JSS MAHAVIDYAPEETHA

JSS SCIENCE AND TECHNOLOGY UNIVERSITY

SRI JAYACHAMARAJENDRA COLLEGE OF ENGINEERING, MYSURU

Scheme of Teaching and Examination 2022-23

Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

JSS SCIENCE AND TECHNOLOGY UNIVERSITY MYSURU

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

HANDBOOK

M.Tech. in INDUSTRIAL ELECTRONICS

Registrar
JSS Science & Technology University
JSS Technical Institutions Campus
Mysuru-570 006, Karnataka

Dean Academic
JSS STU, Mysuru

JSS TECHNICAL INSTITUTIONS

CAMPUS MYSORE - 570 006

Dean (Engg. & Tech.)
JSS Science & Technology University
MYSURU-570 006

2022-2024

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About JSS Science and Technology University

JSS Science and Technology University is one of the recent additions to the institutions administered by JSS Mahavidyapeetha, and is the second University being established besides a Medical University at Mysuru. India's higher education system is on the verge of major reforms and JSS Science and Technology University has been established envisioning creating a bright future and a desired learner centric eco-system and transforming into a futuristic global University. The Availability of skilled human resources and trained technical manpower in engineering and technology is a major reason for growing investments in the state. In this context higher education system has a key role and more particularly JSS S&T U with an objective of transforming the students at all levels of higher education including research and innovation with measures to improve quality of workforce.

National Focus:

We'll orient our efforts towards overall development of students', aligning our investments with our strategic priorities to cater to the Nations' Vision. We'll streamline our systems and processes to make the most of our resources, and minimize bureaucracy.

Global reach:

We'll broaden our efforts to meet the global needs of the larger world community with focused priorities including a multi-cultural community of students and staff and become a truly international university. We'll prepare students for diversified technological environments worldwide, and develop international alliances and partnerships.

Multi-disciplinary approaches.

We'll strategically provide encouragement to multi-disciplinary approaches by supporting and developing networks of students, faculty and researchers worldwide. We'll create world leading, multi-disciplinary, learning centers, research institutes that meet our Industries and funders' strategic needs.

The vision of JSS Science and Technology University is to be an effective instrument in enhancement of knowledge in the Society and thus the social transformation.

Our Strategic priority includes:

1. Prominent National Status
2. Quality Teaching & Learning
3. Research of International Repute
4. State of the art infrastructure of International Standard:
5. Open access to knowledge through Distance Education
6. Collaborations & MOU

JSS Science and Technology University strategies to utilize the very best of education technology, optimize teaching methods, and encourage new inter-disciplinary research programs that help connect teaching and research, including applied and action research projects.

Vision of JSS Science and Technology University

1. **Advancing JSS S&T University as a leader in education, research and technology on the international arena.**
2. **To provide the students a universal platform to launch their careers, vesting the industry and research community with skilled and professional workforce.**
3. **Accomplishing JSS S&T University as an epicentre for innovation, centre of excellence for research with state of the art lab facilities.**
4. **Fostering an erudite, professional forum for researchers and industrialist to coexist and to work cohesively for the growth and development of science and technology for betterment of society.**

Mission of JSS Science and Technology University

1. **Education, research and social outreach are the core doctrines of JSS S&T University that are responsible for accomplishment of in-depth knowledge base, professional skill and innovative technologies required to improve the socio economic conditions of the country.**
2. **Our mission is to develop JSS S&T University as a global destination for cohesive learning of engineering, science and management which are strongly supported with interdisciplinary research and academia.**
3. **JSS S&T University is committed to provide world class amenities, infrastructural and technical support to the students, staff, researchers and industrial partners to promote and protect innovations and technologies through patents and to enrich entrepreneurial endeavors.**
4. **JSS S&T University core mission is to create knowledge led economy through appropriate technologies, and to resolve societal problems by educational empowerment and ethics for better living.**

Vision of Sri Jayachamarajendra College of Engineering

Be an international leader in engineering education, research and application of knowledge to benefit society globally.

Mission of Sri Jayachamarajendra College of Engineering

1. **To synergistically develop high-quality manpower and continue to stay competitive in tomorrow's world.**
2. **To foster and maintain mutually beneficial partnerships with our alumni, industry, state and central governments through public services assistance and collaborative research.**
3. **To create empower individuals with sense of identity.**

Vision of the Department of Electronics and Communication Engineering

Be a leader in providing globally acceptable education in electronics and communication engineering with emphasis on fundamentals-to-applications, creative-thinking, research and career-building.

Mission of the Department of Electronics and Communication Engineering

1. **To provide best infrastructure and up-to-date curriculum with a conducive learning environment.**
2. **To enable students to keep pace with emerging trends in Electronics and Communication Engineering.**
3. **To establish strong industry participation and encourage student entrepreneurship.**
4. **To promote socially relevant eco-friendly technologies and inculcate inclusive innovation activities.**

ABOUT THE DEPARTMENT OF ELECTRONICS AND COMMUNICATION

The department of Electronics and Communication Engineering was established in 1968 .The department offers an undergraduate program in Electronics and Communication Engineering, three PG programs namely M.Tech in Industrial Electronics, M.Tech in Network and Internet Engineering and M.Tech in Automotive Electronics. In addition to these, it also offers M.Sc. Engineering by research and Ph.D. programs which provide a platform for bright graduates and postgraduates to conduct research in state-of-the-art technologies. The department is composed of well qualified teaching and technical staff with good retention.

The Department is also a recognized centre under the Quality Improvement Program (QIP) of the Government of India. The well designed curriculum lays a strong foundation in both the analytical and technological aspects of Electronics and Communication Engineering. It also provides ample opportunities to students to work on mini-projects, develop communication skills, explore internship opportunities in industry and take part in national and international design contests like PACE, Aero-JC, cultural and sports activities etc.

The BE degree in Electronics and Communication Engineering at SJCE, JSSSTU is one of the most sought after programs in the state and attracts top ranking students. It has a very good placement record and almost 100 % of the eligible students get placement in top companies with a very good package. Department also encourages students to pursue higher studies and to become entrepreneurs. The department has a very active IEEE student chapter which organises National level paper presentation competitions and other events such as Vacation Project Mania, Latex workshops and mini project competitions, etc.

Apart from teaching, the department also guides UG and PG students for getting Internships at renowned Industries and premier Institutes like IISc, IIT's and NIT's, organizes Industrial visits, conducts expert lectures and workshops. The department also has special labs namely Nano Dielectric and devices lab, Visual TCAD and research lab and e-yantra lab which provides space for researchers to carry out experimental investigations and UG and PG students to implement project ideas.

Programmes offered:

UG Programme:

1. Bachelor of Engineering in Electronics and Communication Engineering: 4 years duration

PG Programme:

1. Master of Technology in Industrial Electronics: 2 Years duration
2. Master of Technology in Network and Internet Engineering: 2 Years duration
3. Master of Technology in Automotive Electronics: 2 Years duration

Research Programme:

1. Doctoral Program
2. M.Sc. (Engineering) by research.

Department faculty Details:

Sl. No.	**Faculty Name**	**Qualification (Specialization)**	**Designation**	Email Id
1	Dr. Shankaraiah	Ph.D.	Professor	shankaraiah@jssstuniv.in shankaraiah@sjce.ac.in
2	Dr. Mahadevaswamy U B	Ph.D.	Professor & Head	mahadevaswamy@jssstuniv.in mahadevaswamy@sjce.ac.in
3	Dr. Gayathri S	Ph.D.	Associate Professor	sgmurthy_65@jssstuniv.in sgmurthy_65@sjce.ac.in
4	Prof. Thyagaraja Murthy A	M. Tech	Associate Professor	thyagarajamurthy@jssstuniv.in thyagarajamurthy@sjce.ac.in
5	Prof. Sujathakumari B A	M. Tech	Associate Professor	sujathakumari@jssstuniv.in sujathakumari@sjce.ac.in
6	Prof. Renuka B S	M. Tech	Associate Professor	renuka@jssstuniv.in renuka@sjce.ac.in
7	Dr. Rudraswamy S B	Ph.D.	Assistant Professor	rudra.swamy@jssstuniv.in rudra.swamy@sjce.ac.in
8	Prof. Halesh M R	M. Tech	Assistant Professor	haleshmr@jssstuniv.in haleshmr@sjce.ac.in
9	Dr. Sudharshan Patil Kulkarni	Ph.D.	Professor	sudarshan_pk@jssstuniv.in sudharshan_pk@sjce.ac.in

10	Dr. Veena M G	Ph.D.	Associate Professor	veenamg@jssstuniv.in veenamg@sjce.ac.in
11	Dr. Gayitri H M	Ph.D.	Assistant Professor	gayitrikumar@jssstuniv.in gayitrikumar@sjce.ac.in
12	Prof. Anitha S Prasad	M. Tech	Assistant Professor	anith.sp@jssstuniv.in anith.sp@sjce.ac.in
13	Prof. Pavithra D R	M. Tech	Assistant Professor	pavithra@jssstuniv.in pavithra@sjce.ac.in
14	Prof. Shivaprasad N	M. Tech	Assistant Professor	shivaprasad_n@jssstuniv.in shivaprasad_n@sjce.ac.in
15	Prof. Supreetha M	M. Tech	Assistant Professor	supreetha.manjanna@jssstuniv.in supreetha.manjanna@sjce.ac.in
16	Prof. Puneeth K M	M. Tech	Assistant Professor	kmpuneeth@jssstuniv.in kmpuneeth@sjce.ac.in
17	Prof. Eshwari A Madappa	M. Tech	Assistant Professor	eshwarinaveen@jssstuniv.in eshwarinaveen@sjce.ac.in
18	Prof. Yashwanth S D	M. Tech	Assistant Professor	yashwanth@jssstuniv.in yashwanth@sjce.ac.in
19	Prof. Vinay Prasad M S	M. Tech	Assistant Professor	vpms1408@jssstuniv.in vpms1408@sjce.ac.in
20	Prof. Kavyashree M K	M. Tech	Assistant Professor	kavyashreemk@jsstuniv.in kavyashreemk@sjce.ac.in
21	Dr. Shashidhar R	Ph.D.	Assistant Professor	shashidhar.r@jsstuniv.in shashidhar.r@sjce.ac.in

22	Prof. Chandrashekar Murthy B N	M. Tech	Assistant Professor	chandrashekar@jssstuniv.in chandrashekar@sjce.ac.in
23	Prof. Praveen Kumar M S	M. Tech	Assistant Professor	ms_praveenkumar@jssstuniv.in ms_praveenkumar@sjce.ac.in
24	Prof. Anupama	M.Tech	Assistant Professor	anupama@jssstuniv.in
25	Prof. Madhu Sudan M P	M.Tech	Assistant Professor	madhusudan.mp@jssstuniv.in
26	Prof. Megha K M	M.Tech	Assistant Professor	meghakm@jssstuniv.in
27	Prof. Rakesh M D	M.Tech	Assistant Professor	rakeshmd@jssstuniv.in
28	Prof. Rohith M N	M.Tech, MBA	Assistant Professor	rohithmn@jssstuniv.in
29	Prof. Priyanka D S	M.Tech	Assistant Professor	priyankads@jssstuniv.in
30	Prof. Roopa M	M.Tech	Assistant Professor	roopam@jssstuniv.in
31	Dr.Rakshith B	Phd	Assistant Professor	rakshithec@jssstuniv.in

Laboratory facilities:

Sl No	Name of the Lab	Major facility
1	E-Yantra Lab	FireBird-V3 Robot, Robotics Atmega - 16A platform, Robotics Atmega - 2600 platform, Servo motor based gripper kit, programmable 32-bit ARM 9 Robotic platform, Robotic arm, depth sensor camera with adapter.
2	Networking and Simulation Lab	Computers, switches , routers, WiFi access, Exata simulator
3	Automotive Controls Lab	dSpace, computers, Power Supplies, CRO.
4	Power Electronics Lab	CRO, Power supplies, multimeters, motors, Choppers, Inverters.
5	Communication Lab	CRO, LCR meter, Spectrum Analyzer, Power Supplies breadboards, Active and Passive ComponentsDigital Storage Oscilloscopes.
6	VLSI and DSP Lab	Computers, Cadence, TCAD software, ARM, MSP, FPGA/CPLD, DSP boards.
7	Nano dielectrics & Devices Lab	Spin coater, Megohmmeter, Electrospinning Espinnano, HV tester, analytical balance, inclined plane tracking, Vaccum Oven, Contact angle meter.
8	Data Sciences and Machine Learning facility (Central Computing facility)	10 High end client systems, 1 PARAM-SHAVAK C-DAC Server. Systems preloaded with software for deep learning and high performance computing.

Power electronics lab

Design and Implementation lab

Structure of Board of Studies:

Sl. No.	Category	Designation	Name of the Person
1	The Dean(s) of the Faculties	Ex-Officio Members	Dr. S B Kivade Principal, SJCE Mysore.
2	Dean (Academics)	Ex-Officio Members	Dr. B Manoj Kumar Professor, Dept of Environmental, Dean (Academics), JSS STU
3	Head of the Department	Chairperson	Dr. U B Mahadevaswamy Professor and Head, Department of E&C, SJCE-JSSSTU, Mysuru
4	All Professors of the Department	Members	1) Dr.Shankaraiah N
			2) Dr.Sudarshan Patil Kulkarni
			3) Dr. M G Veena
5	Two Senior Associate Professors of the concerned Department by Rotation	Members	1) Dr S. Gayathri
			2) Renuka B S
6	One Senior Assistant Professor of the concerned Department by Rotation	Member	1) Dr.Rudraswamy S B
7	One external Subject Expert from any reputed academic/Research Institution/other universities Nominated by the Academic council	Members	1) Dr. Hariprasad S A. Designation. Director - Faculty of Engineering and Technology Jain (Deemed-to-be University), Bengaluru-560069
			2) Dr Ravish Aradya H V, Professor & Head, Department of Electronics and Communication Engineering, RVCE, Bengaluru -560059
8	One external Subject Expert from any reputed academic/Research Institution/other universities Nominated by the vice Chancellor upon recommendation by theDean of Respective Faculty	Members	1) Dr. Sushil Kumar Pandey Assistant Professor, Department of ECE, NITK, Surathkal - 575 025
			2) Dr. P.C.Srikanth Professor & Head, Dean Planning &Development, MCE Hassan-573202.
9	Two external Members From Concerned Industry/Government	Members	1) Mr. Raghavendra B R Domain Manager, Intel, Bengaluru - 560103

	Departments/Public sectors undertakings/allied area relating to placement, nominated by the academic council upon recommendation by the Dean of respective faculty		2) Mr. Venkatasubramanian B Senior Systems Architect, Distinguished Member of Technical Staff (DMTS) at Nokia, Bengaluru - 560045
			3) Dr. T Shreekanth Project Manager - Automotive, L&T Technology Services, Mysore.
10	One postgraduate meritorious alumnus, to be nominated by the Head of the Department	Member	Dr. Parameshwara S. Associate Professor & HoD, Dept. of Electronics & Communication Engineering, National Institute of Engineering, Mysuru. 570008
11	The chairperson, Board of studies, may with the approval of the vice chancellor, co-opt as members: a) One external Subject Expert from reputed academic/Research Institution/other universities/industry/Government Departments/Public Sector undertakings, whenever special Courses of studies or to be formulated. b) Two other members of faculty of the concerned department.	Members	1) Dr. Basavaraj Talawar Assistant Professors, Dept of CSE, NITK, Surathkal - 575 025
			2) Dr. Suresh K V Professor, Dept. of Electronics & Communication Engineering Siddaganga Institute of Technology, Tumkur– 572103
			1) B.A.Sujatha Kumari Associate Professor E&C Dept.SJCE-JSSSTU
			2) A.Thyagaraja Murthy Associate Professor E&C Dept.SJCE-JSSSTU

M. Tech. Program Structure 2022-23

Scheme of Teaching and Examination for I to IV semester

Semester	Credits
I	27
II	27
III	10
IV	16
TOTAL	**80**

Credit Pattern

Semester	Type of Course	Number	Credits
I	Professional Core Professional Elective Professional Core Laboratory Mini Project with Seminar/ Lab	04 02 01 01	16 credits 08 credits 1.5 credits 1.5 credits **Sub Total = 27 credits**
II	Professional Core Professional Elective Open Elective Research Methodology and IPR Professional Core Laboratory	03 02 01 01 01	12 credits 08 credits 04 credits 1.5 credits 1.5 credits **Sub Total = 27 credits**
III	Internship/ Industrial Training Project work (Phase 1)	01 01	04 credits 06 credits **Sub Total = 10 credits**
IV	Project work (Phase 2)	01	**16 credits**
TOTAL			**80 credits**

Grading System

Marks	Grade
90 – 100	**S**
75 – 89	**A**
66 – 74	**B**
56 – 65	**C**
50 – 55	**D**
45 – 49	**E**
< 45	**F**

Semester Wise Credits

Semester	Credits	Total Marks
I	27	700
II	27	700
III	10	100
IV	16	300
Total	**80**	**1800**

Notation in the Scheme

CIE	**Continuous Internal Evaluation**
SEE	**Semester End Examination**
L	**Lecture**
T	**Tutorial**
P	**Practical**

Programme Outcomes:

PO1: Research skills: An ability to independently carry out research/investigation and development work to solve practical problems.

