PG Department of ELECTRONICS and INSTRUMENTATION TECHNOLOGY

Regulations

Five-Year Integrated Master's Programme (FYIMP) in Electronics under NEP 2020

These regulations have to be interpreted with Statutes governing Five-Year Integrated Master's Programme under NEP 2020

1. Offering Department

The programme shall be offered in the **Department of Electronics and Instrumentation Technology**, University of Kashmir, at its main campus under the School of Applied Sciences and Technology.

2. Introduction

The **Five-Year Integrated Master's Programme in Electronics**, aligned with the NEP 2020 scheme, offers a comprehensive five-year curriculum designed to equip students with the knowledge and skills to excel in the ever-evolving field of Electronics. This innovative program comprises a unique Multiple Entry Multiple Exit (MEME) structure. Students can enter in semesters 1, 7, or 9 and exit with qualifications like a certificate, diploma, Bachelor's degree (honors or regular with or without research), PG Diploma, One-Year Master's degree, Two-Year's Master's Degree or Five-Year Integrated Master's degree, depending on the entry and exit points. There is also an option to re-enter the program within three (03) years after exit.

This program offers a rich tapestry of coursework, fostering a well-rounded understanding of the field. Students gain a strong foundation in core electronics through dedicated courses. The programme allows specializations in emerging areas of Electronics such as VLSI, Signal Processing, Communications, Embedded Systems, Computing, Image Processing, Nanoelectronics, Wireless Communications, Wearable Electronics, Internet of Things, Multimedia Signal Coding, Neuromorphic Computing, etc. The programme also includes contemporary courses in ever-evolving fields of computation and Artificial Intelligence. Skill-oriented courses equip them with practical abilities valued by the industry. Multidisciplinary courses encourage a holistic approach by integrating knowledge from various disciplines. Additionally, ability enhancement courses hone communication, critical thinking, and problem-solving skills – essential assets for success.

The curriculum incorporates the latest trends and in-demand skills the electronics industry seeks. This ensures graduates are well-prepared for a successful career path. Furthermore, the program equips students with the necessary skills and knowledge to pursue further research endeavors after graduation.

The program emphasizes practical learning through internships, projects, and problem-based learning methodologies. The curriculum stays at the forefront of the field, ensuring graduates possess in-depth knowledge of contemporary developments in electronics.

This comprehensive and industry-oriented education empowers graduates to become future leaders in the dynamic field of electronics. Graduates can pursue rewarding careers in various sectors, including industry, academia, and business entrepreneurship. Graduates in Electronic Sciences can go on to serve in industries or may opt to establish their Start-Ups. They can also be recruited directly in MNCs after their completion.

The Five-Year Integrated Master's Programme in Electronics positions graduates for success, opening doors to a future brimming with exciting possibilities.

3. Programme Outcomes

PO1. ***Engineering Knowledge:*** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to solve complex engineering problems.

PO2. ***Problem Analysis:*** Identify, formulate, review research literature, and analyze complex engineering problems, reaching substantiated conclusions using the first principles of mathematics, natural sciences, and engineering sciences.

PO3. ***Design/Development of Solutions***: Design solutions for engineering problems & design system components or processes that meet the specified needs with appropriate consideration for public health, safety, and cultural, societal, and environmental considerations.

PO4. ***Conduct Investigation of Complex Problems***: Use research-based knowledge and research methods, including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. ***Modern Tool Usage***: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modeling, to complex engineering activities with an understanding of the limitations.

PO6. ***The Engineer and Society***: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. ***Environment and Sustainability***: Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development.

PO8. ***Ethics***: Apply ethical principles and commit to professional ethics, responsibilities, and norms of engineering practice.

PO9. ***Individual and Teamwork***: Function effectively as an individual, member, or leader in diverse teams and multidisciplinary settings.

PO10. ***Communication***: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11. ***Project Management and Finance***: Demonstrate knowledge and understanding of engineering and management principles and apply these to one's work as a member and leader in a team, as well as to manage projects and multidisciplinary environments.

PO12. ***Life-long Learning:*** Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

4. Programme Specific Outcomes

PSO1. An ability to use the techniques, skills, and modern electronic gadgets necessary for instrumental development practice.

PSO2. Successfully engage in careers in a broad range of areas to serve the needs of both private and public sectors.

PSO3. An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability

PSO4. An ability to use the techniques, skills, and modern electronic tools necessary for daily applications.

PSO5. Detailed understanding of engineering programming in common languages, such as MATLAB, LabVIEW, embedded C, and C++.

PSO6. Fundamental and advanced theory and application of digital signal processing concepts, methods, and algorithms with fuzzy logic and neural network.

PSO7. Theory and practice of digital electronics logic systems design, operation, and system identification.

PSO8. Theory and practice of electronics network analysis power systems in dynamical behavior.

PSO9. Detailed understanding of Advanced Microprocessors, Microcontrollers, Embedded Systems, and the Internet of Things with laboratory practices.

PSO10. Theory and practice of Communication Electronics and Wireless Communications.

PSO11. Specializations in emerging areas of Electronics such as Neuromorphic Computing, Embedded Systems and Security, Digital Image processing, Computational Intelligence & Wireless Communications, Multimedia Signal Coding, Wearable Electronics, nanoelectronics, etc.

PSO12. Give an oral scientific presentation, report on a research project, and produce research reports.

5. Entry, Exit, and Re-entry

i. The five-year Master's Degree Programme shall have multiple entries and exits.

ii. Admission shall be made in the 1st semester (1st year), 7th semester (4th Year), and 9th semester (5th year) with appropriate qualifications as depicted in a later clause of these regulations.

iii. After the first year (completing two semesters, i.e., a minimum of 48 credits), a candidate can receive a **Certificate in ELECTRONICS**.

iv. After the second year (successful completion of four semesters, i.e., a minimum of 88 credits), a candidate is eligible to receive a **Diploma in ELECTRONICS**.

v. After the third year (successful completion of six semesters, i.e., a minimum of 128 credits), a candidate is eligible to receive **Bachelor's Degree in ELECTRONICS**.

vi. After four years (completing eight semesters, i.e., a minimum of 168 credits), a candidate can receive **Bachelors' (Honors) Degree in ELECTRONICS with/without Research**.

vii. A candidate entering the programme in the 4th year and exiting after completion of the 4th year shall be eligible to receive **PG Diploma in ELECTRONICS**.

viii. After completion of 5 years (successful completion of ten semesters), a candidate is eligible to receive a **Five-Year Integrated Master's Degree** in **ELECTRONICS** or a **Master's Degree** in **ELECTRONICS**, depending upon the admission into the programme. A candidate who joins the programme in the 7th semester shall be awarded Two Year **Master's Degree in ELECTRONICS**, and those who in 9th semester shall be awarded One Year **Master's Degree in ELECTRONICS**.

ix. A candidate availing exit option shall have the option to reenter the programme within three years of exit at the beginning of any academic year to complete the degree with the prevailing syllabi, subject to the condition that the candidate completes the degree within a maximum period of 9 years from the date admitted in the first semester.

x. The entry and exit points, with credits earned during the programme are depicted in the following table:

Entry Year	Exit After	MINIMUM Credits Studied							Certificate/Diploma/Degree Awarded
		Major	Minor	MDCs	AECs	VACs	SECs	Total	
1st	1st	12	8	6	6	8	8	48	**Certificate** in Electronics*
	2nd	34	16	9	9	8	12	88	**Diploma** in Electronics
	3rd	66	24	9	9	8	12	128	**Bachelor's Degree** in Electronics

Entry Year	Exit After	MINIMUM Credits Studied							Certificate/Diploma/Degree Awarded
		Major	Minor	MDCs	AECs	VACs	SECs	Total	
	4th	98	32	9	9	8	12	168	**Bachelor's Degree** (Honours) with/without Research in Electronics
	5th	142	32	9	9	8	12	212	**Five-Year Integrated Master's Degree** in Electronics
4th	4th	32	8	-	-	-	-	40	**PG Diploma** in Electronics
	5th	76	8	-	-	-	-	84	**Two Years Master's Degree** in Electronics
5th	5th	44	0	-	-	-	-	44	**One Year Master's Degree** in Electronics

*In addition, 4 credits in work based vocational courses offered during summer/winter term internship/apprentices have to be earned.
Please note that the Major, Minor, MDCs, AECs, VACs, and SECs indicate Courses in the discipline of Electronics, minor discipline, Multi-disciplinary, Ability Enhancement, Value Added and Skill Enhancement respectively.

