	3	3	3	2							1	2	3	
Course Average	**3**	**3**	**2**	**2**	**2**							**1**	**2**		

Course Unitization Plan

Unit No.	Syllabus topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	**Introduction to Electric Drives**	**9**		
	Introduction to electric drives.	1	**1**	1 & 2
	Dynamics of electric drive, four quadrant operation.	1	**1**	1 & 2
	Equivalent drive parameters, friction component, nature of load torque.	1	**1**	1 & 2
	Steady state stability, load equalization, DC motor characteristics.	2	**1**	1 & 2
	Speed – torque characteristics of separately exited DC motor and series DC motor.	2	**1**	1 & 2
	Field control of series motor, motoring and breaking of separately exited and series motor.	2	**1**	1 & 2
Unit No. 2	**Control of DC Motors by Phase Controlled Converters**	**9**		
	Summary of phase-controlled rectifiers.	1	**2**	1,2,3&4
	Speed control of DC motors using single-phase half-controlled rectifiers in continuous and discontinuous mode of operation.	2	**2**	1,2,3&4
	Speed control of DC motors using single-phase fully-controlled rectifiers in continuous and discontinuous mode of operation.	2	**2**	1,2,3&4
	Speed control of DC motors using three-phase half-controlled rectifiers in continuous and discontinuous mode of operation.	2	**2**	1,2,3&4
	Speed control of DC motors using three-phase fully-controlled rectifiers in continuous and discontinuous mode of operation.	2	**2**	1,2,3&4
Unit No. 3	**Control of DC Motor by Choppers**	**9**		
	Introduction to chopper drives.	1	**3**	1,2,3&4
	Power control or motoring control, regenerative-breaking control.	2	**3**	1,2,3&4
	Two quadrant chopper drives – motoring mode and regenerative breaking mode.	2	**3**	1,2,3&4
	Four quadrant chopper drives – forward motoring mode and forward regenerative breaking mode, Reverse motoring mode reverse regenerative breaking mode.	2	**3**	1,2,3&4
	Problems on chopper fed DC drives.	2	**3**	1,2,3&4
Unit No. 4	**Control of Induction Motor by Stator Side**	**9**		
	Introduction to ac drives.	1	**4**	1,2,3&4
	Analysis and performance of three phase IM	2	**4**	1,2,3&4
	Speed control of three phase IM motor by stator voltage control.	1	**4**	1,2,3&4
	Speed control of three phase IM motor by stator frequency control.	1	**4**	1,2,3&4
	Speed control of three phase IM motor by stator voltage and frequency control.	1	**4**	1,2,3&4
	Speed control of three phase IM motor by stator current control.	1	**4**	1,2,3&4
	Numerical problems	2	**4**	1,2,3&4
Unit No. 5	**Control of Induction Motor by Rotor Side**	**9**		
	Introduction	1	**4**	1,2,3&4
	Conventional rotor resistance control	2	**4**	1,2,3&4
	Static rotor resistance control	1	**4**	1,2,3&4
	Static scherbius drive	1	**4**	1,2,3&4
	Closed loop control of static scherbius drive	1	**4**	1,2,3&4
	Static kramer drive	1	**4**	1,2,3&4
	Numerical problems	2	**4**	1,2,3&4

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (50%)	
		CLA-1 (10%)		CLA -2 (10%)		CLA-3 (10%)		Mid - 1 (20%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	70%	-	60%	-	70%	-	60%	-	60%	
	Understand										
Level 2	Apply	30%	-	40%	-	30%	-	40%	-	40%	
	Analyse										
Level 3	Evaluate										
	Create										
Total		**100%**	-	**100%**	-	**100%**	-	**100%**	-	**100%**	

Recommended Resources

1. G.K. Dubey (2007). Fundamentals of Electric Drives (2nd ed.). Narosa Publishers.
2. Vedam Subramanyam (2011). Electric Drives Concepts & Applications (2nd ed.). Tata McGraw Hill.
3. M. H. Rashid. (2018). Power Electronics: Devices, Circuits, and Applications (4th ed.). Pearson.
4. S K Pillai. A First course on Electrical Drives (2nd ed.). New Age International(P)

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Embedded System for Power Applications