PO2: Presentation Skills: An ability to write and present a substantial technical report/ document.

PO3: Domain-specific knowledge: An ability to demonstrate a degree of mastery in the field of industrial electronics.

PO4: Engineering solution: Analyse the problem, design, and demonstrate solutions in the area of industrial electronics. (PSO1)

PO5: Modern tools usage: Investigate real-time industry problems and provide a solution using modern tools. (PSO2)

PO6: Life-long learning: Create an ability to address multidisciplinary research challenges and develop skills for management and entrepreneurship, adhering to ethics. (PSO3)

Programme Educational Objectives:

PEO1: To empower graduates to formulate, analyze, design, and provide innovative solutions in the field of automotive and controls engineering for real life problems.

PEO2: To ensure that graduates have adequate exposure to research and emerging technologies through industry interaction

PEO3: To enable graduates to pursue successful professional career with ethics and social responsibilities of the engineering profession.

QUALITY POLICY

The department of Electronics and communication engineering is committed to provide highest quality education and training in the field of higher education

1. To inculcate moral and ethical values among the students and the staff.
2. To provide a sound academic and research environment to students for a complete learning experience.
3. To develop strong Industry-Institute –Interaction to enrich the teaching-learning process and exploring career opportunities for students.
4. To train and develop faculty members for imparting quality education, to satisfy the industrial and societal needs of the aspirants.
5. Implementation of feedback responses from the stakeholders on qualiquality-related processes in curriculum enhancement.
6. Enhancing skillset in the identified thrust areas of the department.

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II	Professional Core Professional Elective Open Elective Laboratory Research Methodology and IPR Professional Core Laboratory	03 02 01 01 01	12credits 08 credits 04 credits 1.5 credits 1.5credits **Sub Total = 27 credits**
III	Internship/ Industrial Training Project work (Phase 1)	01 01	04 credits 06 credits **Sub Total = 10 credits**
IV	Project work (Phase 2)	01	**16 credits**
TOTAL			**80 credits**

M. Tech. INDUSTRIAL ELECTRONICS PROGRAM

SEMESTER I

Sl. No.	Code	Course Title	Course	Teaching Hours per Week				Credits	Examination			
				L	T	P/ S/ SDA	Total Contact Hours		CIE	SEE	Total Marks	Duration in Hours
1	22PIE110	**Linear Algebra**	PCC 1	**3**	**2**	**0**	**5**	4	40	60	100	3
2	22PIE120	**Power Electronics**	PCC 2	**3**	**2**	**0**	**5**	4	40	60	100	3
3	22PIE130	**Embedded Systems**	PCC 3	**3**	**2**	**0**	**5**	4	40	60	100	3
4	22PIE140	**MEMS**	PCC 4	**3**	**2**	**0**	**5**	4	40	60	100	3
5	22PIE15Y	**Professional Elective 1**	PEC 1	**3**	**2**	**0**	**5**	4	40	60	100	3
6	22PIE16Y	**Professional Elective 2**	PEC 2	**3**	**2**	**0**	**5**	4	40	60	100	3
7	22PIE170L	**Industrial electronics lab**	PCCL	0	0	3	3	1.5	50	-	50	-
8	22PIE180	**Design and Implementation lab**	Mini Project with Seminar (MPS)/ Lab (PCCL)	-	-	-	-	1.5	50	-	50	-
TOTAL								**27**	**340**	**360**	**700**	

Note: L: Lecture/ Theory; T: Tutorial; P: Integrated Practical/ Practice; S: Seminar; SDA: Skill Development Activities
PCC: Professional Core Course; PEC: Professional Elective Course; PCCL: Professional Core Course Laboratory; MPS: Mini Project with Seminar

Professional Elective 1			Professional Elective 2	
Course Code	**Course Title**		**Course Code**	**Course Title**
22PIE151	Advanced DSP		22PIE161	Advances in VLSI
22PIE152	Low-power VLSI design		22PIE162	Mechatronics
22PIE153	Neural network and machine learning		22PIE163	Analog and mixed mode VLSI

M. Tech. INDUSTRIAL ELECTRONICS PROGRAM
SEMESTER II

Sl. No.	Code	Course Title	Course	Teaching Hours per Week				Credits	Examination			
				L	T	P/ S/ SDA	Total Contact		CIE	SEE	Total Marks	Duration in hours
1	22PIE210	**Digital control systems**	PCC 5	**3**	**2**	**0**	**5**	4	40	60	100	3
2	22PIE220	**Robotics and Industrial automation**	PCC 6	**3**	**2**	**0**	**5**	4	40	60	100	3
3	22PIE230	**Automotive Electronics**	PCC 7	**3**	**2**	**0**	**5**	4	40	60	100	3
4	22PIE24Y	**Professional Elective 3**	PEC 3	**3**	**2**	**0**	**5**	4	40	60	100	3
5	22PIE25Y	**Professional Elective 4**	PEC 4	**3**	**2**	**0**	**5**	4	40	60	100	3
6	22PIE26YOE	**Professional Open Elective**	OEC	**4**	**0**	**0**	**4**	4	40	60	100	3
7	22PIE 270	**Research Methodology and IPR**	MC	2	0	0	2	1.5	50	-	50	-
8	22PIE280L	**Digital controls lab**	PCCL	0	0	3	3	1.5	50	-	50	-
TOTAL								**27**	**340**	**360**	**700**	

Note: L: Lecture/ Theory; T: Tutorial; P: Integrated Practical/ Practice; S: Seminar; SDA: Skill Development Activities
PCC: Professional Core Course; PEC: Professional Elective Course; OEC: Open Elective Course; MC: Mandatory Course; PCCL: Professional Core Course Laboratory

Professional Elective 3	
Course Code	**Course Title**
22PIE241	Operations Research and optimization
22PIE242	Medical Electronics
22PIE243	Electric vehicles

Professional Elective 4	
Course Code	**Course Title**
22PIE251	Testing and Verification of VLSI circuits
22PIE252	Image processing and computer vision
22PIE253	Renewable energy systems

Professional Open Elective	
Course Code	**Course Title**
22PIE260OE	Deep learning for speech processing
22PNI260OE	Advanced wireless technologies
22PAE260OE	Nano dielectrics

M. Tech. INDUSTRIAL ELECTRONICS PROGRAM

SEMESTER III

Sl. No.	Code	Course Title	Course	Teaching Hours				Total Credits	Examination			
				L	T	P/ S/ SDA	Contact Hours		CIE	SEE	Total Marks	Duration in hours
1	22PIE310P	Internship/ Industrial Training	INT	Minimum 08 weeks commencing from intervening vacation of II and III semesters				4	50	-	50	3
2	22PIE320P	Project Work (Phase-1)	PROJ	-	-	6	6	6	50	-	50	-
TOTAL								10	100		100	

Note: L: Lecture/ Theory; T: Tutorial; P: Integrated Practical/ Practice; S: Seminar; SDA: Skill Development Activities
MCC: Mandatory Credit Course; INT: Internship/ Industrial Training; PROJ: Project Work

***22PAE310P - 42hrs/ weeks = (40 hours / week in Industry + 2 hours / week in college)**
****22PAE320P - 12 Weeks: 40 Hours / week**

SEMESTER IV

Sl. No.	Code	Course Title	Contact hours	Total credits	CIE	SEE	Total Marks	Exam Duration in hours
1	22PAE410P	Project Work (Phase-2)	22 weeks***	16	100	200	300	3
Total				16				

*****22PAE410P - 22 Weeks: 40 Hours / week**

Category Code:

PCC – Professional Core Course (Including Laboratory subjects)
PEC – Professional Elective Course
OEC – Open Elective Course
INT- Internship
PROJ – Project Work

Detailed Syllabus
First semester

DEPARTMENT	**Electronics and Communication Engineering**						
Course Code	**22PIE 110**	*Total Credits*	*4*	*Course Type*	Professional Core Course		
Course Title	**Linear Algebra**						
Teaching Learning Process		*Contact Hours*	*Credits*	*Assessment in Weightage and marks*			
	Lecture	**39**	**3**		**CIE**	**SEE**	**Total**
	Tutorial	**26**	**1**	*Weightage*	*40 %*	*60 %*	*100 %*
	Practical	**0**	**0**	*Maximum Marks*	*40 Marks*	*60 Marks*	*100 Marks*
	Total	**65**	**4**	*Minimum Marks*	*20 marks*	*25 marks*	*45 Marks*

COURSE PREREQUISITE: Student should be familiar with basic concepts of calculus

COURSE OBJECTIVE:
To understand the theory of systems of linear equations and its transformations for real time applications.

COURSE OUTCOMES (COs): After completing this course student will be able to

CO#	Course Outcomes	Highest Level of Cognitive Domain
CO1	Solve systems of linear equations and homogeneous systems of linear equations by different methods	L3
CO2	Obtain solutions for signal processing applications using vector space concepts	L3
CO3	Analyze the concept of a linear transformation as a mapping from one vector space to another.	L3
CO4	Apply the concepts of factorization, SVD and Optimization to formulate and solve engineering problems.	L4
CO5	Communicate and understand mathematical statements, ideas and results both verbally and in writing with correct use of mathematical definitions, terminology and symbolism by working collaboratively.	L4

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create

Course Content / Syllabus:

UNIT No.	Content	Hours	
		Lecture	Tutorial
1	**Linear equations:** Fields, system of linear equations, and its solution sets, elementary row operations and echelon forms, matrix operations, invertible matrices, LU-factorization. **Vector spaces:** Vector spaces, subspaces, bases and dimension, coordinates, summary of row- equivalence, computations concerning subspaces.	8	5
2	**Linear Transformations:** Algebra of linear transformations, singular and nonsingular linear transformation, isomorphism, representation of transformations by matrices, linear functions, transpose of a linear transformation.	8	5
3	**Canonical Forms:** Characteristic values, annihilating polynomials, invariant subspaces, direct- sum decompositions, invariant direct sums, primary decomposition theorem, cyclic bases, Jordan canonical form, Iterative estimates of characteristic values.	8	5
4	**Inner Product Spaces:** Inner products, inner product spaces, Cauchy – Schwartz Inequality, applications, orthogonality, orthogonal sets and projections, Gram-Schmidt process, QR-factorization.	8	5
5	**Symmetric Matrices and Quadratic Forms:** Digitalization, quadratic forms, singular value decomposition.	7	6

Text Books:

1. Gilbert Strang, "*Linear Algebra and its Applications*," 4th Edition, Cengage India Private Limited, 2005.
2. Kenneth Hoffman and Ray Kunze, "*Linear Algebra*," 2nd Edition, Pearson Education (Asia) Pvt. Ltd/ Prentice Hall of India, 2004.
3. David C. Lay, "*Linear Algebra and its Applications*," 5th Edition, Pearson Education (Asia) Pvt. Ltd, 2015.

Reference Books:

1. S. K. Jain and A. D. Gunawardena, "*Linear Algebra, An Interactive Approach*," Thomson, Brooks/Cole, 2004.
2. Bernard Kolman and David R. Hill, "*Introductory Linear Algebra with Applications*," Pearson Education (Asia) Pvt. Ltd, 7th edition, 2003.

SWAYAM/NPTEL:

1. https://nptel.ac.in/courses/111106051
2. https://nptel.ac.in/courses/111104137

Self-Learning Exercises:

1. Mini Projects – complex problem solving using Linear algebra concepts

Course Articulation:

COURSE OUTCOMES↓	PROGRAM OUTCOMES					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1				3		
CO2				3		
CO3				3	2	
CO4				3	2	
CO5	3	2	2	3	3	2

High – 3, Medium – 2, Low – 1

DEPARTMENT	**Electronics and Communication Engineering**						
Course Code	**22PIE 120**	*Total Credits*	*4*	*Course Type*	Professional core course		
Course Title	**Power Electronics**						
Teaching Learning Process		*Contact Hours*	*Credits*	*Assessment in Weightage and marks*			
	Lecture	**39**	**3**		**CIE**	**SEE**	**Total**
	Tutorial	**26**	**1**	*Weightage*	*40 %*	*60 %*	*100 %*
	Practical	**0**	**0**	*Maximum Marks*	*40 Marks*	*60 Marks*	*100 Marks*
	Total	**65**	**4**	*Minimum Marks*	*20 Marks*	*25 marks*	*45 Marks*

COURSE PREREQUISITE:

circuit theory, basic electrical engineering and transform techniques

COURSE OBJECTIVE:

1. To Learn the fundamental concepts on conversion, control and monitoring of electric energy using power converters
2. To understand of the underlying principles of quantitative and qualitative research related to Power electronics

COURSE OUTCOMES (COs): After completing this course student will be able to

CO#	Course Outcomes	Highest Level of Cognitive Domain
CO1	Explain the operation of power semiconductor devices, power electronic circuits and explore their applications.	L2
CO2	Analyze power electronic circuits and examine important relations	L4
CO3	Solve power electronic circuits and compute important performance parameters	L3
CO4	Design power electronic circuits for the given specifications and interpret the results,	L5
CO5	Develop the skill set to build an application related to Power electronics using EDA tools.	L3

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create

Course Content / Syllabus:

UNIT No.	Content	Hours	
		Lecture	Tutorial
1	**Power Semiconductor Devices:** Introduction to Power Electronics, Construction of power semiconductor devices. Operation, switching characteristics, specifications of Power Diodes, Power BJTs, Power MOSFETs and IGBTs. Firing, Protection and base drive Circuits. Design of snubbers	8	**5**
2	**DC-DC Switched -Mode Converters**: Basic switching Regulator, Switched mode power supplies, Continuous and discontinuous conduction modes of non-isolated Buck, Boost and Buck-Boost Converters. Effect of converter non-idealities, Switch utilization factor, Buck and Boost derived isolated converters – single ended forward converter, Half-bridge, Full Bridge and Push pull converters. Isolated Cuk converters, Multi output converters	8	**5**
3	**DC-AC Switched -Mode Converters:** Voltage Source, Current Source and Current Regulated, Principle of operation of half, full bridge single phase and three phase inverters. Performance Parameters – Voltage Control of Single Phase and three phase Inverters using various PWM techniques, Harmonics reduction techniques.	8	**5**
4	**Multilevel Inverters:** Introduction, types, diode clamped multi-level inverters, features & applications.	8	**5**
5	**Resonant Converters:** ZCS Resonant Switch Converter, ZVS Resonant Switch Converter, Series resonant inverter, Series resonant DC-DC Converter, Parallel resonant DC-DC Converter, Resonant Converter Comparison, Resonant DC link converter	7	**6**

Textbooks:

1. Ned Mohan, Tore M Undeland& William P Robbins: ***Power Electronics - Converters, Applications and Design*** 3rd Ed, John Wiley, 2014.
2. Joseph Vithayathil : ***Power Electronics, Principles and Applications,*** McGraw Hill, 2013.

Reference Books:

1. V.R Moorthi: ***Power Electronic Devices, Circuits & Industrial Applications***, Oxford University Press.
2. Daniel W. Hart: ***Power Electronics***, TATA McGraw Hill,2012.

Journals/Magazines:

1. https://jpels.org/

Web/Digital resources:

1. https://www.mathworks.com/campaigns/offers/next/power-electronics-resource-library.html
2. https://power-electronics.com/en/digitalization/

SWAYAM/NPTEL:

1. https://nptel.ac.in/courses/108102145

PRACTICE BASED LEARNING:

No	Topics to be covered	Tools and Techniques	Expected Skill/Ability
1	Simulation	Any Open Source Tool	Programming

Self-Learning Exercises:

Mini Projects

Course Articulation:

	PROGRAM OUTCOMES					
COURSE OUTCOMES ↓	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1			2	2		
CO2			2	2		
CO3			2	2		
CO4			2	2		
CO5		2	2		2	

High – 3, Medium – 2, Low – 1

DEPARTMENT	**Electronics and Communication Engineering**						
Course Code	**22PIE 130**	*Total Credits*	*4*	*Course Type*	Professional Core Course		
Course Title	**Embedded Systems**						
Teaching Learning Process		*Contact Hours*	*Credits*	*Assessment in Weightage and marks*			
	Lecture	**39**	**3**		**CIE**	**SEE**	**Total**
	Tutorial	**26**	**1**	*Weightage*	*40 %*	*60 %*	*100 %*
	Practical	**0**	**0**	*Maximum Marks*	*40 Marks*	*60 Marks*	*100 Marks*
	Total	**65**	**4**	*Minimum Marks*	*20 marks*	*25 marks*	*45 Marks*

COURSE PREREQUISITE:
Digital electronics, Microprocessors, Microcontrollers, C programming

COURSE OBJECTIVE:

1. To understand the Building Blocks of Embedded System.
2. To learn the Various Embedded Development Strategies, Communication in processors, and Input/output interfacing.
3. To know the Basics of Real time operating system.