6. Eligibility for Admission

Subject to the University of Kashmir Policy from time to time, eligibility to enter the programme at different levels shall be as follows:

1st Year (Semester I): Candidates who have Passed the 10+2 examination (Science Subjects) with a minimum of 45% marks in case of general category and 40% marks in case of reserved category candidates from the Jammu and Kashmir Board of School Education or from any other recognized board/institution whose examinations have been recognized as equivalent to that by the Jammu and Kashmir Board of School Education.

4th Year (Semester VII): Three-year Bachelors' Degree in Electronics from any recognized University under NEP 2020 with a minimum of 45% marks in case of general category and 40% marks in case of reserved category candidates.

5th Year (Semester IX): Four-Year Honors' Degree in Electronics under NEP 2020 or B.E./B.Tech. in Electronics or equivalent with a minimum of 45% marks in case of general category and 40% marks in case of reserved category candidates.

7. Mode of Selection

Admission shall be made through Entrance Test and admission shall be granted on the basis of the merit obtained in the entrance test, conducted by the University. Further, if the number of available seats is more than the total number of applicants, then Entrance Test shall not be conducted.

8. Intake

First Year (1st Semester): 20 students excluding self-finance, foreign nationals, supernumerary, and other similar categories.

Fourth Year (7th Semester): 10 students excluding self-finance, foreign nationals, supernumerary, and other similar categories and exits after 3rd year.

Fifth Year (9th Semester): 5 students excluding self-finance, foreign nationals, supernumerary, and other similar categories and exits after 4th year.

The intake for self-finance, foreign nationals, supernumerary, and other similar categories shall follow the University policy.

9. Fee Structure

The fee shall be as follows:

(i) **General Category:** Rs. 11,375/= per year.

(ii) **Self-Finance Category:** A self-finance fee of Rs. 11,375/= per year in addition to fee mentioned for general category.

(iii) **Foreign Nationals Category:** Rs.30,000/= per semester.

(iv) In addition, an Industrial Training Fee of Rs. 10,000/= shall be charged in the 5th year (9th semester). This Fee component shall be payable by students admitted under all categories.

(v) Examination Fees, Hostel Fees, etc., shall be charged extra as per the University policy in Vogue.

(vi) Any change in fee shall be notified from time to time by the University.

10. Programme Structure

The programme structure of the Five-Year Integrated Master's Degree Programme in Electronics shall be as follows:

Course Type		Semester & Credits (L+T+P)									
		1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
Major Subject ELECTRONICS	**Major 1**	**4+2**	**4+2**	**4+2**	**3+1**	**3+1**	**3+1**	**3+1**	**3+1**	**22**	**22**
	Major 2	x	x	x	**4+2**	**4+2**[1]	**4+2**	**4+2**	**4+2**[2]		
	Major 3	x	x	x	**4+2**	**4+2**	**4+2**	**4+2**	**4+2**[2]		
Minor Subject*	**Minor**	**4 to 6**	**4 to 6**	**4 to 6**	**4**	**4**	**4**	**4**	**4**	x	x
Internship/ Research		[1]**Additional** 2 credits of Summer/Winter Internship [2]12 credits of Research Project for Research otherwise Honours									
Multi-Disciplinary Courses**		**3**	**3**	**3**	x	x	x	x	x	x	x
Ability Enhancement Courses (AECs)**		**3**	**3**	**3**	x	x	x	x	x	x	x
Value-Added Courses (VACs)**		**2x2 = 4**	**2x2 = 4**	-	x	x	x	x	x	x	x
Skill Enhancement Course Vertical (SEC)**		**2+2 = 4**	**2+2 = 4**	**2+2 = 4**	x	x	x	x	x	x	x
Total Credits (Semester)		**24** to **26**	**24** to **26**	**20** to **22**	**20**	**20**	**20**	**20**	**20**	**22**	**22**
Total Credits **(Certificate)**		**48** to **52 Credits**		➔ Exit with **a Certificate** in **Electronics*****							
Total Credits **(Diploma)**		**88** to **94 Credits**				➔ Exit with **Diploma** in **Electronics******					
Total Credits **(Bachelor's Degree)**		**128** to **134 Credits**						➔ Exit with **a Bachelor's Degree** in **Electronics**			
Total Credits **(Bachelor's Degree Honours with/without research)**		**168** to **174 Credits**								Exit with **Bachelor's Degree** with **H/R** in **Electronics**	
Total Credits **(Five-Year Master's Degree)**		**212** to **218 Credits (Five-Year Integrated Master's Degree in Electronics)**									

*Minor subject should be from allied subjects, e.g., Artificial Intelligence, Information Technology, Computer Sciences, Physics, Mathematics, Statistics, etc.
**The course list will, as per the available basket for each course type, updatable with the introduction/availability of new courses in the respective baskets.
*** Students exiting the programme after securing 40 credits will be awarded UG certificate in Electronics provided they secure 4 credits in work based vocational courses offered during summer/winter term internship/apprentices in addition to 6 credits from skill-based courses earned during first and second semester.
**** Students exiting the programme after securing 80 credits will be awarded UG Diploma in Electronics provided they secure additional 4 credits in skill based vocational courses offered during first year or second year summer/winter term.

11. Courses Layout and Titles

11.1. Foundation Courses: 1st and 2nd Semesters

These zero-credit foundation courses are used in the first year to strengthen students' fundamentals and enable them to cope with the degree programmes better. Foundation courses will not carry any credit; however, they are mandatory courses with a pass/fail grade. These courses shall be offered to the students enrolled at the Department for Five-Year Integrated Master's Degree Programme in Electronics.

Semester	Course Type & Credits	Course Code	Course Title	Hours		Credits	Marks		
				Theory (L)	Lab (P)		Internal	End Term	Total
1	Preparatory	IELEMJMA0124	Mathematics	4	0	0	20	80	100
2	Preparatory	IELEMJPY0124	Physics	3	2	0	20	80	100

11.2. Major Courses: 1st to 10th Semesters

Discipline Centric Courses (Major) are courses from the major discipline i.e. Electronics. The Department shall offer these courses to the students enrolled at the Department in the Five-Year Integrated Master's Degree Programme in Electronics.