Course Code	EEE 434	**Course Category**	Core Elective V (CE)		**L**	**T**	**P**	**C**
					3	0	0	3
Pre-Requisite Course(s)	Microcontrollers and Applications	**Co-Requisite Course(s)**	Power Electronics	**Progressive Course(s)**	-			
Course Offering Department	EEE	**Professional / Licensing Standards**	-					

Course Objectives / Course Learning Rationales (CLRs)

- Understand the basics of embedded systems and the architecture of the PIC16F877A microcontroller.
- Acquire programming skills for the PIC16F877A using C.
- Explore various peripherals of PIC16F877A.
- Learn the communication protocols for data transfer and device interfacing.
- Appreciate the role of embedded systems in electrical engineering applications.

Course Outcomes / Course Learning Outcomes (CLOs)

CO's	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
1	Describe the architecture and features of the PIC16F877A microcontroller.	**2**	70%	65%
2	Develop and debug programs for the PIC16F877A using the C programming language.	3	70%	65%
3	Interface digital and analog devices with the PIC16F877A.	3	70%	65%
4	Utilize I2C, SPI, and USART protocols for communication with external devices.	3	60%	65%
5	Design and execute an embedded system project relevant to electrical engineering.	5	50%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and ICT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	2	2	2	2				2			3	3	2	1
Outcome 2	3	2	2	2	2				2			3	3	3	2
Outcome 3	3	2	2	2	2				2			3	3	3	2
Outcome 4	3	2	2	2	2				2			3	3	3	2
Outcome 5	3	3	3	3	3				3	**2**	2	3	3	3	2
Course Average	**3**	**2**	**2**	**2**	**2**				**2**	**1**	**1**	**3**	**3**	**3**	**2**

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No.1	**Introduction to Microcontrollers and Development Tools:** Introduction to Embedded Systems: Overview and applications in electrical engineering, Introduction to microcontrollers	2	1	1-3
	PIC16F877A Microcontroller Architecture: Overview of the PIC16F877A, Pin configuration and functions, Memory organization (Flash, RAM, EEPROM)	3	1	1-3
	Development Tools and Programming Environment: MPLAB X IDE setup, Introduction to XC8 Compiler, Writing and simulating the first program (LED blink)	2	1	1-3
	Digital I/O Interfacing: Configuring and using digital I/O ports, Interfacing LEDs and switches	2	1	1-3
Unit No.2	**Fundamentals of C Programming for PIC:** Basic syntax and structure, Variables, data types, and operators, Control structures (if, switch, loops)	6	2	1-3
Unit No.3	**Timers, Counters, and ADC:** Timers and Counters: Understanding timers and counters, Timer configurations and modes, Generating time delays and PWM signals	4	3	1-3
	Analog-to-Digital Conversion (ADC): ADC theory and applications, Configuring the ADC module, Interfacing potentiometers and sensors	3	3	1-3
	Practical Applications of Timers and ADC: Using timers for event counting and frequency measurement, ADC applications in sensor data acquisition and signal processing	3	3	1-3
Unit No.4	**Communication Protocols:** Serial Communication (USART): Basics of serial communication, Configuring USART for communication, Interfacing with serial devices (PC)	3	4	1-3
	I2C and SPI Communication Protocols: Overview of I2C and SPI, Configuring and using I2C and SPI modules, Interfacing with external EEPROM and sensors	4	4	1-3
	Interrupts and Low Power Modes: Understanding interrupts, Configuring and handling interrupts, Power-saving techniques and modes	3	4	1-3
Unit No.5	**Advanced Applications and Project Development using Microcontroller:** Tentative Projects: Power monitoring and management, Energy harvesting and battery management, Electric drives and vehicles	8	5	1-3
	Project Presentations and Review	2	5	N.A.

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (50%)	
		CLA-1 (5%)		CLA-2 (5%)		CLA-3 (20%)		Mid Term (20%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	60%	-	50%	-	-	-	60%	-	-	50%
	Understand										
Level 2	Apply	40%	-	50%	-	50%	-	40%	-	-	50%
	Analyse										
Level 3	Evaluate	-	-	-	-	50%	-	-	-	-	-
	Create										
Total		**100%**	-	**100%**	-	**100%**	-	**100%**	-	-	**100%**

Recommended Resources

1. Peatman, J. B. (2013). Design with PIC Microcontrollers. India: Pearson Education.
2. Wilmshurst, T. (2010). Designing Embedded Systems with PIC Microcontrollers: Principles and Applications (2nd ed.). Elsevier Science.
3. Microchip Technology Inc. (2013). PIC16F87XA Data Sheet.