COURSE OUTCOMES (COs): After completing this course student will be able to

CO#	Course Outcomes	Highest Level of Cognitive Domain
CO1	Explain basics of Embedded Systems	L2
CO2	Analyze various devices , communication protocols, interrupts, and device drivers used in embedded Systems	L4
CO3	Explain contemporary techniques for Hardware-Software co-design of embedded systems	L2
CO4	Demonstrate the knowledge on concepts of RTOS	L3
CO5	Analyze, implement and demonstrate Embedded System Applications	L4

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create

Course Content / Syllabus:

UNIT No.	Content	Hours	
		Lecture	**Tutorial**
1	**Introduction to Embedded Systems:** Embedded systems, Processor Embedded into a system, Embedded Hardware Units and Devices in a system, Embedded Software in a system, Examples of Embedded Systems, Design Process in Embedded system, Formalization of System Design, Examples.	**8**	**5**
2	**Devices and Communication Buses for Device Network:** I/O types and examples, Serial Communication Devices, Parallel Device Ports, Sophisticated Interfacing features in Device Ports, Wireless Devices, Serial Bus Communication Protocols, Parallel Bus Device Protocols, Network Protocols, Wireless and Mobile system	**8**	**5**

	protocols		
3	**Device Drivers and Interrupt Service Mechanism:** Programmed I/O Busy-wait approach without interrupt service mechanism, ISR concept, Interrupt sources, Interrupt servicing mechanism, multiple interrupts, Device Drivers.	**8**	**5**
4	**Hardware Software Co-Design, Program Modeling, Embedded Firmware Design and Development:** Fundamental Issues in Hardware Software Co-Design, Computational models in Embedded Design, Hardware Software tradeoffs, Embedded Firmware Design approaches, Embedded Firmware Development languages, Programming concepts in Embedded C	**8**	**5**
5	**RTOS based Embedded System Design:** OS basics, Types of Operating Systems, Tasks, process and Threads, Multiprocessing and Multi tasking, Task Scheduling, Threads, Processes and Scheduling, Task Communication, Task Synchronization	**7**	**6**

Text Books:

1. Raj Kamal: "*Embedded Systems - SoC, IoT, AI and Real-Time Systems*", 4th Edition, TMH, 2020.
2. Shibu K V: *"Introduction to Embedded Systems",* 2nd Edition, TMH, 2017.

Reference Books:

1. James K Peckol: "*Embedded Systems- A Contemporary Design Tool*", 1st edition, John Wiley, 2019.
2. Santanu Chattopadhyay, "*Embedded System Design*", 2nd edition, PHI Learning, 2013

Web/Digital resources:

1. https://nptel.ac.in/courses/108102045
2. https://www.coursera.org/learn/introduction-embedded-systems

Self-Learning Exercises:
Case Study projects
Mini Projects

Course Articulation:

COURSE OUTCOMES↓	PROGRAM OUTCOMES					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1			3			
CO2			3	3		
CO3			3	3		
CO4			3	3		
CO5		3	3	3	3	

High – 3, Medium – 2, Low – 1

DEPARTMENT	**Electronics and Communication Engineering**						
Course Code	**22EPIE 140**	*Total Credits*	*4*	*Course Type*	Professional Elective Course		
Course Title	**MEMS**						
Teaching Learning Process		*Contact Hours*	*Credits*	*Assessment in Weightage and marks*			
	Lecture	**39**	**3**		**CIE**	**SEE**	**Total**
	Tutorial	**26**	**1**	*Weightage*	*40 %*	*60 %*	*100 %*
	Practical	**0**	**0**	*Maximum Marks*	*40 Marks*	*60 Marks*	*100 Marks*
	Total	**65**	**4**	*Minimum Marks*	*20 marks*	*25 marks*	*45 Marks*

COURSE PREREQUISITE:

Fundamental concepts of sensors, actuators, and mechanical engineering.

COURSE OBJECTIVE:

1. To familiarize on the working of sensors and actuators in micro dimensions.
2. To gain knowledge on the fabrication process of sensors and actuators.

COURSE OUTCOMES (COs): After completing the course, students will be able to

CO#	Course Outcomes	Highest Level of Cognitive Domain
CO1	Explain the fundamentals of sensors, actuators, polymer, and device fabrication techniques.	L2
CO2	Analyze the design considerations of sensors and actuators.	L4
CO3	Apply MEMS to disciplines beyond electrical and mechanical engineering.	L3
CO4	Engage in independent study as a member of a team and make an effective oral presentation on the usage of software tools/mini project.	L4

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create

Course Content / Syllabus:

UNIT No.	Content	Hours	
		Lecture	**Tutorial**
1	**INTRODUCTION:** Intrinsic Characteristics of MEMS – Energy Domains and Transducers- Sensors and Actuators –Introduction to Microfabrication - Silicon based MEMS processes – New Materials – Review of Electrical and Mechanical concepts in MEMS – Semiconductor devices – Stress and strain analysis– Flexural beam bending- Torsional deflection.	**8**	**6**

2	**SENSORS AND ACTUATORS-I**: Electrostatic sensors – Parallel plate capacitors – Applications – Interdigitated Finger capacitor – Comb drive devices – Thermal Sensing and Actuation – Thermal expansion – Thermal couples –Thermal resistors – Applications – Magnetic Actuators – Micromagnetic components – Case studies of MEMS in magnetic actuators	**8**	**5**
3	**SENSORS AND ACTUATORS-II:** Piezoresistive sensors – Piezoresistive sensor materials - Stress analysis of mechanical elements. Applications to Inertia, Pressure, Tactile and Flow sensors – Piezoelectric sensors and actuators –piezoelectric effects – piezoelectric materials –Applications to Inertia, Acoustic, Tactile and Flow sensors.	**8**	**5**
4	**MICROMACHINING:** Silicon Anisotropic Etching – Anisotrophic Wet Etching – Dry Etching of Silicon – Plasma Etching –Deep Reaction Ion Etching (DRIE) – Isotropic Wet Etching – Gas Phase Etchants – Case studies Basic surface micromachining processes – Structural and Sacrificial Materials – Acceleration of sacrificial Etch – Striction and Antistriction methods – Assembly of 3D MEMS – Foundry process.	**8**	**5**
5	**POLYMER AND OPTICAL MEMS**: Polymers in MEMS– Polyimide - SU-8 - Liquid Crystal Polymer (LCP) – PDMS – PMMA – Parylene –Fluorocarbon - Application to Acceleration, Pressure, Flow and Tactile sensors- Optical MEMS, Lenses and Mirrors – Actuators for Active Optical MEMS.	**7**	**5**

Text Books:

1. Chang Liu (2012), 'Foundations of MEMS', Pearson Education Inc.
2. Tai Ran Hsu (2002), "MEMS & Micro systems Design and Manufacture" Tata McGraw Hill, New Delhi.

Reference Books:

1. Nadim Maluf (2002), " An introduction to Micro electro mechanical system design", Artech House.
2. Vijaya K. Vardhan, K.J. Vinoy and S. Gopalakrishnan (2011) "Smart material system and MEMS" Wiley, India.

Journals/Magazines:

1. **https://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=84**
2. **https://www.mdpi.com/journal/micromachines/special_issues/Advances_MEMS**

Web/Digital resources:

SWAYAM/NPTEL:
https://nptel.ac.in/courses/117105082

PRACTICE BASED LEARNING:

No	Topics to be covered
1	Sensors and actuators for microfluidics and drug delivery

Course Articulation:

COURSE OUTCOMES↓	PROGRAM OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1			3	3		
CO2			3	3		
CO3			3	3		
CO4	1	3	3	3	3	1

High – 3, Medium – 2, Low – 1

DEPARTMENT	**Electronics and Communication Engineering**						
Course Code	**22IE 151**	*Total Credits*	4	*Course Type*	Professional Elective - I		
Course Title	**Advanced DSP**						
Teaching Learning Process		*Contact Hours*	*Credits*	*Assessment in Weightage and marks*			
	Lecture	**39**	**3**		**CIE**	**SEE**	**Total**
	Tutorial	**26**	**1**	*Weightage*	*40 %*	*60 %*	*100 %*
	Practical	**0**	**0**	*Maximum Marks*	*40 Marks*	*60 Marks*	*100 Marks*
	Total	**65**	**4**	*Minimum Marks*	*20 marks*	*25 marks*	*45 Marks*

COURSE PREREQUISITE:

Digital Signal Processing.

COURSE OBJECTIVE:

1. To gain knowledge on the parametric models, adaptive filters, and power spectrum estimation.
2. To understand the concepts of Multirate Signal Processing and wavelet transform.

COURSE OUTCOMES (COs): After completing this course, students should be able to:

CO #	Course Outcomes	Highest Level of Cognitive Domain
CO 1	Apply the parametric models for various filter structures.	L3
CO2	Analyze the adaptive filter algorithms and power spectrum estimation techniques.	L4
CO 3	Examine Multirate Signal Processing and applications of wavelet transform.	L4
CO 4	Design, implement and Demonstrate the real-world signal processing applications.	L4

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 – Create

Course Content / Syllabus:

UNIT No.	Content	Hours	
		Lecture	Tutorial
1	**DSP overview:** Discrete time signals and systems, convolution, deconvolution, correlation, DFT, radix-2 FFT algorithms, FIR and IIR filters	8	5
2	**Parametric Signal modeling:** Pade Approximation, Prony's method, Linear Prediction, Properties of LP filters, Lattice filters, Wiener filters, AR and ARMA models, Levinson-Durbin Algorithms.	8	5

3	**Introduction to Adaptive filters:** applications of adaptive filters, Steepest descent algorithm, LMS, Normalized LMS and RLS algorithms, Convergence issues.	**8**	**6**
4	**Introduction to Power Spectrum Estimation:** Periodogram, Non-Parametric methods: Bartlett's method, Welch's method, Blackman-Tukey, Parametric Methods: AR, MA, ARMA spectrum estimation.	**8**	**5**
5	**Introduction to Multirate DSP**: Decimation, Interpolation, Sampling rate conversion, Applications of Multirate signal processing, Digital filter Banks, Introduction to STFT and Wavelet transforms, Applications.	**7**	**5**

Text Books:

1. **John G Proakis and Dimitris G Manolakis**, "*Digital Signal Processing*", Fourth Edition, Pearson Education, 2020.
2. **Monson H. Hayes**, "*Statistical Digital Signal Processing and Modelling*", John Wiley & Sons, 2014.
3. **P. P.Vaidyanathan**, *"Multirate Systems and Filter Banks",* Pearson Education, 2014

Reference Books:

1. **B. Widrow, S. Stearns,** "*Adaptive Signal Processing*", Latest Edition, Pearson 2015.
2. **Shalini Apte**, *"Advanced Digital Signal Processing"*, Wiley India Ltd, 2013

Journals/Magazines:

1. IEEE Signal Processing Magazine, IEEE, https://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=79
2. IEEE Journal of selected Topics in signal Processing, IEEE, https://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=4200690

SWAYAM/NPTEL:

1. NPTEL Video lecture by Prof S Mukhyopadhyay, IIT Kharagpur
2. https://www.youtube.com/watch?v=Ru3FhYbjcFs&list=PL4FB9652402002C76

Self-Learning Exercises:
Mini Projects

Course Articulation:

	PROGRAM OUTCOMES					
COURSE OUTCOMES ↓	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1			3	2		
CO2			3	3		
CO3			3	3		
CO4	3	3	3	3	3	2

High – 3, Medium – 2, Low – 1

DEPARTMENT	Electronics and Communication Engineering						
Course Code	22PIE 152	Total Credits	4	Course Type	Professional Elective Course		
Course Title	Low power VLSI Design						
Teaching Learning Process		Contact Hours	Credits	Assessment in Weightage and marks			
	Lecture	52	0		CIE	SEE	Total
	Tutorial	0	0	Weightage	40 %	60 %	100 %
	Practical	0	0	Maximum Marks	40 Marks	60 Marks	100 Marks
	Total	52	0	Minimum Marks	20 marks	25 marks	45 Marks

COURSE PREREQUISITE:

Basics of Electronics, CMOS VLSI Circuit.

COURSE OBJECTIVE:

1. To learn to enhance the battery life, reduce leakage and dynamic power consumption of portable devices.
2. To analyze the impact of power on system performances and to identify suitable techniques to reduce power dissipation in combinational and sequential circuits.

COURSE OUTCOMES (COs): After completing this course, students will be able to

COs	Course Outcomes	Highest Level of Cognitive Domain
CO1	Explain the need for Low power VLSI circuit design.	L2
CO2	Summarize the knowledge of architectural approaches of low power systems.	L2
CO3	Design the low power-low voltage logic circuits for the given specifications.	L3
CO4	Analyze the performance of adders and multipliers using the modern tool.	L4
CO5	Examine the working of Low power memories to meet the requirements using EDA tool.	L4

L1-Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create

Course Content / Syllabus:

UNIT No.	Content	Hours	
		Lecture	Tutorial
1	**Introduction:** Need for Low Power Circuit Design, Sources of Power Dissipation – Switching Power Dissipation, Short Circuit Power Dissipation, Leakage Power Dissipation, Glitching Power	10	0

	Dissipation, Short Channel Effects –Drain Induced Barrier Lowering and Punch Through, Velocity Saturation, Impact Ionization, Hot Electron Effect.		
2	**Low-Power Design Approaches:** Low-Power Design through Voltage Scaling – VTCMOS circuits, MTCMOS circuits, Architectural Level Approach –Pipelining and Parallel Processing Approaches. Switched Capacitance Minimization Approaches: System Level Measures, Circuit Level Measures, and Mask level Measures.	12	0
3	**Design and Test of Low-power low- voltage CMOS circuits**: Circuit design style, Leakage currents in deep submicron transistors, Deep submicron device design issues Key to minimizing SCE, Low-voltage current design techniques. Logic Families, Low-Power and Standard Cell Libraries, Logic Styles for Specific Applications - Library Cells for Self-Timed Design, SEU-Tolerant Logic Single-Clock Latches and Flip-Flops.	10	0
4	**Low-Voltage Low-Power Adders and multipliers:** Standard Adder Cells, CMOS Adder's Architectures, Ripple Carry Adders, Carry Look- Ahead Adders, Carry Select Adders, Carry Save Adders, Low-Voltage Low-Power Multipliers: Low- Voltage Low-Power Design Techniques –Trends of Technology and Power Supply Voltage, Low- Voltage Low-Power Logic Styles.of Multiplication, Types of Multiplier Architectures, Braun Multiplier, Baugh- Wooley Multiplier, Booth Multiplier, Introduction to Wallace Tree Multiplier.	10	0
5	**Low-Voltage Low-Power Memories:** Basics of ROM, Low-Power ROM Technology, Future Trend and Development of ROMs, Basics of SRAM, Memory Cell, Precharge and Equalization Circuit, Low-Power SRAM Technologies, Basics of DRAM, Self-Refresh Circuit, Future Trend and Development of DRAM.	10	0

Text Books:

1. Kaushik Roy, Sharat Prasad, "Low-Power CMOS VLSI Circuit Design" Wiley, 2000.
2. Gary K. Yeap, "*Practical Low Power Digital VLSI Design*", KAP, 2002

Reference Books:

1. Christian Piguet "*Low power CMOS circuits – Technology, logic design and CAD tools*", 1st Edition, CRC Press, Taylor& Francis Group 2006.
2. Rabaey, Pedram, "*Low Power Design Methodologies*" Kluwer Academic, 2010.

Web/Digital resources:

1. https://www.youtube.com/watch?v=ruClwamT-R0&list=PLTEh-62_zAfHmJE-pcjgREKiKyPSgjkxj
2. https://www.youtube.com/watch?v=K2kL7pMnL_0&list=PLVDb88QIgXkeeUo6I2oudLvc76GbLGrTi

Course Articulation:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		3	3		3
CO2	3	2	3	3	2	3
CO3	3		3	3		3
CO4	3	2	3	3	2	3
CO5	3	2	3	3	2	3

High – 3, Medium – 2, Low – 1

DEPARTMENT	**Electronics and Communication Engineering**						
Course Code	**22PIE 153**	***Total Credits***	*4*	***Course Type***	Professional Elective		
Course Title	**Neural Networks and Machine Learning**						
Teaching Learning Process		***Contact Hours***	***Credits***	***Assessment in Weightage and marks***			
	Lecture	**39**	**3**		**CIE**	**SEE**	**Total**
	Tutorial	**26**	**1**	***Weightage***	***40 %***	***60 %***	***100 %***
	Practical	**0**	**0**	***Maximum Marks***	***40 Marks***	***60 Marks***	***100 Marks***
	Total	**65**	**4**	***Minimum Marks***	***20 marks***	***25 marks***	***45 Marks***

COURSE PREREQUISITE:
Basic mathematics.