Semester	Course Type & Credits	Course Code	Course Title	Hours		Credits	Marks		
				Theory (L)	Lab (P)		Internal	End Term	Total
1	Major *(4+2 Credits)*	IELEMJNA0124	Network Analysis & Analog Electronics	4	4	6	30	120	150
2	Major *(4+2 Credits)*	IELEMJDE0224	Digital Integrated Electronics	4	4	6	30	120	150
3	Major *(4+2 Credits)*	IELEMJOA0324	Operational Amplifier & Applications	4	4	6	30	120	150
4	Major *(3+1 Credits)*	IELEMJSS0424	Signals and Systems	3	2	4	20	80	100
	Major *(4+2 Credits)*	IELEMJMP0424	Applied Mathematics and Programming	4	4	6	30	120	150
	Major *(4+2 Credits)*	IELEMJEM0424	Electromagnetic Waves and Antennas	4	4	6	30	120	150
5	Major *(3+1 Credits)*	IELEMJMM0524	Microprocessors & Microcontrollers	3	2	4	20	80	100
	Major *(4+2 Credits)*	IELEMJDD0524	Digital System Design and VHDL	4	4	6	30	120	150
	Major *(4+2 Credits)*	IELEMJME0524	Microwave Engineering	4	4	6	30	120	150

Semester	Course Type & Credits	Course Code	Course Title	Hours Theory (L)	Hours Lab (P)	Credits	Marks Internal	Marks End Term	Marks Total
6	Major *(3+1 Credits)*	IELEMJCE0624	Communication Electronics - I	3	2	4	20	80	100
	Major *(4+2 Credits)*	IELEMJAM0624	Advanced Microprocessors and Microcontrollers	4	4	6	30	120	150
	Major *(4+2 Credits)*	IELEMJSP0624	Digital Signal Processing	4	4	6	30	120	150
7	Major *(3+1 Credits)*	IELEMJEI0724	Electronic Instrumentation	3	2	4	20	80	100
	Major *(4+2 Credits)*	IELEMJES0724	Embedded Systems and Internet of Things	4	4	6	30	120	150
	Major *(4+2 Credits)*	IELEMJCE0724	Communication Electronics - II	4	4	6	30	120	150
8	Major *(3+1 Credits)*	IELEMJPE0824	Power Electronics & Photonics	3	2	4	20	80	100
	Honors								
	Major *(4+2 Credits)*	IELEMJCS0824	Control Systems	4	4	6	30	120	150
	Major *(4+2 Credits)*	IELEMJMS0824	Material Sciences and VLSI Technology	4	4	6	30	120	150
	Research								
	Major *(0+12 Credits)*	IELEMJRP0824	Research Project	0	24	12	60	240	300
9	Major *(3+1 Credits)*	IELEMJSD0924	Physics of Semiconductor Devices	3	2	4	20	80	100
	Major *(3+1 Credits)*	IELEMJMP0924	Mini Project	0	8	4	20	80	100
	Major *(3+1 Credits)*	IELEMJMC0924	Mobile Communication and Networks	3	2	4	20	80	100
	Major *(2+2 Credits)*	IELEMJIT0924	Industrial Training and Seminar Work	2	4	4	20	80	100
	Specialization S1 (Elective E1)								
	Major *(4+2 Credits)*	IELEMJNC0924	Neuromorphic Computing	4	4	6	30	120	150
		IELEMJES0924	Embedded System Design with ARM Cortex Microcontrollers	4	4	6	30	120	150
		IELEMJIP0924	Digital Image Processing	4	4	6	30	120	150
		IELEMJCI0924	Computational Intelligence and Wireless Communications	4	4	6	30	120	150
10	Major *(3+1 Credits)*	IELEMJIC1024	Digital and Analog IC Design	3	2	4	20	80	100
	Specialization S2 (Elective E2)								
	Major *(4+2 Credits)*	IELEMJNA1024	Nanoelectronics	4	4	6	30	120	150
		IELEMJCS1024	Cyber Security, Cryptography, and the Internet of Things	4	4	6	30	120	150
		IELEMJSC1024	Multimedia Signal Coding and Communication	4	4	6	30	120	150
		IELEMJWE1024	Wearable Electronics and Antennas	4	4	6	30	120	150
	Major *(0+12Credits)*	IELEMJRP1024	Research Project/Internship	0	24	12	60	240	300

11.3. Minor Courses: 1st to 8th Semesters

Related Discipline Centric Courses (Minor) courses are chosen from any other discipline/subject, intending to seek exposure beyond Electronics subject courses. Ordinarily, all minor courses shall be offered by the related department. In the absence of a university department offering Minor Courses, the Department shall float minor courses/make appropriate arrangements to make these courses available to the students from either Artificial Intelligence or other subjects depending upon relevance and resource availability. Also, the students can take permissible number of minor credits from other universities or institutions or online as permitted under NEP2020.

Semester	Course Type & Credits	Course Code	Course Title	Hours		Credits	Marks		
				Theory (L)	Lab (P)		Internal	End Term	Total
Minor: Artificial Intelligence									
1	Minor *(4+2 Credits)*	IELEMICI0124	Essential Mathematics for AI	4	4	6	30	120	150
2	Minor *(4+2 Credits)*	IELEMIAI0224	Programming for AI	4	4	6	30	120	150
3	Minor *(4+2 Credits)*	IELEMIPY0324	Introduction to AI and Machine Learning	4	4	6	30	120	150
4	Minor *(3+1 Credits)*	IELEMIDS0424	Introduction to Data Analytics	3	2	4	20	80	100
5	Minor *(3+1 Credits)*	IELEMIML0524	Neural Networks and Deep Learning	3	2	4	20	80	100
6	Minor *(3+1 Credits)*	IELEMIAI0624	Robotics and AI	3	2	4	20	80	100
7	Minor *(3+1 Credits)*	IELEMINN0724	Hardware Architectures for AI	3	2	4	20	80	100
8	Minor *(3+1 Credits)*	IELEMIAA0824	AI Ethics and Society	3	2	4	20	80	100

Note: These courses shall be modified/revised with the revision/availability.

11.4. Multi-Disciplinary Courses: 1st to 3rd Semesters

Multi-disciplinary Courses are courses from disciplines other than Electronics or the related discipline (Minor) to acquire knowledge in various other fields. Those courses can be chosen if a student has neither studied at the +2 level nor has taken any of these subjects as a major or minor in the programme. Ordinarily, all Multi-disciplinary Courses shall be offered by the other Departments/Institutions of the University. In the absence of a university department offering Multi-disciplinary Courses, the Department shall float/make appropriate arrangements to make the following multi-disciplinary courses available to the students. Also, the students can opt for permissible credits from other universities or institutions or online as permitted under NEP2020. *The syllabus for these courses shall be the same as the one notified for the respective course under FYIMP by the University. The course list shall* *be updated with the introduction/availability of new courses in the multi-disciplinary basket.*

11.5. Ability Enhancement Courses (AECs): 1st to 3rd Semesters

Ability Enhancement Courses help students enhance their communication, language, and personality skills. They also promote a deeper understanding of subjects like social sciences and ethics, culture and human behaviour, and human rights and law. Ordinarily, university departments offer Ability Enhancement Courses. In the absence of a university department offering Ability Enhancement Courses, the Department shall float these courses/make appropriate arrangements to make these courses available to the students. Also, the students can opt for permissible minor credits from other universities or institutions or online as permitted under NEP2020. Every student must study one of the three courses in each of the 1st three Semesters so that every student studies all three courses. *The syllabus for these courses shall be the same as the one notified for the respective course under FYIMP by the University. The course list shall be updated with the introduction/availability of new courses in the multi-disciplinary basket.*

11.6. Value Added Courses (VACs): 1st to 3rd Semesters

Value-added courses are designed to enhance the standard of the learners beyond those levels specified in major or related disciplines. These courses are intended to enhance employability opportunities for the learners. Ordinarily, these courses shall be offered by other university departments. The department will offer these courses if no other University department offers these courses. Every student shall have to study two of the four courses in each of the first two semesters so that every student can study all four courses in the first two semesters. The syllabus for these courses shall be the same as notified for the respective course under FYIMP by the University. The course list shall be updated with the introduction/availability of new courses in the Value-Added Course basket.