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Electric Vehicle Engineering

Course Code	EEE 255	**Course Category**	Open Elective (OE)		**L**	**T**	**P**	**C**
					3	0	0	3
Pre-Requisite Course(s)	Electrical Machines, Power Electronics	**Co-Requisite Course(s)**	-	**Progressive Course(s)**	Indian Standards for Electrical Engineering			
Course Offering Department	EEE	**Professional / Licensing Standards**	-					

Course Objectives / Course Learning Rationales (CLRs)

- To understand the various properties and characteristics of batteries and charging systems.
- To investigate different methods of power transfer techniques.
- To analyse the operation of electrical drives and calculate the harmonic component.
- To understand the various controllers and communication systems.
- To understand the recent advancements of electric vehicles.

Course Outcomes / Course Learning Outcomes (CLOs)

CO's	**At the end of the course, the learner will be able to**	**Bloom's Level**	**Expected Proficiency Percentage**	**Expected Attainment Percentage**
1	To explore and comprehend the diverse properties and operational characteristics of batteries and their corresponding charging systems.	2	70%	70%
2	To investigate and evaluate various power transfer methodologies, focusing on optimizing energy efficiency and reliability.	4	70%	60%
3	To analyse the functioning of electrical drives and assess harmonic components to improve system performance and minimize energy losses.	4	70%	60%
4	To gain a deep understanding of controllers and communication systems, fostering the development of advanced control strategies and integration of communication protocols for enhanced vehicle performance.	2	60%	50%
5	To understand the recent advancements in electric vehicles with the ability to innovate and contribute to the evolving field.	2	60%	50%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	**Program Learning Outcomes (PLO)**														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and ICT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Lifelong Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	1								1		2	3	1	1
Outcome 2	3	2								1		2	2	1	1
Outcome 3	3	3								1		2	2	1	1
Outcome 4	3	2								1		2	2	1	1
Outcome 5	3	2								1		2	2	1	1
Course Average	**3**	**2**								**1**		**2**	**2**	**1**	**1**

Course Unitization Plan

Unit No.	Syllabus Topic	Required Contact Hours	CLOs Addressed	References Used
Unit No 1	Introduction to EVs and History of EVs	1.5	1	1,2,3
	Battery Fundamentals, Lithium-Ion Batteries	3	1	2,3
	Battery Characteristics	1.5	1	1,3,4
	Charging Level, Charging Connectors	1.5	1	1,3,4
	Charging Process, DC Fast Chargers	1.5	1	1,2,3
Unit No 2	Vehicle Grid Interface, DC Fast Charger Impact on Grid	1.5	2	1,3,4
	Electric Vehicles in Microgrids: Microgrids and Controls	1.5	2	2,3,4
	V2H and H2V Power Converters	3	2	1,2,3
	Solar Generation Integration with Electric Vehicles	1.5	2	1,2,3
Unit No 3	Introduction to Electric Drive Components	1.5	3	1, 2,3
	Two and Four-Quadrant Chopper Drives	3	3	1, 2,3
	AC Drives: Six-Step Operation with Harmonic Analysis	3	3	1, 2,3
	Pulse Width Modulated Inverter Fed-Drives	1.5	3	1, 2,3,4
Unit No 4	Vehicle Controllers and Types, Microcontroller Types	1.5	4	2, 3
	Microcontroller Components: Central Processing Unit, Memory and Registers, Timers and Counters, Peripherals,	3	4	2,3,4
	Basic Microcontroller Coding	1.5	4	2, 3
	Controller Area Network: Requirement, Communication protocol, Physical and Transfer Layer	3	4	1, 3
Unit No 5	Advanced Electric Drives for EVs	3	5	1, 2,3
	Recent advancements in Fast Charging	1.5	5	1, 2,3
	Wireless Charging	1.5	5	1, 2,3,4
	Innovative Vehicle Designs	1.5	5	1, 2,3,4
	Self-Driving Vehicles	1.5	5	1, 2,3
	Role of AI in Electric Vehicles	1.5	5	1, 2,3
Total Contact Hours		**45**		