COURSE OBJECTIVE:
1. To learn the concepts of neural network architecture and algorithms.
2. To understand supervised and unsupervised machine learning algorithms.

COURSE OUTCOMES (COs): After completing this course, students will be able to:

CO #	Course Outcomes	Highest Level of Cognitive Domain
CO1	Explain the theoretical foundation of neural networks and machine learning.	L2
CO2	Examine neural network architecture and algorithms.	L4
CO3	Analyze supervised and unsupervised machine learning algorithms.	L4
CO4	Design, and implement the real-world applications using neural networks and Machine Learning	L4

L1

L1– Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 – Create

Course Content / Syllabus:

UNIT No.	Content	Hours	
		Lecture	**Tutorial**
1	**Linear Regression and Classification:** Problem Formulation, Parameter Estimation: Maximum Likelihood Estimation, Overfitting in Linear Regression, Maximum A Posteriori Estimation, Linear Regression for multiple features, Direct method and Gradient descent method, Bayesian Linear Regression, Classification using Decision Tree, Confusion matrix, Classification matrix.	**8**	**5**

2	**Dimensionality Reduction with Principal Component Analysis:** Optimization with constraints, Optimization using Lagrange multipliers. Problem Setting for PCA, Maximum variance perspective: Direction with maximal variance, M-dimensional subspace with Maximal variance, Projection Perspective: Setting and objective, Finding Optimal Coordinates, Finding the Basis of the Principal Subspace, Eigenvector Computation, and Low –Rank Approximations, PCA in High Dimensions,	**8**	**5**
3	**Neural Network:** Introduction, Network Architectures, learning process, Rosenblatt perceptron, algorithm for linearly separable data, implementation of Boolean functions using neurons. Multilayer Perceptrons: Batch Learning and On-Line Learning, The Back-Propagation Algorithm, Back Propagation and differentiations, The Minimum Description-Length Principle, Convolutional Networks, Small-scale Versus Large-Scale Learning Process.	**8**	**6**
4	**Kernel Methods and Radial-Basis Function Networks:** Cover's Theorem on the separability of patterns, The Interpolation Problem, Radial-Basis-Function Networks, K-means Clustering, Recursive Least-squares estimation of the Weight Vector, Hybrid Learning Procedure for RBF Networks, Interpretations of the Gaussian Hidden Units, Kernel Regression and Its Relation to RBF Networks, The Support Vector Machine Viewed as a Kernel Machine, Design of Support Vector Machines.	**8**	**5**
5	**Regularization Theory:** Regularization Networks, Semi supervised Learning, Manifold Regularized: Preliminary Considerations, Differentiable Manifolds, Spectral Graph Theory, Laplacian Regularized Least mean squares algorithm.	**7**	**5**

Text Books:

1. **Cheistopher M. Bishop** "*Pattern Recognition and Machine Learning*" Springer. 2006.
2. **Simon Haykin** "*Neural networks and Learning Machines*" Pearson, 3rd Edition. 2016.

Reference Books:

1. **Tomm. Mitchell** "*Machine Learning*" McGraw Hill Education, 22nd reprint 2018.
2. **Bekkerman, Ron, Mikhail Bilenko, and John Langford, eds**. *"Scaling up machine learning: Parallel and distributed approaches"* Cambridge University Press, 2011.
3. **Frank Pane**, "*Hands-On Data Science and Python Machine Learning*", Packt Publishers 2017.

Journals/Magazines:

1. Machine Learning, Springer, https://www.springer.com/journal/10994.
2. IEEE Transactions on Neural Networks and Learning Systems, IEEE. https://ieeexplore.ieee.org/xpl/aboutJournal.jsp?punumber=5962385.

SWAYAM/NPTEL:

1. https://nptel.ac.in/courses/117105084
2. https://onlinecourses.nptel.ac.in/noc22_cs29/preview

3. https://nptel.ac.in/courses/106105152

Self-Learning Exercises:

1. **Case Study projects**
2. **Mini Projects**

Course Articulation:

COURSE OUTCOME	PROGRAM OUTCOME					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1		2	3			
CO2		2	3	3		
CO3		2	3	3		
CO4	3	3	3	3	3	2

High – 3, Medium – 2, Low – 1

DEPARTMENT	**Electronics and Communication Engineering**						
Course Code	**22PIE 161**	*Total Credits*	*4*	*Course Type*	Professional Elective Course		
Course Title	**Advances in VLSI Design**						
Teaching Learning Process		*Contact Hours*	*Credits*	*Assessment in Weightage and marks*			
	Lecture	**39**	**3**		**CIE**	**SEE**	**Total**
	Tutorial	**26**	**1**	*Weightage*	*40 %*	*60 %*	*100 %*
	Practical	**0**	**0**	*Maximum Marks*	*40 Marks*	*60 Marks*	*100 Marks*
	Total	**65**	**4**	*Minimum Marks*	*20 marks*	*25 marks*	*45 Marks*

COURSE PREREQUISITE:

CMOS VLSI Design

COURSE OBJECTIVE:

1. To learn the principles of MESFET, MISFET, MODFET,
2. To understand processing challenges, SCE, beyond CMOS technology
3. To realize digital functions and functional blocks using MOSFET.

COURSE OUTCOMES (COs): Upon completion of this course, the student will be able to:

COs	Course Outcomes	Highest Level of Cognitive Domain
CO1	Illustrate the energy band diagram and small signal equivalent circuits of MESFET, MISFET and MOSFET	L2
CO2	Analyze the SCE , processing challenges and the technology beyond CMOS	L2
CO3	Design digital circuits using MOSFET and functional blocks using nMOS and CMOS.	L3
CO4	Demonstrate the system design to meet requirements using modern tools.	L4

L1– Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create

Course Content / Syllabus:

UNIT No.	Content	Hours	
		Lecture	**Tutorial**
1	MESFETS: MESFET and MODFET operations, quantitative description of MESFETS. **MIS structures and MOSFETS:** MIS systems in equilibrium, under bias, small signal operation of MESFETS and MOSFETS.	**8**	**5**
2	**Short channel effects and challenges to CMOS**: Short channel	**8**	**5**

	effects, scaling theory, processing challenges to further CMOS miniaturization **Beyond CMOS:** Evolutionary advances beyond CMOS, carbon Nano tubes, conventional vs. tactile computing, computing, molecular and biological computing Mole electronics-molecular Diode		
3	**Super buffers, Bi-CMOS and Steering Logic:** Introduction, RC delay lines, super buffers- An NMOS super buffer, tri state super buffer and pad drivers, CMOS super buffers, Dynamic ratio less inverters, large capacitive loads, pass logic, designing of transistor logic, General functional blocks - NMOS and CMOS functional blocks.	**8**	**5**
4	**Special circuit layouts and technology mapping:** Introduction, Talley circuits, NAND- NAND, NOR- NOR, and AOI Logic, NMOS, CMOS Multiplexers, Barrel shifter, Wire routing and module lay out.	**8**	**6**
5	**System design:**CMOS design methods, structured design methods, Strategies encompassing hierarchy, regularity, modularity & locality, CMOS Chip design Options, programmable logic, Programmable inter connect, programmable structure, Gate arrays standard cell approach, Full custom Design.	**7**	**5**

Text Books:

1. Kevin F Brenan***: "Introduction to semiconductor device",*** Cambridge publications

Reference Books:

1. **Douglas. A. Pucknell, Kamran Eshragian:** *"Basic VLSI Design,"* 3rd Edition, Prentice-Hall of Indi , 2006.
2. Eugene D Fabricius: "***Introduction to VLSI design",*** McGraw-Hill International publications

Course Articulation:

Course outcomes	**Program outcomes**					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		3	3		3
CO2	3	2	3	3	2	3
CO3	3		3	3		3
CO4	3	2	3	3	2	3
CO5	3	2	3	3	2	3

High – 3, Medium – 2, Low – 1

DEPARTMENT	**Electronics and Communication Engineering**						
Course Code	**22PIE 162**	*Total Credits*	*4*	*Course Type*	Professional Elective Course		
Course Title	**Mechatronics**						
Teaching Learning Process		*Contact Hours*	*Credits*	*Assessment in Weightage and marks*			
	Lecture	**39**	**3**		**CIE**	**SEE**	**Total**
	Tutorial	**26**	**1**	*Weightage*	*40 %*	*60 %*	*100 %*
	Practical	**0**	**0**	*Maximum Marks*	*40 Marks*	*60 Marks*	*100 Marks*
	Total	**65**	**4**	*Minimum Marks*	*20 marks*	*25 marks*	*45 Marks*

COURSE PREREQUISITE:

Basics of electronics

COURSE OBJECTIVE:

1. To understand the basics of mechatronics system
2. To study sensing, actuation and data acquisition techniques
3. To learn programming for process controlled applications

COURSE OUTCOMES (COs): After completing this course, students will be able to:

CO#	Course Outcomes	Highest Level of Cognitive Domain
CO1	Explain the fundamentals of Mechatronics System	L2
CO2	Explain the different types of sensors and actuators	L2
CO3	Apply the actuation and data acquisition techniques in different applications	L3
CO4	Develop ladder diagrams for process controlled applications	L3

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create

Course Content / Syllabus:

UNIT No.	Content	Hours	
		Lecture	**Tutorial**
1	Overview of Mechatronics: key elements of Mechatronics system, Mechatronic Design Approach, System Interfacing, Instrumentation, and Control Systems, Microprocessor-Based Controllers and Microelectronics, An Introduction to Micro- and Nanotechnology	08	05
2	Mechatronic Sensors and transducers: Sensor Characteristics, Linear and Rotational, Acceleration, Force, Torque, Flow, Stress and Strain Measurement, Pressure and Temperature, proximity, light detection Sensors	08	05
3	Mechatronic Actuators: Mechanical actuation system, Electromechanical Actuators, Piezoelectric, hydraulic and pneumatic actuation systems, Myoelectrically Controlled Robotic Arm, Mechatronic Design of a Coin Counter, Mechatronic Design of a	08	05

	Robotic Walking Machine		
4	Data Acquisition systems: Introduction to signal processing, Quantization theory, Analog-to-Digital Conversion, Digital-to-Analog Conversion, Virtual Instrumentation, Data Acquisition and Control	07	05
5	Industrial automation and control: Control architecture of PLC, Programming of PLCs using ladder diagram, PID controller, Closed loop temperature control system, conveyor speed control system, servo position control system	08	06

Text Books:

1. R.K.Rajput, "Mechatronics", S Chand,2007
2. Robert H. Bishop, "Mechatronic Systems, Sensors and Actuators", CRC Press, 2nd Edition,2008
3. David G.Alciatore, Michael B. Histand, "Introduction to Mechatronics and Measurement Systems", 4th Edition,2011

Reference Books:

1. Godfrey onwubolu, "Mechatronics principles and applications", Elsevier, 2005
2. Wiley,Mechatronics with experiments,2nd Edition,2015
3. Bogdan M. Williamowski, J. David Irwin, "Control and Mechatronics",2nd Edition,2010

SWAYAM/NPTEL:

https://onlinecourses.nptel.ac.in/noc21_me27/preview

https://nptel.ac.in/courses/112103174

https://nptel.ac.in/courses/108105062

PRACTICE BASED LEARNING:

No	Topics to be covered	Tools and Techniques	Expected Skill/Ability
1	PLC programming using ladder diagram	Open-source software	Programming
2	Hardware models using sensors and actuators	Hardware	Interfacing

Self-Learning Exercises:

1. **Case Study projects**
2. **Mini Projects**

Course Articulation:

COURSE OUTCOMES ↓	PROGRAM OUTCOMES					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1		2	3			
CO2		2	3	3		
CO3		2	3	3		
CO4	3	3	3	3	3	2

High – 3, Medium – 2, Low – 1

DEPARTMENT	**Electronics and Communication Engineering**						
Course Code	**22PIE 163**	*Total Credits*	*4*	*Course Type*	Professional Elective Course		
Course Title	**Analog and mixed mode VLSI**						
Teaching Learning Process		*Contact Hours*	*Credits*	*Assessment in Weightage and marks*			
	Lecture	**39**	**3**		**CIE**	**SEE**	**Total**
	Tutorial	**26**	**1**	*Weightage*	*40 %*	*60 %*	*100 %*
	Practical	**0**	**0**	*Maximum Marks*	*40 Marks*	*60 Marks*	*100 Marks*
	Total	**65**	**4**	*Minimum Marks*	*20 marks*	*25 marks*	*45 Marks*

COURSE PREREQUISITE:
Basics of VLSI circuits

COURSE OBJECTIVE:

1. Understand, design, and model the CMOS analog circuits.
2. Implement the design, simulate and analyze the circuit/results.
3. Test the hand calculations using simple models.
4. Understand the present hierarchical approach of sub-blocks, blocks, circuits, and systems.

COURSE OUTCOMES (COs): After completing this course, students will be able to:

CO#	Course Outcomes	Highest Level of Cognitive Domain
CO1	Explain the design procedure for single stage analog amplifier circuits.	L3
CO2	Analyze the biasing techniques to design single stage and differential amplifier.	L3
CO3	Design feedback circuits for a given application.	L4
CO4	Design and Demonstrate the analog circuits using EDA tool.	L5

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create

Course Content / Syllabus:

UNIT No.	Content	Hours	
		Lecture	**Tutorial**
1	Introduction to MOSFET device structure and operation, MOS as an amplifier, Biasing in MOS amplifier circuits, Small signal equivalent circuit model, Single stage MOS amplifiers, Characterizing amplifiers	**8**	**5**
2	IC biasing-current sources, Current mirrors and current-steering circuits, Cascade and Wilson current mirror, Multiple-Transistor IC amplifiers, Cascade configuration, Folded cascade and self cascade structure, Voltage follower, Flipped voltage follower.	**8**	**5**
3	MOS differential pair, Small signal operation, Differential gain, Common mode gain, Common mode rejection ration, Non ideal	**8**	**5**

	characteristics, Active loaded differential amplifier, Frequency response.		
4	General feedback structure, Negative feedback, Four basic topologies, Loop gain, Stability, Effect of feedback on amplifier poles, Single pole response, Two pole response, Frequency compensation, Compensation Techniques,	**8**	**6**
5	Oscillators and Phase Locked Loops: Ring Oscillators, LC Oscillators, VCO, Mathematical Model of VCO. Simple PLL, Charge pump PLL, Non-ideal effects in PLL, Delay locked loops and applications.	**7**	**5**

Text Books: Use APA format: AUTHOR/s, Title, publisher, Edition, Year.

1. Sedra and Smith, "Microelectronic circuits", 7th Edition, Oxford University Press, 2017.
2. Kenneth R. Laker and Willy M.C. Sansen, "Design of Analog Integrated Circuits and systems", 2nd Edition, McGraw-Hill, 2010.
3. Philip E. Allen and Douglas R. Holberg, "CMOS Analog Circuit Design", 3rd Edition, Oxford University Press, 2012

Reference Books: Use APA format.

1. Behzad Razavi, "Design of Analog CMOS Integrated Circuit", 2nd Edition, Tata McGraw Hill, 2017.
2. Gray R.Paul, Hurst J. Paul, Lewis H. Stephen and Meyer G. Robert, "Analysis and Design of Analog Integrated Circuits", 5thEdition, John Wiley and Sons, 2012.
3. R. Jacob Baker," CMOS: Mixed-Signal Circuit Design", 2nd Edition, John Wiley and Sons, 2009.

Journals/Magazines:

1. AMC – Digital Library - https://dl.acm.org/journals
2. IEEE - Solid-State Circuits Magazine.
3. IEEE - Transactions of Circuits and Systems II (TCAS-II)

Web/Digital resources:

1. https://youtu.be/Q3WYZF5wzgU?list=PLbMVogVj5nJQB44z6h0XO2644Vbv7OM8_ - Lecture series on Electronics - CMOS Analog VLSI Design

SWAYAM/NPTEL:

1. https://youtu.be/DfSG8FzFGfo?list=PLUtfVcb-iqn9PmsLh_tkzhlNfIFdk_NsI – Lecture Series on Analog Circuits and Systems through SPICE Simulation – NPTEL

PRACTICE BASED LEARNING:

No	Topics to be covered	Tools and Techniques	Expected Skill/Ability
1	Design and simulation of single stage amplifiers	Electric / Cadence	Explore the EDA tool
2	Simulation with validation of analog CMOS VLSI Circuits.	Electric / Cadence	Design methodology in VLSI Circuits.