11.7. Skill Enhancement Courses (SECs): 1st to 3rd Semesters

Skill Enhancement Courses provide the opportunity and knowledge to develop and strengthen the necessary skills to gain, maintain, and advance in a chosen area. The conditions to opt for these courses in the first three semesters shall be that no course will be repeated and the student should have neither studied any of the opted courses (subjects) under this category at the +2 level nor has s/he taken any of these subjects as a major or minor at the undergraduate level. **These courses are preferably aligned to major or minor subjects and one vertical per-semester.** Students can choose these courses from either parent or related departments. The department will offer the following skill development courses aligned to Electronics discipline to the enrolled students and students of allied departments.

Semester	Course Type & Credits	Course Code	Course Title	Hours Theory (L)	Hours Lab (P)	Credits	Marks Internal	Marks End Term	Marks Total
1	SECs *(2+2 Credits* **Vertical - 1**	CEL122S	CONSUMER ELECTRONICS (HOME APPLIANCES) (2024)	2	4	4	20	80	100
2		CEL222S	CONSUMER ELECTRONICS (OFFICE APPLIANCE) (2024)	2	4	4	20	80	100
3		CEL322S	CONSUMER ELECTRONICS (COMMUNICATION APPLIANCES) (2024)	2	4	4	20	80	100
1	SECs *(2+2 Credits)* **Vertical - 2**	SRS122S	SURVEILLANCE SYSTEMS (DTH, SET-TOP BOX INSTALLATION AND SERVICE TECHNIQUES	2	4	4	20	80	100
2		SRS222S	SURVEILLANCE SYSTEMS (ELECTRONIC SECURITY)	2	4	4	20	80	100
3		SRS222S	SURVEILLANCE SYSTEMS (INSTALLATION REPAIR & MAINTENANCE OF IPABX AND CCTV SYSTEM)	2	4	4	20	80	100
1	SECs *(2+2 Credits)* **Vertical - 3**	RME122S	REPAIR AND MAINTENANCE OF ELECTRONIC APPLIANCES (ELECTRICAL CIRCUITS AND NETWORKING SKILLS)	2	4	4	20	80	100
2		RME222S	REPAIR AND MAINTENANCE OF ELECTRONIC APPLIANCES (REPAIR AND MAINTENANCE OF POWER SUPPLIES, INVERTERS AND UPS)	2	4	4	20	80	100
3		RME322S	REPAIR AND MAINTENANCE OF ELECTRONIC APPLIANCES (REPAIR AND MAINTENANCE OF MOBILE PHONES)	2	4	4	20	80	100

The syllabus for these courses shall be the same as notified for the respective course under FYIMP by the University. The list is based on current availability. The course list shall be updated with the introduction/availability of new courses in the Skill Enhancement Course basket.

11.8. Minor Courses for ALLIED DEPARTMENTS: 1st to 8th Semesters

The department will offer the minor courses in the field of Electronics to the Five-Year Master's Degree students of other allied departments of the University.

11.9. Multi-Disciplinary Courses for OTHER DEPARTMENTS: 1st to 3rd Semesters

The department will offer the following multi-disciplinary courses to students from other university departments. The conditions to opt for these courses in the first three semesters shall be that no course will be repeated and the student should have neither studied any of the opted courses (subjects) under this category at the +2 level nor has s/he taken any of these subjects as a major or minor at the undergraduate level. The syllabus for these courses shall be the same as notified for the respective course under FYIMP by the University. The course list shall be updated with the introduction/availability of new courses in the multi-disciplinary basket.

If required, the Department may appoint guest faculty/visiting faculty/contractual faculty to offer a course in minor discipline, multi-disciplinary courses, Ability Enhancement Courses, or other non-electronics courses.

Further, the students can take permissible credits from other universities or institutions or online as permitted under NEP2020.

12. Format of Question Paper

12.1. Courses with Four (4) Theory Credits, *e.g., 4+2 credit courses*

The question paper shall have to be answered in 3 Hours and shall contain questions across three sections as described below:
Section A: Eight very short answer type questions (two from each unit of the syllabus) will be answered in about 20 words each and carry TWO (2) marks each. i.e. 8×2marks=16 marks. This section shall have no choice.
Section B: Four short answer type questions (one from each unit of the syllabus) are to be answered in about 250 words each and carry EIGHT (8) marks each. i.e. 4×8marks=32 marks. This section shall have no choice.
Section C: Four long answer type questions (one from each unit of the syllabus), out of which two have to be answered in about 500 words each, carrying Twelve (16) marks each. i.e., 2×16=32 marks.
The question paper shall carry a total marks of 80.

12.2. Courses with three (3) Theory Credits (*e.g., 3+1 credit courses)*

The question paper shall have to be answered in 2 Hours and shall contain questions across three sections as described below:
Section A: Six very short answer-type questions (two from each unit of the syllabus) will be answered in about 20 words each and carry TWO (2) marks each. i.e. 6×2marks=12 marks. This section shall have no choice.
Section B: Three short answer type questions (one from each unit of the syllabus) are to be answered in about 250 words each and carry EIGHT (8) marks each. i.e. 3×8marks=24marks. This section shall have no choice.
Section C: Four long answer type questions (at least one from each unit of the syllabus), out of which two have to be answered in about 500 words each and carrying Twelve (12) marks each. i.e. 2×12marks=24 marks.
The question paper shall carry a total marks of 60.

12.3. Courses with two (2) Theory Credits, *e.g., 2+0 credit courses*

The question paper shall have to be answered in 1.5 Hours and shall contain questions across three sections as described below:
Section A: Four very short answer-type questions (two from each unit of the syllabus) will be answered in about 20 words each and carry TWO (2) marks each. i.e., 4×2marks = eight marks. This section shall have no choice.

Section B: Two short answer type questions (one from each unit of the syllabus) are to be answered in about 250 words each and carry EIGHT (8) marks each. i.e. 2×8marks = 16 marks. This section shall have no choice.
Section C: Two long answer type questions (one from each unit of the syllabus), out of which one has to be answered in about 500 words each and carrying Sixteen (16) marks each. i.e., 1×16=16 marks.
The question paper shall carry a total mark of 40.

12.4. Courses with Laboratory Credits

Each laboratory credit shall be examined for 30 minutes of experimental work and an additional 15 minutes of viva voce examination about the course, assigned experiment, or both. Each laboratory credit has an end-term weightage of 20 Marks.

12.5. Project/Research Project and Internship

A thesis committee comprising the head of the Department, external expert, supervisor (assigned to each project student), and at least two more faculty members will serve as thesis and oral examiners for each student pursuing the thesis. A soft copy of the thesis in PDF format (in a specific style) should be sent to the thesis committee before its final submission. The Thesis committee shall examine it for suitability of publication (including any possible plagiarism) before the thesis goes into print and for binding. Any publication must be the sole work of the student and shall be adequately awarded, but it shall not be a compulsory requirement for the thesis submission. Further, the student should produce a presentation certificate for conference publication to the thesis committee.