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)				End Semester Exam (50%)
		CLA-1 (10%)	Mid-1 (20%)	CLA-2 (10%)	CLA-3 (10%)	
		Th	Th	Th	Th	Th
Level 1	Remember	40%	40%	40%	40%	40%
	Understand					
Level 2	Apply	60%	60%	60%	60%	60%
	Analyse					
Level 3	Evaluate	-	-	-	-	-
	Create					
Total		**100%**	**100%**	**100%**	**100%**	**100%**

Recommended Resources

1. Husain, Electric and Hybrid Vehicles: Design Fundamentals (3rd ed.). CRC Press. https://doi.org/10.1201/9780429490927.
2. Per Enge, Nick Enge, Stephen Zoepf, Electric Vehicle Engineering, McGraw-Hill Education, 15 Dec 2020.
3. James Larminie, John Lowry, Electric Vehicle Technology Explained, Second Edition, John Wiley & Sons, Ltd, DOI:10.1002/9781118361146.
4. "Electric and Hybrid Vehicles: Technologies, Modeling and Control - An Introduction" by H. K. Khalil.

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Introduction to Green Energy Technologies

Course Code	EEE 243	**Course Category**	Open Elective	**L**	**T**	**P**	**C**
				3	0	0	3
Pre-Requisite Course(s)	Basics of Electrical and Electronics Engineering	**Co-Requisite Course(s)**	-	**Progressive Course(s)**	-		
Course Offering Department	EEE	**Professional / Licensing Standards**	-				

Course Objectives / Course Learning Rationales (CLRs)

- Realize the need of renewable energy sources and its importance.
- Study the performance of solar thermal systems and solar photovoltaic systems.
- Explore the concepts involved in wind energy conversion systems and performance.
- Study the operation of biogas generation and fuel cell systems.

Course Outcomes / Course Learning Outcomes (CLOs)

CO's	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
1	Understand the need of renewable energy sources.	2	65%	70%
2	Develop the electrical model of PV cell and study the characteristics.	3	65%	70%
3	Illustrate the various solar thermal energy conversion systems.	2	65%	70%
4	Describe the working principle of wind energy conversion systems.	3	65%	70%
5	Understand the biomass energy conversion systems and fuel cell technology.	2	65%	70%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and ICT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Lifelong	PSO 1	PSO 2	PSO 3
Outcome 1	3	2	2	2	2		3					1			3
Outcome 2	2	1	2	3	2		3					2			2
Outcome 3	3	3	3	3	2		3					2		3	3
Outcome 4	3	3	3	3	3		3					2		2	3
Outcome 5	3	1	3	2	2		3					2			2
Course Average	**3**	**2**	**3**	**3**	**2**		**3**					**2**		**3**	**3**