Self-Learning Exercises:

Case Study projects - Paper Presentation and implementation of the same from reputed journals

Course Articulation:

COURSE OUTCOMES↓	Course outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1			3	3		
CO2	3		3	3		
CO3	3		3	3	3	
CO4	3	3	3	3	3	3

High – 3, Medium – 2, Low – 1

DEPARTMENT	**Electronics and Communication Engineering**						
Course Code	**22PIE 170L**	*Total Credits*	*1.5*	*Course Type*	Professional Core Course		
Course Title	**Industrial Electronics lab**						
Teaching Learning Process		*Contact Hours*	*Credits*	*Assessment in Weightage and marks*			
	Lecture	**0**	**0**		**CIE**	**SEE**	**Total**
	Tutorial	**0**	**0**	*Weightage*	*40 %*	*60 %*	*100 %*
	Practical	**39**	**1.5**	*Maximum Marks*	*40 Marks*	*60 Marks*	*100 Marks*
	Total	**39**	**1.5**	*Minimum Marks*	*20 marks*	*25 marks*	*45* Marks*

COURSE PREREQUISITE:

Power Electronics

COURSE OBJECTIVE:

1. To Learn the experimental concepts on conversion, control and monitoring of electric energy using power converters.
2. To understand of the underlying principles of quantitative and qualitative research related to Power electronics.

COURSE OUTCOMES (COs): After completing this course, students will be able to:

CO#	Course Outcomes	Highest Level of Cognitive Domain
CO1	Analyze the operating principles of various power electronic converters.	L4
CO2	Use power electronic simulation packages & hardware to develop the power converters.	L4
CO3	Analyze and choose the appropriate converters for various applications.	L4

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create

Course Content / Syllabus:

Week	List of Experiments/ Programs	No. of Hours
1	Design and testing of firing circuits for choppers.	3
2	Design and testing of firing circuits for Inverters.	3
3	Performance analysis of Single-phase bridge inverter for RL Load and voltage control by single pulse width modulation.	3
4	Performance analysis of practical chopper fed DC Drive system.	3
5	Simulation and performance analysis of buck, boost, with R and R-L Load for continuous and discontinuous current modes.	3
6	Simulation and performance analysis of Buck-boost converters (Basic Topology) with R and R-L Load for continuous and discontinuous current modes.	3
7	Simulation and performance analysis of Forward and fly back converters (Basic Topology) with R and R-L Load	3

8	Simulation and performance analysis of sinusoidal PWM inverters with R-L Load	3
9	Simulation and performance analysis of series resonant DC-DC converter with R load	3
10	Generation of firing signals for converters / inverters using digital circuits / microprocessors	3
11	Simulation and analysis of MOSFET circuits.	3
12	Simulation and analysis of BJT drive circuits.	3
13	Laboratory Test	3

Text Books:

1. Daniel W. Hart, Power Electronics, McGraw Hill Publications, 2011

Reference Books:

1. Muhammad H. Rashid: SPICE for Power Electronics and Electric Power 3rd Ed, CRC Press
2. L Umanand: Power Electronics, Essentials and applications 1st Ed, Wiley & Sons.

Journals/Magazines:

1. https://jpels.org/

Web/Digital resources:

3. https://www.mathworks.com/campaigns/offers/next/power-electronics-resource-library.html
4. https://power-electronics.com/en/digitalization/

SWAYAM/NPTEL:

2. https://nptel.ac.in/courses/108102145
3. lkmnbbvcxzzhttps://nptel.ac.in/courses/108102145

Course Articulation:

	PROGRAM OUTCOMES					
COURSE OUTCOMES ↓	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1		2	2	3		
CO2		2	2	3		
CO3		2	2	3	2	

High – 3, Medium – 2, Low – 1

DEPARTMENT	**Electronics and Communication Engineering**						
Course Code	**22PIE180**	*Total Credits*	*1.5*	*Course Type*	Mini-project with seminar		
Course Title	**DESIGN AND IMPLEMENTATION LABORATORY**						
Teaching Learning Process		*Contact Hours*	*Credits*	*Assessment in Weightage and marks*			
	Lecture	**0**	**0**		**CIE**	**SEE**	**Total**
	Tutorial	**0**	**0**	*Weightage*	*40 %*	*60 %*	*100 %*
	Practical	**39**	**1.5**	*Maximum Marks*	*40 Marks*	*60 Marks*	*100 Marks*
	Total	**39**	**1.5**	*Minimum Marks*	*20 Marks*	*25 marks*	*45 Marks*

COURSE PREREQUISITE:

To be enthusiastic to work in groups, identifying new problems and proposing solutions by exploring new tools.

COURSE OBJECTIVE:

1. To generate new innovative interdisciplinary ideas
2. To design a method to realize the ideas.
3. To build a mathematical model and prototype
4. To carry out tests and Analysis
5. To prepare report and write articles

COURSE OUTCOMES (COs): After completing this course, students will be able to:

CO#	Course Outcomes	Highest Level of Cognitive Domain
CO1	Survey the literature, identify gaps and innovatively give a renewed solution.	L4
CO2	Construct prototype, verify the results, prepare report and publish article adhering to standards.	L6

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create

Course Content / Syllabus:

Week	List of Experiments/ Programs	No. of Hours
1	Idea generation	3
2	Literature survey	3
3	Literature survey ,Problem statement	3
4	Synopsis preparation and presentation	3
5	Design and implementation	3

6	Design and implementation	3
7	Mid phase evaluation	3
8	Develop and implement solution	3
9	Integrate designed modules/circuits	3
10	Test, verify and validate the results	3
11	Report and articles preparation	3
12	Final Demo	3
13	Laboratory Test	

Reference Books:

1.Web resources

2. company websites and white papers

Journals/Magazines:

1.IEEE Publications

2.Journals and Magazines

Course Articulation:

Course outcomes	Program outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	2		
CO2	3	3	3	3	3	3

High – 3, Medium – 2, Low – 1

Second semester

DEPARTMENT	**Electronics and Communication Engineering**						
Course Code	**22PIE 210**	*Total Credits*	*4*	*Course Type*	Professional Core Course		
Course Title	**Digital control systems**						
Teaching Learning Process		*Contact Hours*	*Credits*	*Assessment in Weightage and marks*			
	Lecture	**39**	**3**		**CIE**	**SEE**	**Total**
	Tutorial	**26**	**1**	*Weightage*	*40 %*	*60 %*	*100 %*
	Practical	**0**	**0**	*Maximum Marks*	*40 Marks*	*60 Marks*	*100 Marks*
	Total	**65**	**4**	*Minimum Marks*	*20 marks*	*25 marks*	*45 Marks*

COURSE PREREQUISITE:
Analog control systems, calculus, linear algebra

COURSE OBJECTIVE:
1. To introduce students to digital control systems fundamentals.
2. To develop design techniques for digital controllers for both transfer function and state space models.

COURSE OUTCOMES (COs): After completing this course, students will be able to:

CO#	Course Outcomes	Highest Level of Cognitive Domain
CO1	Analyze discrete time signals and systems using z-transforms	L4
CO2	Analyze discrete time systems and its properties using transfer function and state-space model	L4
CO3	Design digital controllers for transfer function and state-space models.	L6
CO4	Simulate and validate the design of digital control systems using modern tools and present the results.	L6

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create

Course Content / Syllabus:

UNIT No.	Content	Hours	
		Lecture	**Tutorial**
1	Basic digital control systems, examples of digital control systems, revision of Laplace and Z-Transforms, sampling, ideal sampler, evaluation of $F^*(S)$, properties of $F^*(S)$, zero order hold, first order hold, Z-transform properties, inverse Z-Transform methods, solution of difference equations, mapping from S-Plane to Z-Plane.	**8**	**5**
2	Open loop discrete time systems with and without zero order hold, pulse transfer function of interconnected sampled data systems, closed loop systems, transfer function using signal flow graph and	**8**	**5**

	block diagram reduction, system time response, system characteristic equation, steady state error. State-space model of sampled data system, state solution of discrete time system.		
3	BIBO Stability definition, theorems, Routh-Hurwitz and Jury's stability tests, stability analysis using root locus technique, stability analysis in frequency domain; Bode plot and Nyquist's plot.	**8**	**5**
4	Design of Digital Controllers Indirect Method: Design of PI, PID, Phase-lead controllers.Design of Digital Controller Direct method: Ragazzini's method, Realizability of digital controllers, dead beat controllers.	**8**	**5**
5	Controllability and Observability of SS models, State Variable Feedback for Discrete Time systems, Pole-placement design, State observers, closed-loop observer design, Combined system of controller and observer.	**7**	**6**

Text Books:

1. M. Gopal, Digital Control and State Variable Methods, Mc Graw Hill India, 2012

Reference Books:

1. Charles L. Phillips, H. TroyNagle,AranyaChakraborthy,*Digital Control Systems, Analysis and Design*, 4th Edition, McGraw Hill, 2014.
2. Gene F. Franklin, J. David Powell and Michael Workman, *Digital Control of Dynamic Systems*, 3rd Edition, Ellis-Kagle Press, 2006.

Journals/Magazines:

1. IEEE Transaction on Automatic Control

Web/Digital resources:

1. **https://www.youtube.com/watch?v=RuxceEdXzo&list=PLCPLSoBCDMT9oasGriNX3gPL4u2btKp_E**
2. **https://www.mathworks.com/products/control.html**

SWAYAM/NPTEL:

https://nptel.ac.in/courses/108103008

PRACTICE BASED LEARNING:

No	Topics to be covered	Tools and Techniques	Expected Skill/Ability
1	Step response of DT systems	MATLAB	Numerical computing and simulation
2	Root-locus for DT system	MATLAB	Numerical computing and

			simulation
3	Digital controller design	MATLAB	Numerical computing and simulation
4	State Variable feedback design	MATLAB	Numerical computing and simulation

Self-Learning Exercises:

1. **Case Study projects**
2. **Mini Projects**

Course Articulation:

COURSE OUTCOME	**PROGRAM OUTCOME**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1		2	3			
CO2		2	3	3		
CO3		2	3	3		
CO4	3	3	3	3	3	2

High – 3, Medium – 2, Low – 1

DEPARTMENT	**Electronics and Communication Engineering**						
Course Code	**22PIE 220**	*Total Credits*	*4*	*Course Type*	Professional Core Course		
Course Title	**Robotics and Industrial Automation**						
Teaching Learning Process		*Contact Hours*	*Credits*	*Assessment in Weightage and marks*			
	Lecture	**39**	**3**		**CIE**	**SEE**	**Total**
	Tutorial	**26**	**1**	*Weightage*	*40 %*	*60 %*	*100 %*
	Practical	**0**	**0**	*Maximum Marks*	*40 Marks*	*60 Marks*	*100 Marks*
	Total	**65**	**4**	*Minimum Marks*	*20 marks*	*25 marks*	*45 Marks*

COURSE PREREQUISITE:
Control system

COURSE OBJECTIVE:
1. To impart knowledge on various electrical and electronics used in robotics.
2. To learn about various sensors, actuators and hybridization methods.

COURSE OUTCOMES (COs): After completing this course, students will be able to:

CO#	Course Outcomes	Highest Level of Cognitive Domain
CO1	Explain the Robot anatomy, required background material for Robotics and to describe mathematically the position and orientation in 3-space.	L2
CO2	Apply the inverse kinematics of robot arms and solve related problems.	L3
CO3	Model the dynamics of manipulators by applying the knowledge of kinematics of velocities and static forces.	L3
CO4	Examine the motions of manipulators and their control .	L4
CO5	Infer the knowledge on the state of the art in external robot sensors for industrial automation.	L4

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create

Course Content / Syllabus:

UNIT No.	Content	Hours	
		Lecture	Tutorial
1	**Introduction to Robotics:** Definitions, Laws of Robotics, Robot anatomy, Design and control issues, Manipulation and Control, Sensors and Vision, Programming Robots. **Coordinate Frames, Mapping and Transforms:** Mapping Frames,	**8**	**5**

	Description of objects in Space, Transformation of Vectors, Inverting a Homogeneous Transform, Fundamental Rotation Matrices.		
2	**Modelling of Robots:** Direct Kinematics, Mechanical Structures and Notations, Description of Links and Joints, Kinematic Modeling of Manipulator, Denavit-Hartenberg notation, Kinematic Relationship between Adjacent Links, Manipulator Transformation Matrix. Inverse Kinematics, Manipulator Workspace, Solvability of Inverse Kinematic Model, Solution Techniques and Closed form Solution.	**8**	**5**
3	**Manipulator Differential Motion and Statics:** Linear and Angular Velocity of a Rigid body, Relationship between Transformation Matrix and Angular Velocity, Mapping Velocity Vector, Velocity Propagation along Links, Manipulator Jacobian, Jacobian Inverse and Singularities, Static Analysis. **Dynamic Modelling:** Lagrangian Mechanics, Two-degree of Freedom Manipulator, Lagrange- Euler Formulation and Newton-Euler Formulation and their Comparison, Inverse Dynamics	**8**	**5**
4	**Trajectory Planning:** Definitions and Planning Tasks, Joint Space Techniques and Cartesian Space Techniques and their Comparison. **Control of Manipulators:** Open and Closed loop control, Manipulator Control problem, Linear Control Schemes, Linear Second Order SISO Model of a Manipulator Joint, Joint Actuators, Partitioned PD Control	**8**	**5**
5	**Robotic Sensors and Vision:** Meaning of Sensors, Sensors in Robotics, Kinds of Robotic Sensors, Robotic Vision, Applications of Vision-Controlled Robotic Systems. Process of Imaging, Architecture of Robotic Vision Systems, Image Acquisition and Other Components of Vision System. **Industrial Applications of Robots:** Material Handling, Processing Applications – Arc Welding, Assembly Applications, Inspection Applications, Robot Safety.	**7**	**6**

Text Books:

1. R. K. Mittal and I. J. Nagarath: ***Robotics and Control,*** 6th Reprint, Tata Mcgraw-Hill Education, Delhi 2007.
2. K. S, Fu, R. C. Gonzalez, and C. S. G. Lee: ***Robotics: Control, Sensing, Vision, and Intelligence,*** 8th Ed, Pearson Education 2007.

Reference Books:

John J. Craig: "*Introduction to Robotics: Mechanics and Control"**,*** 3rd Ed, Pearson Education, New Delhi 2006.

Self-Learning Exercises:

1. **Case Study projects**
2. **Mini Projects**

Course Articulation:

COURSE OUTCOMES↓	PROGRAM OUTCOMES					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1				3		
CO2			3	3		
CO3			3	3		
CO4	3	3	3	3	3	
CO5	2	2				3

High – 3, Medium – 2, Low – 1

DEPARTMENT	**Electronics and Communication Engineering**						
Course Code	**22PIE230**	*Total Credits*	*4*	*Course Type*	Professional Core Course		
Course Title	**Automotive Electronics**						
Teaching Learning Process		*Contact Hours*	*Credits*	*Assessment in Weightage and marks*			
	Lecture	**39**	**3**		**CIE**	**SEE**	**Total**
	Tutorial	**26**	**1**	*Weightage*	*40 %*	*60 %*	*100 %*
	Practical	**0**	**0**	*Maximum Marks*	*40 Marks*	*60 Marks*	*100 Marks*
	Total	**65**	**4**	*Minimum Marks*	*20 marks*	*25 marks*	*45 Marks*

COURSE PREREQUISITE:
Digital electronics, Sensors

COURSE OBJECTIVE:
1. To gain knowledge on various electrical and electronics used in vehicles.
2. To learn about various sensors, actuators and hybridization methods

COURSE OUTCOMES (COs): After completing this course, students will be able to:

CO#	Course Outcomes	Highest Level of Cognitive Domain
CO1	Explain various Electrical and Electronic systems used in vehicle.	L2
CO2	Analyze the various sensor types and measuring principles	L4
CO3	Explain the various hybridization methods and actuators	L2
CO4	Analyze, implement and demonstrate real time examples	L4

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create

Course Content / Syllabus:

UNIT No.	Content	Hours	
		Lecture	**Tutorial**
1	**Electrical and electronic systems in the vehicle:** Overview, Motronic-engine management system, Electronic diesel control, Lighting technology, Electronic stability program, ABS, Adaptive cruise control, Occupant-protection systems	**8**	**5**
2	**Networking and bus systems:** Cross-system functions, Requirements for bus systems, Classification of bus systems, Applications in the vehicle, Coupling of networks, Examples of networked vehicles. **Architecture of electronic systems & Control Units:** Overview, Vehicle system architecture. Control units: Operating conditions, Design, Data processing, Digital modules in the control unit and control unit software	**8**	**5**
3	**Automotive sensors:** Basics and overview, Automotive applications, Sensor market, Features of vehicle sensors, Sensor classification,	**8**	**5**

	Error types and tolerance requirements, Reliability, Main requirements & trends, Physical effects for sensors, Selection of sensor technologies		
4	**Sensor measuring principles:** Sensors for the measurement of position, speed, rpm, acceleration, pressure, force, and torque, Flow meters, temperature sensors. **Sensor types:** Engine speed sensors, Hall phase sensors, Sensors for transmission control & wheel speed, Yaw-rate sensors, Pressure sensors, Temperature sensors, , Position sensors, Piezoelectric knock sensors, , Acceleration sensors, Force & torque sensors.	**8**	**5**
5	**Actuators:** Electromechanical & fluid mechanical actuators, Electrical machines. Hybrid **drives:** Drive concepts, Operating strategies for electric hybrid vehicles, Recuperative brake system, Electrical energy accumulators. **EMC and Interference suppression:** EMC between different systems in the vehicle, EMC between the vehicle and its surrounding	**7**	**6**

Text Books:

1. Robert Bosch GmbH, *"Bosch Automotive Electrics and Automotive Electronics",* 5th Edition, Springer Vieweg, 2014.
2. William B. Ribbens,*"Understanding Automotive Electronics: An Engineering Perspective",* 8thEdition, Elsevier, 2017
3. Tom Denton "*Automobile Electrical and Electronic Systems*" , 3rd Edition, Elsevier, 2004.