The head of the Department and counselor (assigned to each internship student) will collect mid-term feedback to ensure smooth progress toward the completion of an internship. A certificate (satisfactory/unsatisfactory) and marks from the concerned person of the organization shall be collected by the head of the Department. An Internship committee comprising the Head of the Department, an External Expert, a counselor, and two department faculty members shall collect the report from the student, evaluate it, and conduct a viva voce examination. The certificate from the organization where the internship was carried out will be considered. If the certificate is unsatisfactory, the Internship committee will review the matter. If they agree with the given certificate, the student must continue the internship at the same or different place.

13. Removal of Difficulties

If any difficulty arises in giving effect to the provisions of these regulations after commencement or otherwise, the University may submit proposed provisions/ regulations as appear to it necessary or expedient for removing difficulties to the competent authority and/or Bodies for approval in anticipation or ratification depending upon the exigency of the situation as the case may be.

PG Department of ELECTRONICS *and* INSTRUMENTATION TECHNOLOGY

Five-Year Integrated Master's Programme (FYIMP) in Electronics under NEP 2020

Detailed Syllabus (Foundation and Major Courses)

Foundation Courses: 1st and 2nd Semesters

These zero-credit foundation courses are used in the first year to strengthen students' fundamentals and enable them to cope with the degree programmes better. Foundation courses will not carry any credit; however, they are mandatory courses with a pass/fail grade. These courses shall be offered to the students enrolled at the Department for Five-Year Integrated Master's Degree Programme in Electronics.

Semester	Course Type & Credits	Course Code	Course Title	Hours		Credits	Marks		
				Theory (L)	Lab (P)		Internal	End Term	Total
1	Preparatory	IELEMJMA0124	Mathematics	4	0	0	20	80	100
2	Preparatory	IELEMJPY0124	Physics	3	2	0	20	80	100

Major Courses: 1st to 10th Semesters

Discipline Centric Courses (Major) are courses from the major discipline and are divided into three types: foundation/core courses of the major discipline; intermediate courses of the major discipline; and advanced courses of the major discipline. The Department shall offer these courses to the students enrolled at the Department in the Five-Year Master's Degree Programme in Electronics.

Semester	Course Type & Credits	Course Code	Course Title	Hours		Credits	Marks		
				Theory (L)	Lab (P)		Internal	End Term	Total
1	Major *(4+2 Credits)*	IELEMJNA0124	Network Analysis & Analog Electronics	4	4	6	30	120	150

Semester	Course Type & Credits	Course Code	Course Title	Hours: Theory (L)	Hours: Lab (P)	Credits	Marks: Internal	Marks: End Term	Marks: Total
2	Major *(4+2 Credits)*	IELEMJDE0224	Digital Integrated Electronics	4	4	6	30	120	150
3	Major *(4+2 Credits)*	IELEMJOA0324	Operational Amplifier & Applications	4	4	6	30	120	150
4	Major *(3+1 Credits)*	IELEMJSS0424	Signals and Systems	3	2	4	20	80	100
	Major *(4+2 Credits)*	IELEMJMP0424	Applied Mathematics and Programming	4	4	6	30	120	150
	Major *(4+2 Credits)*	IELEMJEM0424	Electromagnetic Waves and Antennas	4	4	6	30	120	150
5	Major *(3+1 Credits)*	IELEMJMM0524	Microprocessors & Microcontrollers	3	2	4	20	80	100
	Major *(4+2 Credits)*	IELEMJDD0524	Digital System Design and VHDL	4	4	6	30	120	150
	Major *(4+2 Credits)*	IELEMJME0524	Microwave Engineering	4	4	6	30	120	150
6	Major *(3+1 Credits)*	IELEMJCE0624	Communication Electronics – I	3	2	4	20	80	100
	Major *(4+2 Credits)*	IELEMJAM0624	Advanced Microprocessors and Microcontrollers	4	4	6	30	120	150
	Major *(4+2 Credits)*	IELEMJSP0624	Digital Signal Processing	4	4	6	30	120	150
7	Major *(3+1 Credits)*	IELEMJEI0724	Electronic Instrumentation	3	2	4	20	80	100
	Major *(4+2 Credits)*	IELEMJES0724	Embedded Systems and Internet of Things	4	4	6	30	120	150
	Major *(4+2 Credits)*	IELEMJCE0724	Communication Electronics – II	4	4	6	30	120	150
8	Major *(3+1 Credits)*	IELEMJPE0824	Power Electronics & Photonics	3	2	4	20	80	100
	Honors								
	Major *(4+2 Credits)*	IELEMJCS0824	Control Systems	4	4	6	30	120	150
	Major *(4+2 Credits)*	IELEMJMS0824	Material Sciences and VLSI Technology	4	4	6	30	120	150
	Research								
	Major *(0+12 Credits)*	IELEMJRP0824	Research Project	0	24	12	60	240	300
9	Major *(3+1 Credits)*	IELEMJSD0924	Physics of Semiconductor Devices	3	2	4	20	80	100
	Major *(3+1 Credits)*	IELEMJMP0924	Mini Project	0	8	4	20	80	100
	Major *(3+1 Credits)*	IELEMJMC0924	Mobile Communication and Networks	3	2	4	20	80	100
	Major *(2+2 Credits)*	IELEMJIT0924	Industrial Training and Seminar Work	2	4	4	20	80	100
	Specialization S1 (Elective E1)								
	Major *(4+2 Credits)*	IELEMJNC0924	Neuromorphic Computing	4	4	6	30	120	150
		IELEMJES0924	Embedded System Design with ARM Cortex Microcontrollers	4	4	6	30	120	150
		IELEMJIP0924	Digital Image Processing	4	4	6	30	120	150
		IELEMJCI0924	Computational Intelligence and Wireless Communications	4	4	6	30	120	150
10	Major *(3+1 Credits)*	IELEMJIC1024	Digital and Analog IC Design	3	2	4	20	80	100

Semester	Course Type & Credits	Course Code	Course Title	Hours		Credits	Marks		
				Theory (L)	Lab (P)		Internal	End Term	Total
	Specialization S2 (Elective E2)								
	Major (4+2 Credits)	IELEMJNA1024	Nanoelectronics	4	4	6	30	120	150
		IELEMJCS1024	Cyber Security, Cryptography, and the Internet of Things	4	4	6	30	120	150
		IELEMJSC1024	Multimedia Signal Coding and Communication	4	4	6	30	120	150
		IELEMJWE1024	Wearable Electronics and Antennas	4	4	6	30	120	150
	Major (0+12Credits)	IELEMJRP1024	Research Project/Internship	0	24	12	60	240	300

Semester - 1

Course Name: **Mathematics**, Course Code: **IELEMJMA0124**, Course Type: **Foundation**

Hours			Total Credits	Maximum Marks				Time Allowed for Theory Examination
Lecture	Tutorial	Practical		Internal	End Term		Total	
					Theory	Lab		
4	0	0	4	20	80	0	**100**	2 ½ Hrs

Course Objectives:

The aim of this course is to solidify the foundational knowledge of mathematics necessary for advanced coursework in electronics. It will enable students to apply mathematical concepts to various fields such as signal processing, circuit design, and system modeling.