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	**Introduction to Energy Sources and Solar Radiation:** Introduction about the renewable energy sources and Impact of renewable energy generation on environment.	1	1	1, 2, & 4
	Solar constant, extra-terrestrial and terrestrial solar radiation.	1	1	1, 2, & 4
	Types of solar radiation - beam and diffuse radiation.	1	1	1, 2, & 4
	Sun-earth geometry, declination angle, hour angle, LAT with examples.	2	1	1, 2, & 4
	solar angles with examples.	3	1	1, 2, & 4
	Insolation on horizontal flat plate and energy on horizontal flat plate.	2	1	1, 2, & 4
	Instruments for measuring solar radiation and sunshine recorder.	1	1	1, 2, & 4
Unit No. 2	**Solar Photovoltaic Cell:** A historical perspective.	1	2	1, 2, & 4
	PV cell characteristics and equivalent circuit.	2	2	1, 2, & 4
	Model of photovoltaic cell and its parameters.	1	2	1, 2, & 4
	Effect of temperature on open circuit voltage, short circuit current and maximum power point.	1	2	1, 2, & 4
	Data sheet study, cell efficiency and fill factor.	1	2	1, 2, & 4
	Concept of load line, identical and non-identical cells connected in series	1	2	1, 2, & 4
	Identical and non-identical cells connected in Parallel.	1	2	1, 2, & 4
	Concept of maximum power point tracking, input impedance of buck converter.	1	2	1, 2, & 4
	Input impedance of boost and buck-boost converter.	2	2	1, 2, & 4
Unit No. 3	**Solar Thermal Systems:** Introduction to solar collectors and classifications.	1	3	1, 2, & 4
	Performance indices of solar collectors.	1	3	1, 2, & 4
	Non concentrated collectors and Classification of concentrated collectors	1	3	1, 2, & 4
	Modified flat plate collector and compound parabolic concentrator.	1	3	1, 2, & 4
	Applications of solar collectors.	1	3	1, 2, & 4
Unit No. 4	**Wind energy:** Introduction to wind energy, Wind energy conversion system and its merits and demerits.	1	4	1, 2, 3 & 4
	Power and energy from wind turbines with examples.	2	4	1, 2, 3 & 4
	Maximum rotor efficiency with examples.	2	4	1, 2, 3 & 4
	Effect of tower height on wind speeds with examples.	2	4	1, 2, 3 & 4
	General Classification of Wind Turbines-Rotor Turbines-Multiple-Blade Turbines.	1	4	1, 2, 3 & 4
	Downwind and upwind turbine, Pitch control and yaw control.	1	4	1, 2, 3 & 4
	Horizontal axis wind turbine and its important parts.	1	4	1, 2, 3 & 4
	vertical axis wind turbine and its important parts.	1	4	1, 2, 3 & 4
Unit No. 5	**Biomass Energy and fuel cell:** Introduction to biomass, biomass energy and its merits and demerits.	1	5	1, 2, & 4
	Principles of biomass conversion and Photosynthesis.	1	5	1, 2, & 4
	Combustion and fermentation.	1	5	1, 2, & 4
	Types of biogas digesters and its working.	2	5	1, 2, & 4
	Introduction about fuel cell and working of fuel cell.	1	5	1, 2, & 4
	Efficiency of fuel cell and concept of fuel cell technology.	1	5	1, 2, & 4

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (50%)								End Semester Exam (50%)	
		CLA-1 (5%)		CLA-2 (10%)		CLA-3 (15%)		Mid Term (20%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	70%	-	40%	-	40%	-	40%	-	40%	30%
	Understand										
Level 2	Apply	30%	-	60%	-	60%	-	60%	-	60%	70%
	Analyse										
Level 3	Evaluate	-	-	-	-	-	-	-	-	-	-
	Create										
Total		**100%**	-	**100%**	-	**100%**	-	**100%**	-	**100%**	**100%**

Recommended Resources

1. G. D. Roy. (1988). Non-Conventional Energy Sources (6th ed.). Khanna Publishers.
2. S. P. Sukhatme and J. K. Nayak (2017). Solar Energy (4th ed.). Tata Mc Graw Hill.
3. John Twidell and Tony Weir (2021). Renewable Energy Resources (4th ed.). Taylor & Francis.
4. Solanki, Chetan Singh (2009). Renewable Energy Technologies: Practical Guide For Beginners (2nd ed.). PHI Learning Pvt. Ltd.

Other Resources

1. Prof. R. Anandalakshmi, Prof. Vaibhav Vasant Goud. Renewable Energy Engineering: Solar, Wind and Biomass Energy Systems. NPTEL Course IIT Guwahati. URL: https://www.youtube.com/playlist?list=PLwdnzlV3ogoXUifhvYB65lLJCZ74o_fAk.

SRM University *AP*, Andhra Pradesh
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Design of Industrial Drives

Course Code	SEC	**Course Category**	SEC		**L**	**T**	**P**	**C**
					3	0	0	3
Pre-Requisite Course(s)	Design of Power Electronics Circuits Lab	**Co-Requisite Course(s)**	-	**Progressive Course(s)**	Power Electronics			
Course Offering Department	EEE	**Professional / Licensing Standards**	-					

Course Objectives / Course Learning Rationales (CLRs)

- To familiarize with advanced simulation tools used to design various industrial drives.
- To understand the practical considerations involved and techniques used to design an industrial drive.
- To practice the design of common application-specific industrial drives.
- To justify the machines used and control techniques used for a given industrial drive system.