Reference Books:

1. K. Babu,*"Automotive Electrical and Electronics",* Khanna Publishers, 1st Edition, 2018.
2. John F. Kershaw, Ed.D. and James D. Halderman,*"Automotive Electrical and Electronic Systems",*5th Edition, Pearson Prentice Hall, 2007.
3. Barry Hollembeak,*"Automotive Electricity and Electronics",* Cengage Learning, 6th Edition, 2014.

Self-Learning Exercises:

1. **Case Study projects**
2. **Mini Projects**

Course Articulation:

	PROGRAM OUTCOMES					
COURSE OUTCOMES↓	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1			3			
CO2			3	3		
CO3			3	3		
CO4		3	3	3	3	

High – 3, Medium – 2, Low – 1

DEPARTMENT	**Electronics and Communication Engineering**						
Course Code	**22PIE 241**	***Total Credits***	***4***	***Course Type***	Professional Elective Course		
Course Title	**Operations Research and Optimization**						
Teaching Learning Process		***Contact Hours***	***Credits***	***Assessment in Weightage and marks***			
	Lecture	**39**	**3**		**CIE**	**SEE**	**Total**
	Tutorial	**26**	**1**	***Weightage***	***40 %***	***60 %***	***100 %***
	Practical	**0**	**0**	***Maximum Marks***	***40 Marks***	***60 Marks***	***100 Marks***
	Total	**5**	**4**	***Minimum Marks***	***20 marks***	***25 marks***	***45 Marks***

COURSE PREREQUISITE:
Fundamentals of algebra and matrix operations.

COURSE OBJECTIVE:

1. Familiarization of operation research concepts and optimization techniques.
2. Problem formulation using optimization techniques for different models.
3. Solve operation research problems applied to engineering and management.

COURSE OUTCOMES (COs): Upon completion of the course, student will be able to:

Cos	Course Outcomes	Highest Level of Cognitive Domain
CO1	Describe the importance and significance of Operation Research concepts and techniques in various applications.	L2
CO2	Apply Operation Research techniques to solve problems related to optimization.	L3
CO3	Analyze and solve transportation, assignment, network, queuing and game theory problems.	L4
CO4	Demonstrate the skill sets to use software tools to solve Operation Research and optimization problems.	L4

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create

Course Content / Syllabus:

UNIT No.	Content	Hours	
		Lecture	Tutorial
1	Introduction to Operations Research (OR), Overview of OR Modeling approaches, Introduction to Linear Programming (LP), assumptions, problem formulation.	8	5
2	Solving LP problems, Simplex method computer implementation, other algorithms for LP, Dual simplex, parametric, upper bound and interior point algorithms.	8	5
3	Transportation and assignment problems. Network optimization methods, examples, case studies.	8	5
4	Bit Integer Programming (BIP), Integer Programming branch and bound, constraint programming and capacity assignments.	8	6
5	Game theory, solving simple game problems, introduction to queuing theory, distributions, applications.	7	5

Text Books:

1. Hiller and Lieberman, (2007), *"Introduction to Operations Research"*, TMH.
2. Hamdy Taha, (2003), "*Operations Research",* Pearson Prentice Hall
3. R. Pannerselvam, (2006) "*Operations Research*", PHI.

Reference Books:

1. Bronson and Naadimuthu (1997), "*Operations Research - Schaum's Series*", Tata McGraw Hill.
2. Wayne Winston, (2003), "*Operations Research - Applications and Algorithms",* Cengage.

Journals/Magazines:

1. **https://pubsonline.informs.org/journal/opre#**
2. **https://pubsonline.informs.org/magazine/orms-today**
3. **https://www.sciencedirect.com/journal/operations-research-perspectives**

Web/Digital resources: Nil

SWAYAM/NPTEL:

1. https://nptel.ac.in/courses/110106062
2. https://onlinecourses.swayam2.ac.in/cec20_ma10/preview

PRACTICE BASED LEARNING:

No	Topics to be covered	Tools and Techniques	Expected Skill/Ability
1	Parametric linear programming and capacity assignments	OR techniques/tools	Problem solving and analysis

Selflearning Exercises:

1. **Case Study:** Transportation, assignment and network optimization techniques.
2. **Mini Projects**
3. **Any others**

Course Articulation:

Course outcomes	Program outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		3	3	3	
CO2	3		3	3	3	
CO3	3		3	3		
CO4	2	3	3	3	3	1

High – 3, Medium – 2, Low – 1

DEPARTMENT	**Electronics and Communication Engineering**						
Course Code	**22PIE242**	*Total Credits*	*4*	*Course Type*	Professional Elective Course		
Course Title	**Medical Electronics**						
Teaching Learning Process		*Contact Hours*	*Credits*	*Assessment in Weightage and marks*			
	Lecture	**52**	**0**		**CIE**	**SEE**	**Total**
	Tutorial	**0**	**0**	*Weightage*	*40 %*	*60 %*	*100 %*
	Practical	**0**	**0**	*Maximum Marks*	*40 Marks*	*60 Marks*	*100 Marks*
	Total	**52**	**0**	*Minimum Marks*	*20 marks*	*25 marks*	*45 Marks*

COURSE PREREQUISITE: Electronics and sensors.

COURSE OBJECTIVE:

The study design, mechanics and software development of the medical devices used for diagnostic purposes

COURSE OUTCOMES (COs): Upon completion of this course, student should be able to:

COs	Course Outcomes	Highest Level of Cognitive Domain
CO1	Explain the origin of various bioelectric signals and issues related to their acquisition.	L2
CO2	Investigate the various lifesaving diagnosis and therapeutic instruments.	L3
CO3	Describe the various patients monitoring system and understand the concept of telemedicine	L2
CO4	Design medical systems to enhance the performance of medical devices	L4

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create

Course Content / Syllabus:

UNIT No.	Content	Hours	
		Lecture	Tutorial
1	**Bioelectric Signals and Electrodes :** Sources of biomedical signals, Basic medical instrumentation system, General constraints in design of medical instrumentation systems, Origin of bioelectric signals, Electrocardiogram (ECG), Electroencephalogram (EEG), Electromyogram (EMG), Electrooculogram (EOG), Electroretinogram (ERG), Electrodes – Electrode-tissue interface,	**10**	**0**

	Polarization, Skin contact impedance, Motion artifacts, Silver-Silver Chloride electrodes, Electrical conductivity of electrode jellies and creams.		
2	**Acquisition of Bioelectrical signals and Pacemakers**: Electrodes for ECG, ECG leads, Effects of artifacts, Multi-channel ECG machine, Vector cardiograph, Phonocardiograph, Electrodes of EMG, Electrodes for EEG, 10-20 electrode systems, computerized analysis of EEG, Pacemakers & Defibrillator: Need for cardiac pacemaker, External pacemaker, Implantable pacemakers-types, Need for defibrillator, DC defibrillator, Automatic external defibrillator, Implantable defibrillators	**10**	**0**
3	**Diagnosis and Therapeutic Instruments:** Spirometry: Basic spirometer, Ultrasonic spirometer, Ventilators, types, Modern ventilators, High frequency ventilators, Nebulizers, Artificial Kidney: Introduction, Dialyzers, Membranes for Hemodialysis, Hemodialysis machine, Oximetry, Blood flow measurement by Doppler imaging, Nuclear Magnetic Resonance& Laser Doppler flow meter.	**12**	**0**
4	**Patient Monitoring Systems and Telemedicine:** Cardiac monitor, Bedside patient monitoring system, measurement of heart rate-average and instantaneous heart rate meters, Measurement of pulse rate, Blood pressure measurement: Direct method, Indirect method-automatic pressure measurement using Korotkoff's method, Single channel telemetry systems, Multichannel wireless telemetry systems, Multi-patient telemetry, Telemedicine applications, Essential parameters for telemedicine, Telemedicine technology.	**10**	**0**
5	**Medical Imaging Systems**: Basic components and working principle of X-rays, Ultrasound, Computed Tomography (CT), Magnetic Resonance Imaging (MRI)& Radionuclide Imaging.	**10**	**0**

Text Books:

1. R.S.Khandpur,***Handbook of Biomedical Instrumentation***, 2nd Edition, Tata McGraw Hill, 2003
2. Kirk Shung, Michael Smith and Benjamin M.W Tsui, ***Principles of Medical Imaging***, Academic Press limited, 1992.
3. ***Biomedical Instrumentation and Measurement*** Leslie Cromwell, Fred J Weibell and Erich Pfeiffer, 2nd Edition, Prentice-Hall India.

Reference books:

1. Guyton & Hall,***Text Book Of Medical Physiology,***11th edition, Saunders/Elsevier.
2. Joseph J. Carr and John M. Brown,***Introduction to Biomedical Equipment Technology,*** 4th Edition, Pearson Education, 2000.

Course Articulation:

Course outcomes	Program outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1		2	3			
CO2		2	3	3		
CO3		2	3	3		
CO4	3	3	3	3	3	2

High – 3, Medium – 2, Low – 1

DEPARTMENT	**Electronics and Communication Engineering**						
Course Code	**22PIE 243**	*Total Credits*	*4*	*Course Type*	Professional Elective Course		
Course Title	**Electric vehicle**						
Teaching Learning Process		*Contact Hours*	*Credits*	*Assessment in Weightage and marks*			
	Lecture	**39**	**3**		**CIE**	**SEE**	**Total**
	Tutorial	**26**	**1**	*Weightage*	*40 %*	*60 %*	*100 %*
	Practical	**0**	**0**	*Maximum Marks*	*40 Marks*	*60 Marks*	*100 Marks*
	Total	**65**	**4**	*Minimum Marks*	*20 marks*	*25 marks*	*45 Marks*

COURSE PREREQUISITE:

Basics of Electrical and Electronics

COURSE OBJECTIVE:

1. To study the fundamentals, design concepts of hybrid and electric vehicles.
2. To learn the various types of electric machines and energy storage devices in electric vehicles.

COURSE OUTCOMES (COs)

CO#	Course Outcomes	Highest Level of Cognitive Domain
CO1	Demonstrate the knowledge of architecture, technology, and fundamentals of electric and hybrid vehicles.	L2
CO2	Analyze various energy storage technologies and propulsion systems utilized in hybrid electric vehicles.	L4
CO3	Examine the working of different configurations of electric, hybrid vehicle, performance analysis and Energy Management strategies used in HEVs.	L4
CO4	Take part in a group/individual activity and complete the assigned task by demonstrating skills related to implementation, documentation and presentation.	L4

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create

Course Content / Syllabus:

UNIT No.	Content	Hours	
		Lecture	**Tutorial**
1	**Introduction to Electric Vehicle:** History of Electric Vehicles, Development towards 21st Century, Types of Electric Vehicles in use today – Battery Electric Vehicle, Hybrid (ICE & others), Fuel Cell EV, Solar Powered Vehicles. Motion and Dynamic Equations of the Electric Vehicles: various forces acting on the Vehicle in static and dynamic conditions. **Introduction to Hybrid Electric Vehicle:** Social and environmental importance of hybrid and electric vehicles, impact of modern drive-	**8**	**5**

	trains on energy supplies. Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid Drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.		
2	**Electric Drive Trains:** Basic concept of electric traction, introduction to various electric drive- train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis. Electric Propulsion unit **Hybrid vehicle architectures:** Series hybrid vehicle architectures, Parallel hybrid vehicle architectures, Series-Parallel hybrid vehicle architectures –range extender and full hybrid systems, Parallel hybrid architectures, Plug-in hybrid architectures, commercially available electric and hybrid vehicles.	**8**	**5**
3	**Energy Storage:** Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices. Battery Management System (BMS) / Energy Management System (EMS)	**8**	**5**
4	**Electric Propulsion unit:** Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.	**8**	**5**
5	**Energy Management Strategies:** Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies. Introduction to various charging techniques and schematic of charging stations	**7**	**6**

Text books:

1. James Larminie, J. Lowry, "Electric Vehicle Technology Explained", John Wiley & Sons Ltd. 2003.
2. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design", CRC Press, 2004.
3. William B. Ribbens, "UnderstandingAutomotiveElectronics", Butterworth, Heinemann Woburn, 5th Edition,1998.
4. SethiH.M, "AutomobileTechnology",TataMcGraw-Hill-2003.

Reference Books:

1. Crouse and Anglin "Automotive Mechanism", Tata McGraw-Hill, 9thEdition. 2003.
2. Newton, Steeds and Garet, "Motor vehicles", Butter worth Publishers, 1989.
3. S. Onori, L. Serrao and G. Rizzoni, "Hybrid Electric Vehicles: Energy Management Strategies",Springer, 2015.

4. Iqbal Hussein, “Electric and Hybrid Vehicles: Design Fundamentals”, CRC Press, 2003.

Web/Digital resources:

1. https://archive.nptel.ac.in/content/syllabus_pdf/108103009.pdf
2. https://www.youtube.com/watch?v=V004WUdpHeA&list=PLCBKiW2ShR0B5Rs-ytbbp-uyiPAzqdZts
3. https://www.youtube.com/watch?v=BMrA-5EDakg&list=PLQnccOCAloDQXQ62BTGvsRQFBBisedbJT
4. https://www.youtube.com/watch?v=ErV5lGVso1w&list=PL2ir4svMoaYj48N0VWoic25P9LaU2wlbA
5. https://www.youtube.com/watch?v=hcNqUZ1TiRM&list=PL2CubuFTe28NyTyClUCMizxksWmmeY36x

PRACTICE BASED LEARNING:

No	Topics to be covered	Tools and Techniques	Expected Skill / Ability
1	Hybrid Vehicle simulation	Any simulation tool for automotive domain.	Programming/ Simulation

Self-Learning Exercises:

1. **Case Study projects**
2. **Mini Projects**

Course Articulation:

COURSE OUTCOMES↓	PROGRAM OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		3	3		
CO2	3		3	3		
CO3	3	3	3	3		
CO4	3	3	3	3	3	

High – 3, Medium – 2, Low – 1

DEPARTMENT	**Electronics and Communication Engineering**						
Course Code	**22PIE251**	***Total Credits***	***4***	***Course Type***	Professional Elective Course		
Course Title	**Testing and verification of VLSI circuits**						
Teaching Learning Process		***Contact Hours***	***Credits***	***Assessment in Weightage and marks***			
	Lecture	**39**	**3**		**CIE**	**SEE**	**Total**
	Tutorial	**26**	**1**	***Weightage***	***40 %***	***60 %***	***100 %***
	Practical	**0**	**0**	***Maximum Marks***	***40 Marks***	***60 Marks***	***100 Marks***
	Total	**65**	**4**	***Minimum Marks***	***20 marks***	***25 marks***	***45 Marks***

COURSE PREREQUISITE:
Digital electronics and CMOS VLSI Design

COURSE OBJECTIVE:

1. To learn low power design, fault models, memory testing, and test methodologies.
2. To apply concepts of scan based, BIST and boundary scan methods for testing VLSI circuits.

COURSE OUTCOMES (COs): Upon completion of this course, student should be able to:

COs	Course Outcomes	Highest Level of Cognitive Domain
CO1	Explain the fundamentals of testing and verification of VLSI circuits.	L2
CO2	Develop fault models using different types of faults.	L3
CO3	Analyze the concepts of memory testing.	L3
CO4	Summarize the different test methodologies.	L2
CO5	Apply the concepts of testing methods on VLSI circuits to evaluate its performance.	L4

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create

Course Content / Syllabus:

UNIT No.	Content	Hours	
		Lecture	**Tutorial**
1	Scope of testing and verification in VLSI design process. Issues in test and verification of complex chips, embedded cores and SOCs. Fundamentals of VLSI testing.	**8**	**5**
2	Fault models: Functional vs structural testing, levels of fault models, single stuck faults Automatic test pattern generation for combinational and sequential circuits	**8**	**5**
3	Memory test: Test levels, fault modeling, memory testing, Delay test: Path delay test, test methodologies Idd_q testing: methods, limitations	**8**	**5**

4	Digital DFT and scan design: Design rules, tests for scan circuits, partial scan design BIST: Random logic BIST, Memory BIST	**8**	**5**
5	Boundary scan standard: System configuration BSDL system test and core-based design: Functional test, diagnostic test, testable system design, core based design	**7**	**6**

Text Books:

1. M. L. Bushnell and V.D. Agrawal: "*Essentials of Electronic Testing for Digital Memory and Mixed Signal VLSI Circuits*", Springer, 2005

Reference Books:

1. M. Abramovici, M. Breuer, and A. Friedman: "*Digital System Testing and Testable Design"*, IEEE Press, 1994

Course Articulation:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		3	3		3
CO2	3	2	3	3	2	3
CO3	3		3	3		3
CO4	3	2	3	3	2	3
CO5	3	2	3	3	2	3

High – 3, Medium – 2, Low – 1

DEPARTMENT	**Electronics and Communication Engineering**						
Course Code	**22PIE252**	***Total Credits***	***4***	***Course Type***	Professional Elective Course		
Course Title	**Image processing and computer vision**						
Teaching Learning Process		***Contact Hours***	***Credits***	***Assessment in Weightage and marks***			
	Lecture	**39**	**3**		**CIE**	**SEE**	**Total**
	Tutorial	**26**	**1**	***Weightage***	***40 %***	***60 %***	***100 %***
	Practical	**0**	**0**	***Maximum Marks***	***40 Marks***	***60 Marks***	***100 Marks***
	Total	**65**	**4**	***Minimum Marks***	***20 marks***	***25 marks***	***45 Marks***

COURSE PREREQUISITE:
Linear algebra

COURSE OBJECTIVE:

1. To introduce various spatial domain and frequency domain image processing techniques.
2. To study the concepts of computer vision.