Expected Learning Outcomes:

After going through this course, the student shall be able to:

1. ***Solve algebraic equations*** *(linear, quadratic, simultaneous) using appropriate methods.*
2. ***Analyze graph and functions*** *(polynomial, exponential, logarithmic, trigonometric) and understand their key properties.*
3. ***Calculate limits, continuity, and apply differentiation*** *for solving optimization and rate-of-change problems.*
4. ***Apply integration techniques*** *to solve problems, including area calculation.*
5. ***Solve differential equations*** *and apply basic methods like separation of variables.*

Detailed Syllabus

Unit 1: Number System, Sets and Functions

- **Number System:** Review and properties of Natural numbers, Integers, rational and real numbers. Prime numbers and divisibility, complex numbers, basic operations and polar form.
- **Sets:** Definition, examples and properties of sets. Cartesian product, relations and equivalence relations.

Functions: Domain, range, and types of functions (linear, quadratic, polynomial, exponential, logarithmic, and trigonometric functions). Composition of functions and plotting of graphs.

Unit 2: Matrices and Determinants

- **Linear Equations**: Solutions of linear equations in one and two variables. Applications in real-world problems.
- **Matrices and Determinants:** Definition, examples, Operations, inverse and rank of a matrix. Determinants and their properties. Consistency and solution techniques.
- **Simultaneous Equations**: Systems of linear equations, solutions using substitution, elimination, and matrix methods (including determinants and Cramer's rule and Gauss elimination method).
- **Matrix Equations:** Eigenvalues and Eigenvectors, characteristic equation and minimal equations. Examples and applications for the stability of the system.

Unit 3: Calculus

- **Limits and Continuity**: Concept of limits, examples and properties. Definition of continuity with basic properties.
- **Derivatives**: Definition of derivative, interpretation as a rate of change and slope of the tangent. Derivative of simple functions by power rule, product rule, quotient rule, and chain rule.
- **Integration**: Integration as the reverse process of differentiation, basic integration formulas. Rules of integration by; substitution, parts and partial fractions.
- **Definite Integrals**: Properties of definite integrals, evaluation of definite integrals, and applications in calculating area under curve.

Unit 4: Differential Equations

- **Basic differential equations:** Definition, Formation and examples. Order and degree of a differential equation. Linear and non-linear differential equations. Concept of elementary ordinary and partial differential equations.
- **Solution Methods:** solutions by variable separable method, integrating factor method. Solution of homogeneous and Bernoulli's type of differential equations. Solution of elementary second order differential equations using auxiliary equations.
- **Applications of Derivatives**: Rules for finding maxima and minima. Solution of simple problems arising in control system, circuit analysis, heat and energy dissipation.

Recommended Books

1. G. B. Thomas and R.L. Finney, Calculus, Pearson Education, 2007.
2. E. Kreyszig, "Advanced Engineering Mathematics", 8th Ed., John Wiley, Singapore, (2001).
3. R. K. Jain, and S. R. K. Iyengar, "Advanced Engineering Mathematics", 2nd Ed., Narosa Publishing House, New Delhi (2003).
4. Ayres Frank, Schaum's outline of Theory and Problems of Differential and Integral Calculus, 1994.
5. Das & Mukherjee, "Differential Calculus", U.N. Dhur & Sons Pvt. Ltd.
6. Das & Mukherjee, "Integral Calculus", U.N. Dhur & Sons Pvt. Ltd.

Semester - 2

Course Name: **Physics**, Course Code: **IELEMJPY0124**, Course Type: **Foundation**

Hours			**Total Credits**	**Maximum Marks**				Time Allowed for Theory Examination
Lecture	Tutorial	Practical		Internal	End Term		**Total**	
					Theory	Lab		
3	0	2	4	20	60	20	**100**	1 ¾ Hrs

Course Objectives:

This course is designed to introduce students to fundamental concepts in physics, with an emphasis on understanding physical principles and developing problem-solving skills required in the field of electronics.

Expected Learning Outcomes:

After going through this course, the student shall be able to:

1. ***Apply kinematic and dynamic principles*** *(motion, Newton's laws, work-energy theorem) to solve problems in mechanics.*
2. ***Analyze electrical circuits*** *using Ohm's law, Kirchhoff's rules, and concepts of electrostatics, magnetism, and electromagnetic induction.*
3. ***Understand wave and optics principles****, including interference, diffraction, and the behavior of light in both geometrical and physical optics.*
4. ***Apply thermodynamic laws*** *(energy conservation, entropy, efficiency) to analyze heat and work in physical systems.*

Detailed Syllabus

Unit 1: Mechanics

- **Kinematics**: Motion in one and two dimensions; displacement, velocity, and acceleration; equations of motion under constant acceleration.
- **Newton's Laws of Motion**: Introduction to forces, free-body diagrams, applications of Newton's laws, friction, tension, and normal forces.
- **Work, Energy, and Power**: Work-energy theorem, conservation of mechanical energy, potential and kinetic energy, power, and efficiency.
- **Rotational Dynamics**: Angular velocity, angular acceleration, torque, moment of inertia, angular momentum, and conservation of angular momentum.

Unit 2: Electricity and Magnetism

- **Electrostatics**: Coulomb's law, electric field, electric potential, and Gauss's law.
- **Capacitance**: Parallel plate capacitor, energy stored in capacitors, and dielectrics.
- **Current Electricity:** Electric current, flow of electric charges in a metallic conductor, drift velocity, mobility and their relation with electric current; Ohm's law, V-I characteristics (linear and non-linear), electrical energy and power, electrical resistivity and conductivity, temperature dependence of resistance, Internal resistance of a cell, potential difference and emf of a cell, Kirchhoff's rules.
- **Magnetism**: Lorentz Force Law; magnetic field of a steady current (Biot-Savart law), Ampere's law and its applications.

- **Electromagnetic Induction**: Faraday's law of induction, Lenz's law, self-inductance, and mutual inductance.

Unit 3: Waves, Optics and Thermodynamics

- **Waves**: Types of mechanical waves, wave equation, speed of sound and light, interference and diffraction.
- **Simple Harmonic Motion**: Equation of SHM, energy in SHM, examples like pendulums and springs.
- **Geometrical Optics**: Reflection, refraction, and Snell's law; mirrors and lenses, optical instruments.
- **Physical Optics**: Interference, diffraction patterns (single slit, double slit), and the wave-particle duality of light.
- **Zeroth Law of Thermodynamics**: Concept of temperature and thermal equilibrium.
- **First Law of Thermodynamics**: Internal energy, heat, and work, conservation of energy in thermodynamic processes.
- **Second Law of Thermodynamics**: Entropy, heat engines, and refrigerators; Carnot cycle and the concept of efficiency.

Unit 5: Lab Experiments

- **Experiment 1:** Measurement of gravitational acceleration (g) using a simple pendulum.
- **Experiment 2:** Measurement of Resistance.
- **Experiment 3:** Verification of Ohm's law; determination of resistance and resistivity.
- **Experiment 4:** Study of Series Circuits.
- **Experiment 5:** Study of Parallel Circuits.
- **Experiment 6:** Study of electrical resonance in an RLC circuit and determination of the resonant frequency.
- **Experiment 7:** Verify Biot-Savart law.
- **Experiment 8:** Study of Electromagnetic Induction.
- **Experiment 9:** Measurement of Magnetic Field Using a Solenoid.
- **Experiment 10:** Study of the reflection and refraction of light using glass slabs and mirrors.
- **Experiment 11:** Determination of the Young's modulus of a material using a beam-bending method.
- **Experiment 12:** Double-slit experiment to observe and analyze interference patterns.
- **Experiment 13:** To determine the refractive index of the prism material using spectrometer.
- **Experiment 14:** Measurement of temperature.