Course Outcomes / Course Learning Outcomes (CLOs)

CO's	At the end of the course the learner will be able to	Bloom's Level	Expected Proficiency Percentage	Expected Attainment Percentage
1	Model common electrical drives using state-of-the-art simulation tools.	3	70%	65%
2	Illustrate the techniques and practices involved with the design of an industrial drive.	3	70%	65%
3	Predict the design procedure of a power electronic drive for a given application.	3	70%	65%
4	Develop a power electronic drive set-up for specified applications.	5	60%	65%

Course Articulation Matrix (CLO) to Program Learning Outcomes (PLO)

CLOs	Program Learning Outcomes (PLO)														
	Engineering Knowledge	Problem Analysis	Design and Development	Analysis, Design and Research	Modern Tool and ICT Usage	Society and Multicultural Skills	Environment and Sustainability	Moral, and Ethical Awareness	Individual and Teamwork Skills	Communication Skills	Project Management and Finance	Self-Directed and Life Long Learning	PSO 1	PSO 2	PSO 3
Outcome 1	3	2	3	3	3				3			3	3	3	2
Outcome 2	3	2	2	2	2				3			3	3	3	1
Outcome 3	3	2	3	3	3				3			3	3	3	2
Outcome 4	3	3	3	3	3				3		2	3	3	3	2
Course Average	**3**	**2**	**3**	**3**	**3**				**3**		**1**	**3**	**3**	**3**	**2**

Course Unitization Plan

Unit No.	Syllabus Topics	Required Contact Hours	CLOs Addressed	References Used
Unit No. 1	Verification of the efficiency and losses involved with a 3-ϕ induction machine using Ansys simulation.	6	1	1
	Design of an efficient control algorithm for a 3-ϕ induction motor-based industrial blower using PSIM and performing the comparative analysis with V/f control. .	6	1	2
Unit No. 2	Electrical and mechanical specification estimation for a DC machine.	6	2	3-4
	Position data acquisition for a synchronous motor using Hall sensors and position encoders, and evaluation of the precision of each method	6	2	3-4
	Design of a mechanical load emulator for a PMDC motor and validate it with current measurements.	6	2	3-4
Unit No. 3	Design of a torque control technique using a microcontroller development board for a PMDC motor drive used in engine starters.	6	3	3-4
	Basic regenerative braking in an inverter-connected synchronous motor using a microcontroller development board.	6	3	3-5
Unit No. 4	Design and development of a power electronic drive setup for specified problems.	18	4	N.A.

Learning Assessment

Bloom's Level of Cognitive Task		Continuous Learning Assessments (70%)								End Semester Exam (30%)	
		CLA-1 (10%)		CLA-2 (10%)		CLA-3 (40%)		Mid Term (10%)			
		Th	Prac	Th	Prac	Th	Prac	Th	Prac	Th	Prac
Level 1	Remember	-	-	-	-	-	-	50%	-	20%	-
	Understand										
Level 2	Apply	50%	-	60%	-	60%	-	50%	-	30%	-
	Analyse										
Level 3	Evaluate	50%	-	40%	-	40%	-	-	-	50%	-
	Create										
Total		**100**%	-	**100**%	-	**100**%	-	**100**%	-	**100**%	-

Recommended Resources

1. **Rosu, M., Zhou, P., Lin, D., Ionel, D. M., Popescu, M., Blaabjerg, F., Rallabandi, V., & Staton, D. (2017).** ***Multiphysics simulation by design for electrical machines, power electronics and drives*** **(1st ed.). John Wiley & Sons.**
2. **Powersim Inc. (2020).** ***PSIM User's Guide.***
3. **Jufer, M. (2013).** ***Electric drives: design methodology*** **(2nd ed.). John Wiley & Sons.**
4. **Krause, P. C., Wasynczuk, O., Sudhoff, S. D., Pekarek, S. D. (2013).** ***Analysis of Electric Machinery and Drive Systems*** **(3rd ed.). Wiley.**
5. **Krishnan, R. (2017).** ***Permanent Magnet Synchronous and Brushless DC Motor Drives (1st ed.).*** **CRC Press.**