COURSE OUTCOMES (COs): After completing this course, students will be able to

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 – Create

CO1:	Explain the fundamental concepts of image acquisition, processing and computer vision.	L2
CO2:	Analyze spatial domain and frequency domain image processing techniques	L4
CO3:	Apply various segmentation and morphological operations and techniques	L3
CO4:	Analyze, implement and demonstrate image processing and computer vision techniques using modern tools.	L4

Course Content / Syllabus:

Unit No.	Content	Hours	
		Lecture	**Tutorial**
1	**Fundamentals:** Light & color Spectral representation of light Color, color spaces, color gamut, color consistency, White balance Gamma correction, **Camera model:** Image formation Perspective imaging, mathematical model of camera **Basic Image processing**: Acquiring images from files, cameras and the web, Grey scale conversion, binary conversion, Image histograms, Spatial operations: cropping, resizing, warping, 2d convolution	8	5
2	**Image Processing in Frequency Domain:** 2dimentional DFT, correspondence between filtering in spatial and frequency domain, smoothing and sharpening using Butterworth and Guassian Lowpass and highpass filters, Convolution, correlation, FFT and IFFT in 2D.	8	6

3	**Basic Morphological Algorithms:** Dilation and erosion, Opening and closing, boundary extraction, region filling, extraction of connected components, thinning, thickening and pruning. **Features:** Feature detectors, Feature descriptors, Feature mapping, Largescale matching and retrieval, feature tracking	8	5
4	**Edge detection techniques:** Point, line and edge detection, Basic (Robert Cross, Sobel , Prewitt, Canny techniques). **Image segmentation:** Contour Tracking, Lines and Vanishing points, Hough transform, Graph based segmentation	8	5
5	**Motion Estimation:** Translational alignment, Parametric motion, Optical flow **Depth Estimation:** Epipolar geometry, Sparse correspondence, Dense correspondence, Local methods, Multi view stereo techniques	7	5

Text Books:

1. **Oscar Gonzalez,** "Digital Image Processing", 4th Edition, Pearson, 2018.
2. **Richard Szeliski,** "Computer Vision: Algorithms and Application", 2nd Edition, Springer, 2022

Reference Books:

1. **Forsyth David A., Ponce Jean,** "Computer Vision: A Modern Approach", Pearson, 2015.
2. **Jayaraman S , Veerakumar T, Esakkirajan S, "**Digital Image Processing", McGrawHill Education, 2017.

Web Resources:

1. **https://www.imageprocessingplace.com/**
2. **https://www.youtube.com/watch?v=3LaVxEX3F0o&list=PLwdnzlV3ogoVsma5GmBSsgJM6gHv1QoAo (NPTEL course, IIT Gowhati)**

self learning:

CNN architectures and algorithms for object detection

Course Articulation matrix:

COURSE OUTCOME	PROGRAM OUTCOME					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1		2	3			
CO2		2	3	3		
CO3		2	3	3		
CO4	3	3	3	3	3	2

1-Low, 2- Medium, 3-High

DEPARTMENT	**Electronics and Communication Engineering**						
Course Code	**22PIE253**	*Total Credits*	4	*Course Type*	**Professional Elective Course**		
Course Title	***Renewable Energy Systems***						
Teaching Learning Process		*Contact Hours*	*Credits*	*Assessment in Weightage and marks*			
	Lecture	**39**	3		**CIE**	**SEE**	**Total**
	Tutorial	**26**	**1**	*Weightage*	*40 %*	*60 %*	*100 %*
	Practical	**0**	**0**	*Maximum Marks*	*40 Marks*	*60 Marks*	*100 Marks*
	Total	**65**	**0**	*Minimum Marks*	*20 marks*	*25 marks*	*45 Marks*

COURSE PREREQUISITE:
Natural energy resources

COURSE OBJECTIVE:

1. Awareness about renewable Energy Sources and technologies.
2. Recognize current and possible future role of renewable energy sources.

CO#	Course Outcomes	Highest Level of Cognitive Domain
CO1	Explain the renewable energy sources and technologies	L2
CO2	Solve the wind energy and grid integration issues.	L3
CO3	Outline the applications of solar energy and SPV conversion	L2
CO4	Illustrate the basic concepts of biomass energy	L2
CO5	Classify the various types of renewable energy sources and their applications.	L2

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create

Course Content / Syllabus:

UNIT No.	Content	Hours	
		Lecture	**Tutorial**
1	**RENEWABLE ENERGY (RE) SOURCES:** Environmental consequences of fossil fuel use, Importance of renewable sources of energy, Sustainable Design and development, Types of RE sources, Limitations of RE sources, Present Indian and international energy scenario of conventional and RE sources	10	5
2	**WIND ENERGY**: Power in the Wind – Types of Wind Power Plants(WPPs)– Components of WPPs-Working of WPPs- Siting of WPPs-Grid integration issues of WPPs.	12	5

3	**SOLAR PV AND THERMAL SYSTEMS:** Solar Radiation, Radiation Measurement, Solar Thermal Power Plant, Central Receiver Power Plants, Solar Ponds.- Thermal Energy storage system with PCM- Solar Photovoltaic systems : Basic Principle of SPV conversion – Types of PV Systems- Types of Solar Cells, Photovoltaic cell concepts: Cell, module, array ,PV Module I-V Characteristics, Efficiency & Quality of the Cell, series and parallel connections, maximum power point tracking, Applications	10	6
4	**BIOMASS ENERGY**: Introduction-Bio mass resources –Energy from Bio mass: conversion processes-Biomass Cogeneration-Environmental Benefits. Geothermal Energy: Basics, Direct Use, Geothermal Electricity. Mini/micro hydro power: Classification of hydropower schemes, Classification of water turbine, Turbine theory, Essential components of hydroelectric system	10	5
5	**OTHER ENERGY SOURCES**: Tidal Energy: Energy from the tides, Barrage and Non Barrage Tidal power systems. Wave Energy: Energy from waves, wave power devices. Ocean Thermal Energy Conversion (OTEC)- Hydrogen Production and Storage- Fuel cell: Principle of working- various types - construction and applications. Energy Storage System- Hybrid Energy Systems.	10	5

Text Books:

1. A.K.Mukerjee and Nivedita Thakur," Photovoltaic Systems: Analysis and Design", PHI Learning Private Limited, New Delhi, 2011
2. Richard A. Dunlap," Sustainable Energy" Cengage Learning India Private Limited, Delhi, 2015.
3. Chetan Singh Solanki, " Solar Photovoltaics : Fundamentals, Technologies and Applications", PHI Learning Private Limited, New Delhi, 2011

Reference Books:

1. Bradley A. Striebig, Adebayo A. Ogundipe and Maria Papadakis," *Engineeringapplications in Sustainable Design and Development*", Cengage Learning India Private Limited, Delhi, 2016.
2. Godfrey Boyle, "*Renewable energy*", Open University, Oxford University Press in association with the Open University, 2004.
3. ShobhNath Singh, '*Non-conventional Energy resources'* Pearson Education ,2015.

PRACTICE BASED LEARNING:

No	Topics to be covered	Tools and Techniques	Expected Skill/Ability
1	Mini project/case study/ field visit	Report writing on field visit, hard ware project implementation	Practical experience of RE generation
2	Simulation	Open source simulation tools	Simulation skill

Self-Learning Exercises:

1. **Case Study projects/ field visit**
2. **Mini Projects**

Course Articulation:

COURSE OUTCOMES ↓	PROGRAM OUTCOMES					
	PO1	**PO2**	**PO3**	**P04**	**P05**	**PO6**
CO1	3	2	3		3	
CO2	3	2	3		3	
CO3	3	2	3		3	
CO4	3	2	3		3	
CO5	3	2	2		2	

High – 3, Medium – 2, Low – 1

DEPARTMENT	**Electronics and Communication Engineering**						
Course Code	**22PAE 26OE**	*Total Credits*	*4*	*Course Type*	*Open Elective Course*		
Course Title	**NANO DIELECTRICS**						
Teaching Learning Process		*Contact Hours*	*Credits*	*Assessment in Weightage and marks*			
	Lecture	**52**	**4**		**CIE**	**SEE**	**Total**
	Tutorial	**0**	**0**	*Weightage*	*40 %*	*60 %*	*100 %*
	Practical	**0**	**0**	*Maximum Marks*	*40 Marks*	*60 Marks*	*100 Marks*
	Total	**52**	**4**	*Minimum Marks*	*20 marks*	*25 marks*	*45 Marks*

Course Prerequisite: Fundamentals concepts of dielectric materials used in capacitors.

Course Objective:

1. To familiarize on the characteristics, testing and measurement of insulation materials and equipments.
2. To gain knowledge on the advanced computer simulation techniques.

Course Outcomes (COs): After completing the course, students will be able to:

COs	**Course Outcomes**	**Highest Cognitive Domain**
CO1	Describe the fundamentals of nanodielectrics in various applications.	L2
CO2	Apply the different methods to study the structural behavior of nanocomposites.	L4
CO3	Analyze the performance of nanocomposites.	L3
CO4	Demonstrate the skill sets using various tools for experimental/simulation of composite films towards research.	L4

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create

Course Content / Syllabus:

UNIT No.	**Content**	**Hours**	
		Lecture	**Tutorial**
1	**Introduction**: Dielectrics and nanodielectrics, structure, preparation, and characterization of nanodielectrics, attractiveness of polymer nanocomposites.	**10**	**0**

2	**Preparation and structure:** Methods of mixing a quasi-spherical nanofillers into a polymer, surface modification of nanoparticles and its effects. Changes in the movement and structure of atoms and molecules represented by the dielectric properties, Structure of polymer/nanofiller interfaces.	**11**	**0**
3	**Compatibility with other engineering performances:** Electrical conductivity contrast between nanofillers and polymer matrix, electronic conduction effect on polymer/metallic nanoparticles, effect on dielectric breakdown strength, need of high-k and low-k materials, thermal and mechanical characteristics.	**11**	**0**
4	**Computer simulation methods:** Quantum mechanics with electronic states, molecular dynamics and Monte Carlo simulation with the collective motion of atoms and molecules, finite element method and statistical thermodynamics calculation with bulk materials, and phase-field method.	**10**	**0**
5	**Epilogue:** Nanodielectrics research challenges, environmental concerns and future prospects.	**10**	**0**

Text Books:

1. Tanaka, T., & Imai, T., "Advanced nanodielectrics: fundamentals and applications," Pan Stanford Publishing, 2017.
2. Murthy, B. S., Shankar, P., Raj, B., Rath, B. B., & Murday, J., "Textbook of Nanoscience and Nanotechnology," Springer Science & Business Media, 2013.

Reference Books:

1. Kulkarni, S. K., "Nanotechnology: Principles and Practices," Springer, 2019.

Journals/Magazines:

1. https://www.springer.com/journal/12274
2. https://onlinelibrary.wiley.com/journal/21983844
3. https://ietresearch.onlinelibrary.wiley.com/journal/25143255

Web/Digital resources:

https://bajkulcollegeonlinestudy.in/StudyMaterialFinal/Chemistry/6th%20sem-DSE3 Nano%20structure%20%20-%20Dr.%20Sunirban%20Das.pdf

SWAYAM/NPTEL:

1. https://nptel.ac.in/courses/118102003

Practice Based Learning:

No	Topics to be covered	Tools and Techniques	Expected Skill /Ability
1	Nano dielectrics in energy storage	Open-source software tools	Program/simulation
2	Nano dielectrics in power sectors	Open-source software tools	Program/simulation
3	Aging behavior of Nano dielectrics	Open-source software tools	Program/simulation

Course Articulation:

COURSE OUTCOMES↓	PROGRAM OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1			3			
CO2	3		3	3		
CO3	3		3	3		
CO4	3	2	3	3	3	2

High – 3, Medium – 2, Low – 1

DEPARTMENT	**Electronics and Communication Engineering**						
Course Code	**22PIE26OE**	*Total Credits*	*4*	*Course Type*	*Open Elective Course*		
Course Title	**DEEP LEARNING FOR SPEECH PROCESSING**						
Teaching Learning Process		*Contact Hours*	*Credits*	*Assessment in Weightage and marks*			
	Lecture	**52**	**4**		**CIE**	**SEE**	**Total**
	Tutorial	**0**	**0**	*Weightage*	*40 %*	*60 %*	*100 %*
	Practical	**0**	**0**	*Maximum Marks*	*40 Marks*	*60 Marks*	*100 Marks*
	Total	**52**	**4**	*Minimum Marks*	*20 marks*	*25 marks*	*45 Marks*

Course Prerequisite: Basic mathematics and signal processing.

Course Objective:

1. To understand the fundamental concepts of speech processing and deep learning
2. To learn about feature extraction and classification techniques using deep learning algorithms.

COURSE OUTCOMES (COs): After completing the course, students will be able to:

COs	Course Outcomes	Highest Cognitive Domain
CO1	Explain the theoretical concepts of speech processing and deep learning.	L2
CO2	Analyze speech feature extraction and recognition techniques.	L4
CO3	Apply deep learning and CNN Architecture algorithms for Speech recognition.	L3
CO4	Analyze neural network and machine learning algorithms for speech applications.	L4

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 – Create

Course Content / Syllabus:

UNIT No.	Content	Hours	
		Lecture	**Tutorial**
1	**Phonetics:** Speech Sounds and Phonetic Transcription, Articulatory Phonetics, Phonological Categories, and Pronunciation variation, Acoustic Phonetics, and Signals, Phonetic Resources, Advanced: Articulatory and Gestural Phonology, Text Normalization, Phonetic Analysis, Prosodic Analysis, Diphone Waveform Synthesis, Unit	**11**	**0**

	Selection Synthesis.		
2	**Automatic Speech Recognition:** Speech Recognition Architecture, The Hidden Markov Model Applied to Speech, Feature Extraction: MFCC Vectors, Acoustic Likelihood Computation, Embedded Training, Evaluation: Word Error Rate.	**10**	**0**
3	**Basics of Deep Learning:** Introduction, Perceptron Algorithm Explained**,** Multilayer Perceptron, Deep Learning, Model Training, Unsupervised Deep Learning, Framework Considerations.	**10**	**0**
4	**Convolutional Neural Networks:** Basic Building Blocks of CNN, Forward and Backpropagation in CNN, Text Inputs and CNNs, Classic CNN Architectures, Modern CNN Architectures, Applications of CNN in NLP, Fast Algorithms for Convolutions.	**11**	**0**
5	**Applications and User Interfaces:** Application Architecture, Typical Applications, Computer Command and Control, Telephony Applications, Dictation, Accessibility, Handheld Devices, Automobile Applications, Speaker Recognition **Speech Interface Design:** General Principles, Handling Errors, Dialog Flow. Internationalization	**10**	**0**

Text Books:

1. Daniel Jurafsky, James H. Martin "Speech and Language Processing," Pearson, Second Edition, 2017.
2. Uday Kamath, John Liu, James Whitaker "Deep Learning for NLP and Speech Recognition," Springer, 2019
3. Xuedong Huang, Alex Acerd, Hsiad-wuen Hon "Spoken Language Processing: A Guide to Theory, Algorithm and System Development," PH PTR, 2001.

Reference Books:

1. Lawrence Rabinerand Biing-Hwang Juang, "Fundamentals of Speech Recognition," Pearson Education, 2003.
2. Tomm. Mitchell "Machine Learning," McGraw Hill Education, 22nd reprint 2018.
3. Nilanjan Dey "Intelligent Speech Signal Processing,"-Academic Press, 2019.
4. Umberto Michelucci "Applied Deep Learning. A Case-based Approach to Understanding Deep Neural Networks," Apress, 2018.