Recommended Books

1. Halliday, David, Resnick, Robert, & Walker, Jearl. (2018). Fundamentals of Physics (11th ed.). Wiley.
2. Concepts of Physics, Volume 1 (2nd ed.). Bharati Bhawan Publishers & Distributors. Volume 1 and 2.
3. Halliday, David, Resnick, Robert, & Walker, Jearl. (2023). Principles of Physics: Extended International Edition (12th ed.). Wiley.
4. Verma, H.C. (2015). Concepts of Physics (Vol. 1 & Vol. 2, 2nd ed.). Bharati Bhawan Publishers & Distributors.
5. Young, Hugh D., & Freedman, Roger A. (2020). University Physics with Modern Physics (15th ed.). Pearson.

Semester - 1

Course Name: **Network Analysis & Analog Electronics**, Course Code: **IELEMJNA0124**, Course Type: **Major**

Hours			Total Credits	Maximum Marks				Time Allowed for Theory Examination
Lecture	Tutorial	Practical		Internal	End Term		Total	
					Theory	Lab		
4	0	4	6	30	80	40	**150**	2 ½ Hrs

Course Objective:

1. *To review the basic concepts of emf sources and Kirchhoff's laws*
2. *To study network topology, network theorems and two port networks*
3. *To provide a comprehensive understanding of electronic devices and circuits*
4. *To understand the working of diode and transistor and to study basic circuits using diodes and transistors*
5. *To understand the diode and transistor characteristics*
6. *To study the effect of feedback on amplifiers*

Expected Learning Outcomes:

After going through this course, the student shall be able to:

1. *Have a comprehensive understanding of electronic devices and circuits*
2. *Apply their knowledge in analyzing Circuits by using network theorems*
3. *Know the characteristics of diodes and transistors*
4. *Know the benefits of feedback in amplifiers*

Detailed Syllabus

THEORY (4 Credits):

UNIT-I: Circuit Analysis (15 HOURS)

Concept of Voltage and Current Sources. Kirchhoff's Current Law, Kirchhoff's Voltage Law. Mesh Analysis. Node Analysis. Star and Delta networks, Star-Delta Conversion. Principal of Duality. Superposition Theorem. Thevenin's Theorem. Norton's Theorem. Reciprocity Theorem. Maximum Power Transfer Theorem. Two Port Networks: h, y and z parameters and their conversion.

Unit-II: Semiconductor Devices-I (15 HOURS)

Junction Diode and its applications: PN junction diode (Ideal and practical)- I-V characteristics, dc load line analysis, Quiescent (Q) point. Zener diode, Rectifiers- Half wave rectifier, Full wave rectifiers (center tapped and bridge), circuit diagrams, working and waveforms, ripple factor and efficiency. Zener diode as voltage regulator, Introduction to Tunnel diode, metal contact diode.

Unit-III: Semiconductor Devices - II (15 HOURS)

Bipolar Junction Transistor: Review of the characteristics of transistor in CE and CB configurations, Regions of operation (active, cut off and saturation), Current gains α and β. Relations between α and β. dc load line and Q point. Unipolar Devices: JFET and MOSFET. Construction, working and I-V characteristics (output and transfer), Pinch- off voltage.

Unit-IV: Transistor Biasing and Amplifiers (15 HOURS)

Transistor biasing and Stabilization Circuits-Fixed Bias and Voltage Divider Bias. Thermal runaway, stability and stability factor S. Transistor as a two- p or t network, h-parameter equivalent circuit. Small signal analysis of single stage CE amplifier. Input and Output impedance, Current and Voltage gains. Class A, B and C Amplifiers. Cascaded Amplifiers, two stage RC Coupled Amplifier and its Frequency Response. Concept of feedback, negative and positive feedback.

Recommended Books

1. Electrical Circuits, K.A. Smith and R.E. Alley, 2014, Cambridge University Press
2. Network, Lines and Fields, J. D. Ryder, Prentice Hall of India.
3. Electronic Devices and Circuits, David A. Bell, 5th Edition 2015, Oxford University Press.
4. Electronic Circuits: Discrete and Integrated, D.L. Schilling and C. Belove, Tata McGraw Hill
5. Electrical Circuit Analysis, Mahadevan and Chitra, PHI Learning
6. Microelectronic circuits, A.S. Sedra, K.C. Smith, A.N. Chandorkar, 2014, 6th Edn., Oxford University Press.
7. Integrated Electronics, J. Millman and C. C. Halkias, Tata McGraw Hill (2001)
8. 2000 Solved Problems in Electronics, J. J. Cathey, Schaum's outline.
9. Electronic Devices and Circuits, Allen Mottershead, Goodyear Publishing Corporation

PRACTICAL (2 CREDITS: 60 HOURS)

Note: The student is required to attempt at least 10 experiments

1. To familiarize with basic electronic components (R, C, L, diodes, transistors),
2. Measurement of Amplitude, Frequency & Phase difference using Oscilloscope.
3. Verification of (a) Thevenin's theorem and (b) Norton's theorem.
4. Verification of (a) Superposition Theorem and (b) Reciprocity Theorem.
5. Verification of the Maximum Power Transfer Theorem.
6. Study of the I-V Characteristics of (a) p-n junction Diode, and (b) Zener diode.
7. Study of (a) Half wave rectifier and (b) Full wave rectifier (FWR).
8. Study the effect of (a) C- filter and (b) Zener regulator on the output of FWR.
9. Study of the I-V Characteristics of UJT and design relaxation oscillator.
10. Study of the output and transfer I-V characteristics of common source JFET.
11. Study of Fixed Bias and Voltage divider bias configuration for CE transistor.
12. Design of a Single Stage CE amplifier of given gain.

Semester - 2

Course Name: **Digital Integrated Electronics**, Course Code: **IELEMJDE0224**, Course Type: **Major**

Hours			Total Credits	Maximum Marks				Time Allowed for Theory Examination
Lecture	Tutorial	Practical		Internal	End Term		Total	
					Theory	Lab		
4	0	4	6	30	80	40	**150**	2 ½ Hrs

Course Objective:

1. *To acquaint the students with the fundamental principles of two-valued logic and various devices used to implement logical operations on variables*
2. *To describe and explain the operation of fundamental digital gates*
3. *To study the design and implementation of various combinational and sequential logic circuits*
4. *To study various logic families.*

Expected Learning Outcomes:

After going through this course, the student shall be able to:

1. *Use the basic logic gates and various reduction techniques of digital logic circuits*
2. *Analyze and design combinational and sequential circuits*
3. *Analyze the operation of standard combinational circuits like encoder, decoder, multiplexer, demultiplexer, adder etc.*
4. *Analyze the operation of flip-flops and examine relevant timing diagrams*
5. *Analyze the operation of counters and shift registers*
6. *Classify the digital ICs.*

Detailed Syllabus

THEORY (4 Credits):

UNIT-I: Number System and logic Gates (15 HOURS)

Decimal, Binary, Octal and Hexadecimal number systems, base conversions. Representation of signed and unsigned numbers, BCD code. Binary, octal and hexadecimal arithmetic; addition, subtraction by 2's complement method, multiplication. Logic Gates and Boolean algebra: Truth Tables of OR, AND, NOT, NOR, NAND, XOR, XNOR, Universal Gates, Basic postulates and fundamental theorems of Boolean algebra.