Journals/Magazines:

1. IEEE Transactions on Neural Networks and Learning Systems, IEEE, https://ieeexplore.ieee.org/xpl/aboutJournal.jsp?punumber=5962385.
2. IEEE Transactions on Pattern Analysis and Machine Intelligence, IEEE, https://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=34
3. IEEE / ACM Transactions on Audio, Speech, and Language Processing, IEEE, https://signalprocessingsociety.org/publications-resources/ieeeacm-transactions-audio-speech-and-language-processing/about-taslp.

4. Speech Communication, Science Direct (Elsevier). https://www.sciencedirect.com/journal/speech-communication/about/aims-and-scope.

SWAYAM/NPTEL:

1. http://www.digimat.in/nptel/courses/video/117105145/L37.html
2. https://nptel.ac.in/courses/106106184

Self-Learning Exercises:

1. Mini Projects

Course Articulation:

COURSE OUTCOMES ↓	PROGRAM OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1			3			
CO2			3	3		
CO3			3	3		
CO4	3	3	3	3	3	

High – 3, Medium – 2, Low – 1

DEPARTMENT	**Electronics and Communication Engineering**						
Course Code	**22PNI 26OE**	*Total Credits*	**4**	*Course Type*	*Open Elective Course*		
Course Title	**ADVANCED WIRELESS TECHNOLOGIES**						
Teaching Learning Process		*Contact Hours*	*Credits*	*Assessment in Weightage and marks*			
	Lecture	**52**	**4**		**CIE**	**SEE**	**Total**
	Tutorial	**0**	**0**	*Weightage*	*40 %*	*60 %*	*100 %*
	Practical	**0**	**0**	*Maximum Marks*	*40 Marks*	*60 Marks*	*100 Marks*
	Total	**52**	**4**	*Minimum Marks*	*20 marks*	*25 marks*	*45 Marks*

COURSE PREREQUISITE:

1. Analog and Digital communication systems
2. Antennas and propagation

COURSE OBJECTIVE:

1. To understand the basics and technology of advanced communication system

Course Outcomes (COs): After completing the course, students will be able to:

COs	Course Outcomes	Highest Cognitive Domain
CO1	Explain the Satellite fundamentals and types of satellite.	L2
CO2	Illustrate the working of mobile radio system and its subsystems.	L3
CO3	Identify the applications of cellular Technology and system capacity.	L3
CO4	Outline the working principle of propagation model in Mobile communication	L2
CO5	Demonstrate the working principle of GSM Services and Applications	L2

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create

Course Content / Syllabus:

UNIT No.	Content	Hours	
		Lecture	Tutorials
1	**Introduction to Satellite:** Satellite sub systems, Antennas, Transponders, earth station technology, Link calculation, Satellite systems- GEO systems, non-GEO communication systems, Satellite Applications- Global Positioning System, Very Small Aperture Terminal system, Direct to Home Satellite Systems.	**12**	**0**

2	**Evolution of mobile**: Mobile radio communications, paging systems, Cordless telephone systems, comparison of various wireless systems Introduction to Modern Wireless Communication Systems, Second generation cellular networks, third generation wireless networks, fourth generation wireless technologies Wireless in local loop, wireless local area networks, Bluetooth, and Personal Area networks, Over view of WIMAX Technologies, architecture, spectrum allocation.	**10**	**0**
3	**Capacity expansion techniques**: Cellular concept, hand off strategies, Interference, and system capacity: Cell splitting, Sectoring, Repeaters, and Microcells. Cellular System **Design Fundamentals:** Frequency reuse, channel assignment strategies, handoff Strategies, Interference, and system capacity, tracking and grade off service, improving coverage and capacity.	**10**	**0**
4	**Wireless Propagation**: Propagation mechanism, free space propagation model, ground reflection model, path loss, Introduction to fading and diversity techniques, Introduction to MIMO system Introduction to Multiple Access, FDMA, TDMA, Spread Spectrum multiple Access, space division multiple access, CDMA, OFDM Wireless Networking.	**10**	**0**
5	**GSM system and data services**: GSM architecture, radio link aspects, network aspects Introduction to new data services like High-Speed Circuit Switched Data (HSCSD), General Packet Radio Service (GPRS), Enhanced Data Rate for Global Evolution (EDGE), Ultra-wideband systems (UWB).	**10**	**0**

Text Books:

1. Dennis Roody, "Satellite communication," 4/e, McGraw Hill, 2006.
2. Herve Benoit, "Digital Television Satellite, Cable, Terrestrial, IPTV, Mobile TV in the DVB Framework," 3/e, Focal Press, Elsevier, 2008
3. Simon Haykin, Michael Mohar, "Modern wireless communication," Pearson Education, 2008

References:

4. Tomasi, "Advanced Electronic Communication Systems," 6/e, Pearson, 2015.
5. W.C.Y. Lee, "Mobile Cellular Telecommunication," McGraw Hill, 2010.

Practice Based Learning:

No	Topics to be covered	Tools and Techniques	Expected Skill/Ability
1	Mini project/case study/ field visit	Hard ware implementation Report writing on field visit	Practical experience of RE generation
2	Simulation/ virtual lab	Open-source simulation tools	Simulation

Self-Learning Exercises:

1. Case Study projects
2. Mini Projects

Course Articulation:

COURSE OUTCOMES ↓	PROGRAM OUTCOMES					
	PO1	PO2	PO3	P04	P05	PO6
CO1	3	3				
CO2	3	3				
CO3	3	3				
CO4	3	3	3	3		
CO5	3	3	3	3	3	

High – 3, Medium – 2, Low – 1

DEPARTMENT	**Electronics and Communication Engineering**						
Course Code	**22PIE 270**	***Total Credits***	***2***	***Course Type***	Mandatory Course		
Course Title	***Research Methodology and IPR***						
Teaching Learning Process		***Contact Hours***	***Credits***	***Assessment in Weightage and marks***			
	Lecture	**26**	**2**		**CIE**	**SEE**	**Total**
	Tutorial	**0**	**0**	***Weightage***	***50%***	***-***	***0%***
	Practical	**0**	**0**	***Maximum Marks***	***40 Marks***	***60 Marks***	***100 Marks***
	Total	**26**	**2**	***Minimum Marks***	***20 marks***	***25 marks***	***45 Marks***

COURSE PREREQUISITE:

Research methods to effectively search required information, software for paper formatting like LaTeX/MS Office, Plagiarism software.

COURSE OBJECTIVE:

1. To deliver knowledge on formulation of research problem, research methodology, ethics involved
2. To emphasize students on importance of patent along with IPR protection.

COURSE OUTCOMES (COs): After completing the course, students will be able to:

CO#	Course Outcomes	Highest Level of Cognitive Domain
CO1	Analyze the research problem, research related information and follow research ethics.	L4
CO2	Apply the concept of report writing to an article and correlate the outcome with other published results.	L3
CO3	Describe the importance of IPR, laws, its protection and developments.	L2
CO4	Demonstrate the skill sets in writing technical report and research proposal using LaTeX.	L4

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create

Course Content / Syllabus:

UNIT No.	Content	Hours	
		Lecture	Tutorial
1	**RESEARCH METHODOLOGY**: Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, Plagiarism, Research ethics	6	0
2	**DATA COLLECTION AND ANALYSIS** : Importance and scientific methodology in recording results, statics in research, analysis of data, outcome as new idea, hypothesis, concept, theory, model etc.	5	0
3	**INTERPRETATION AND REPORT WRITING:** Significance of technical writing, research report layout, different steps, how to write a manuscript/ responses to reviewers comments, preparation of research article/ research report, Writing a Research Proposal - presentation and assessment, precautions in writing the report.	5	0
4	**IPR**: Terminology and concept, need for Intellectual Property: Patents, Designs, Trade Mark and Copyright. Process of registration and Development: technological research, innovation, patenting and development. Procedure for grants of patents in India and abroad.	5	0
5	**PATENT RIGHTS AND DEVELOPMENTS IN IPR**: Scope of Patent Rights, licensing and transfer of technology. Patent information and databases, geographical indications. New Developments: Administration of patent system and associated law.	5	0

Text Books:

1. Kothari, C. R. Research Methodology - Methods and Techniques (2004), New Age International publishers, New Delhi.
2. Ranjit Kumar (2011), RESEARCH METHODOLOGY a step-by-step guide for beginners, SAGE publishers.
3. T. Ramappa (2008), "Intellectual Property Rights Under WTO", S. Chand.

Reference Books:

1. Stuart Melville and Wayne Goddard, (1996), "Research methodology: an introduction for science & engineering students', Juta & Company.

2. Rüdiger Wolfrum and Peter-Tobias Stoll, (2009), WTO – Trade-Related Aspects of Intellectual Property Rights, Max Planck Institute for Comparative Public Law and International Law, Boston.

Journals/Magazines:

1. http://iprmagazine.com/
2. https://www.researchgate.net/publication/321964409_Research_Methodology

Web/Digital resources:

SWAYAM/NPTEL:

1. https://nptel.ac.in/courses/109106137

PRACTICE BASED LEARNING:

No	Topics to be covered	Tools and Techniques	Expected Skill/Ability
1	Write research reports/article/ proposals	LaTeX commands/ MS office	Communication, ethics

Course Articulation:

COURSE OUTCOMES↓	PROGRAM OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1		3				2
CO2	2	3				
CO3		2				
CO4		3	3	3	3	

High – 3, Medium – 2, Low – 1

DEPARTMENT	**Electronics and Communication Engineering**						
Course Code	**22PIE280L**	*Total Credits*	*1.5*	*Course Type*	Professional Core Course		
Course Title	**Digital Control Lab**						
Teaching Learning Process		*Contact Hours*	*Credits*	*Assessment in Weightage and marks*			
	Lecture	**0**	**0**		**CIE**	**SEE**	**Total**
	Tutorial	**0**	**0**	*Weightage*	*40 %*	*60 %*	*100 %*
	Practical	**39**	**1.5**	*Maximum Marks*	*40 Marks*	*60 Marks*	*100 Marks*
	Total	**39**	**1.5**	*Minimum Marks*	*20 marks*	*25 marks*	*45* Marks*

COURSE PREREQUISITE: CONTROL SYSTEMS, MATLAB

COURSE OBJECTIVE:

1. To verify Digital Control Systems concepts using MATLAB/SIMULINK
2. To design, simulate digital controllers
3. To implement digital controller as hardware

COURSE OUTCOMES (COs): After completing the course, students will be able to:

CO#	Course Outcomes	Highest Level of Cognitive Domain
CO1	To analyze digital control systems using MATLAB/SIMULINK	L4
CO2	To design and validate digital controller for transfer function and state space model	L6
CO3	To implement digital controller for a real time hardware system	L6
CO4	To document the experiments and present in a group adhering to ethics.	L2

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create

Course Content / Syllabus:

Week	List of Experiments/ Programs	No. of Hours
1	Discretization of transfer function and observing step response by varying damping factor.	3
2	Verification of steady state error for Type-0, 1, 2 systems	3
3	Verification of transfer function and state-space model of a DC motor	3
4	Design and verification of PI controller for DC motor model	3
5	Design and verification of phase-lead compensator for DC motor model	3
6	Design and verification of state-variable feedback controller using pole placement technique	3
7	Design and verify closed-loop observer for a DC motor	3
8	Design and verify an LQR controller for a DC motor.	3

9-12	Mini Project: Implementation of real time control system	3 x 4
13	Laboratory Test	3

Text Books: 1. M. Gopal, Digital Control and State Variable Methods, Mc Graw Hill India, 2012

Reference Books:

1. Charles L. Phillips, H. TroyNagle,AranyaChakraborthy,***Digital Control Systems, Analysis and Design***, 4th Edition, McGraw Hill, 2014.
2. Gene F. Franklin, J. David Powell and Michael Workman, ***Digital Control of Dynamic Systems***, 3rd Edition, Ellis-Kagle Press, 2006.

Journals/Magazines:

IEEE Transaction on Automatic Control

Course Articulation:

COURSE OUTCOME	**PROGRAM OUTCOME**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1		2	3	3	3	-
CO2		2	3	3	3	-
CO3		2	3	3	3	-
CO4	3	3	3	3	3	2

High – 3, Medium – 2, Low – 1

Third semester

DEPARTMENT	**Electronics and Communication Engineering**						
Course Code	**22PIE310**	*Total Credits*	*4*	*Course Type*	PWC / Technical Seminar / Internship in Industry		
Course Title	**Industrial training /Internship / Technical Seminar**						
Teaching Learning Process		*Contact Hours*	*Credits*	*Assessment in Weightage and marks*			
	Lecture	**0**	**0**		**CIE**	**SEE**	**Total**
	Tutorial	**0**	**0**	*Weightage*	*100 %*	*---*	*100 %*
	Practical	**8 weeks***	**4**	*Maximum Marks*	*50 Marks*	*---*	*50 Marks*
	Total	**8 weeks***	**4**	*Minimum Marks*	*25 marks*	*---*	*25 Marks*

*** 42hrs/ weeks = (40 hours / week in Industry + 2 hours / week in College)**

COURSE PREREQUISITE:

Domain Knowledge in the professional courses.

COURSE OBJECTIVE:

- Explore career alternatives prior to graduation by integrating theory and practice.
- To Develop communication, interpersonal and other critical skills in the job interview process.

COURSE OUTCOMES (COs): After completion of the course, the students will be able to:

CO#	Course Outcomes	Highest Level of Cognitive Domain
CO1	Build the knowledge by interacting with industrial personnel, follow engineering practices and discipline prescribed in industry.	L4
CO2	Function individually to implement the given task using modern tools, prepare report and present orally adhering to standard practices.	L4

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create

Course Articulation:

COs↓	PROGRAM OUTCOMES					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1		3	3			
CO2	3	3	3		3	3

High – 3, Medium – 2, Low – 1

DEPARTMENT	**Electronics and Communication Engineering**						
Course Code	**22PIE320P**	*Total Credits*	*6*	*Course Type*	*Project work Course*		
Course Title	**Project Work Phase - 1**						
Teaching Learning Process		*Contact Hours*	*Credits*	*Assessment in Weightage and marks*			
	Lecture	**0**	**0**		**CIE**	**SEE**	**Total**
	Tutorial	**0**	**0**	*Weightage*	*100 %*	*---*	*100 %*
	Practical	**12 Weeks***	**6**	*Maximum Marks*	*50 Marks*	**---**	*50 Marks*
	Total	**12 Weeks***	**6**	*Minimum Marks*	*25 marks*	*---*	*25 Marks*

***12 Weeks : 40 Hours / week.**

COURSE PREREQUISITE: Domain Specific Knowledge.

COURSE OBJECTIVE:

1. To generate Domain specific / interdisciplinary idea and methodology leading to product.
2. To perform feasibility analysis, budgetary analysis and schedule the execution of problem.

COURSE OUTCOMES (COs)

CO#	Course Outcomes	Highest Level of Cognitive Domain
CO1	Identify and formulate a problem through an adequate literature survey, taking into consideration societal, environmental and sustainability issues.	L3
CO2	Design, plan, schedule the execution, anticipate the bottleneck, examine the feasibility, prepare the budget and submit the synopsis.	L3

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create

Communicate and report the project synopsis effectively

Course Articulation:

COURSE OUTCOMES	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	3	
CO2	3	3	3	3	3	3

High – 3, Medium – 2, Low – 1

DEPARTMENT	**Electronics and Communication Engineering**						
Course Code	**22PIE410P**	*Total Credits*	*16*	*Course Type*	*Project work Course*		
Course Title	**Project work Phase - 2**						
Teaching Learning Process		*Contact Hours*	*Credits*	*Assessment in Weightage and marks*			
	Lecture	**0**	**0**		**CIE**	**SEE**	**Total**
	Tutorial	**0**	**0**	*Weightage*	*40 %*	*60%*	*100 %*
	Practical	**22 weeks***	**16**	*Maximum Marks*	*40 Marks*	**60 Marks**	*100 Marks*
	Total	**22 weeks***	**16**	*Minimum Marks*	*20 marks*	*25 Marks*	*45 Marks*

***22 Weeks: 40 Hours / week**

COURSE PREREQUISITE: Domain Specific Knowledge

COURSE OBJECTIVE:

1. To function effectively as an individual for the implementation of an idea and to demonstrate the working prototype / product.
2. To prepare a comprehensive report, article and give an effective presentation.

COURSE OUTCOMES (COs)

CO#	Course Outcomes	Highest Level of Cognitive Domain
CO1	Develop the project idea within the stipulated time, interpret the results and apply necessary corrections.	L6
CO2	Test the working of project, validate the results, prepare technical report and publish an article.	L6

L1 – Remember, L2 – Understand, L3 – Apply, L4 – Analyze, L5 – Evaluate, L6 - Create

Course Articulation:

COURSE OUTCOMES	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	3	
CO2	3	3	3	3	3	3

High – 3, Medium – 2, Low – 1