Unit-II: Combinational Logic Analysis and Design (15 HOURS)

Standard representation of logic functions (SOP and POS), Minimization Techniques (Karnaugh map minimization up to 4 variables for SOP). Arithmetic Circuits: Binary Addition. Half and Full

Adder. Half and Full Subtractor, 4- bit binary Adder/Subtractor. Multiplexers, De-multiplexers, Decoders, Encoders.

Unit-III: Sequential Circuits (15 HOURS)

SR, D, T and JK Flip-Flops. Clocked (Level and Edge Triggered) Flip-Flops. Preset and Clear operations. Race-around conditions in JK Flip-Flop. Master-slave JK Flip-Flop. Shift registers: Serial-in- Serial-out, Serial-in-Parallel-out, Parallel-in-Serial-out and Parallel-in-Parallel-out Shift Registers (only up to 4 bits). Ring Counter. Asynchronous counters, Decade Counter. Synchronous Counter.

Unit-IV: Logic Families (15 HOURS)

Classification of digital ICs. IC terminology, Characteristics of logic families- Fan-in, Fan out, Noise Margin, Power Dissipation, Figure of merit, Speed power product, RTL, DTL, ECL and TTL, circuit description of TTL, NAND gate with totem pole and open collector. TTL and CMOS, Comparison of TTL and CMOS families.

Recommended Books

1. Digital Principles and Applications, A.P. Malvino, D. P. Leach and Saha, 7th Ed., 2011, Tata McGraw
2. Fundamentals of Digital Circuits, Anand Kumar, 2nd Edn, 2009, PHI Learning Pvt. Ltd.
3. Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
4. Digital Systems: Principles & Applications, R. J. Tocci, N. S. Widmer, 2001, PHI Learning.
5. Thomas L. Flyod, Digital Fundamentals, Pearson Education Asia (1994)
6. R. L. Tokheim, Digital Principles, Schaum's Outline Series, Tata McGraw- Hill (1994)

PRACTICAL (2 CREDITS: 60 HOURS)

Note: The student is required to attempt at least 10 experiments

1. To design a combinational logic system for a specified Truth Table.
2. To convert Boolean expressions into logic circuits and design circuits using logic gate ICs.
3. To minimize a given Boolean Expression and design Circuits using logic gates.
4. To design Half Adder and Full Adder Circuits.
5. TO Design Half Subtractor and Full Subtractor Circuits.
6. To design binary adder and adder-subtractor Circuits using Full adder IC.
7. To design seven-segment decoder Circuit.
8. To build Flip-Flop (RS, Clocked RS) circuits using NAND gates.
9. To build Flip-Flop (D-type and JK) circuits using NAND gates.
10. To build JK Master-slave flip-flop using Flip-Flop ICs.
11. To build a Counter using D-type/JK Flip-Flop ICs and study timing diagram.
12. To make a Shift Register (serial-in and serial-out) using D-type/JK Flip-Flop ICs.

Semester - 3

Course Name: **Operational Amplifier & Applications**, Course Code: **IELEMJOA0324**, Course Type: **Major**

Hours			Total Credits	Maximum Marks				Time Allowed for Theory Examination
Lecture	Tutorial	Practical		Internal	End Term		Total	
					Theory	Lab		
4	0	4	6	30	80	40	**150**	2 ½ Hrs

Course Objective:

1. *To introduce students to the basic concepts of operational amplifiers.*
2. *To expose students to different applications of operational amplifiers.*
3. *To expose the students to some specialized ICs which are based on operational amplifiers.*

Expected Learning Outcomes:

After going through this course, the student shall be able to use operational amplifier IC and design several applications. Besides, the student shall be able to use some specialized ICs for different applications. After studying the course, the student shall be confident to convert any idea into its circuit-based product.

Detailed Syllabus

THEORY (4 Credits):

UNIT-I: Operational Amplifier (15 HOURS)

Operational Amplifiers: Basic differential Amplifier, Block Diagram of Op-Amp (IC 741), Characteristics of an Ideal and Practical Operational Amplifier, Open and Closed Loop configuration, Concept of Virtual Ground.

Op-Amp Parameters: Input Offset Voltage, Input Offset Current, Input Bias Current, Common Mode Rejection Ratio (CMRR), Slew Rate, Power Supply Rejection Ratio (PSRR).

Unit-II: Operational Amplifier Applications (15 HOURS)

Op-Amp with Negative feedback: General concept of Voltage Series, Voltage Shunt, Current Series and Current Shunt Negative Feedback, Op Amp circuits with Voltage Series and Voltage Shunt Feedback,

Applications of Op-Amps: Inverting and Non-inverting Amplifiers, Summing and Difference Amplifier, Instrumentation Amplifier, Differentiator and Integrator, Comparator and Schmitt Trigger.

Unit-III: Data Converters and Active Filters (15 HOURS)

Data Converters: Analog-to-Digital (Flash and Successive Approximation type), Digital-to-Analog Converters (Weighted Resistor and R-2R Ladder type).

Active Filters using Op-Amps: First and Second Order Active Low Pass, high Pass, Band Pass and Band Stop Butterworth Filters.

Oscillators and Signal Generators: Barkhausen criterion for Sustained Oscillations, Phase Shift Oscillator, Wien-bridge oscillator, Square Wave Generator, Triangle Wave Generators.

Unit-IV: Specialized ICs and applications (15 HOURS)

IC 555 Timer: Introduction, Block diagram, Astable and Monostable multivibrator circuits.

Phase Locked Loops (PLL): Block Diagram and Characteristics, IC565 PLL, Phase Detectors, Voltage Controlled Oscillator (IC 566), Overview of PLL Applications.

Voltage Regulators: Basic circuit configuration and characteristics, Basic blocks of linear voltage regulator, three terminal fixed regulators (78XX and 79XX), Concept of Adjustable and Switching Regulators.

Recommended Books

Text Books:

1. Microelectronics circuits By Sedra and Smith, HRW Publishing.
2. Integrated Electronics By Milliman, McGraw Hill Book Company
3. OP- Amp and Linear Integrated Circuits by R. A. Gayakward, Prentice Hall of India Ltd.

References:

4. Operational Amplifiers and Linear Integrated Circuits by Robert F. Coughlin and Frederick F. Drisiol, Gayakward, Prentice Hall of India Private Ltd.
5. Design with Operational Amplifiers and Analog Integrated Circuits, Sergio Franco, McGraw Hill, 2002.

PRACTICAL (2 CREDITS: 60 HOURS)

Note: The student is required to attempt at least 10 experiments

1. Study Op-Amp Characteristics: CMRR and Slew Rate.
2. Design Inverting Amplifier of given Gain using Op-Amp.
3. Design of Non-Inverting Amplifier of given Gain using Op-Amp
4. Design Analog Adder and Subtractor Circuit using Op-Amp.
5. Design Integrator using Op-Amp.
6. Design Differentiator using Op-Amp.

7. Design First Order Low-Pass and High-Pass Filters using Op-Amp.
8. Design Second Order Low-Pass Filter using Op-Amp.
9. Design Second Order High-Pass Filter using Op-Amp
10. Design RC Phase Shift Oscillator using Op-Amp.
11. Design Wien Bridge Oscillator using Op-Amp.
12. Design of Square Wave and Triangle Wave Generators.
13. Study IC 555 as Astable Multivibrator.
14. Study IC 555 as Monostable Multivibrator.
15. Study the operation of 565 PLL with a given free running frequency.
16. Study line and load regulation using three-terminal regulators.

Semester - 4

Course Name: **Signals and Systems**, Course Code: **IELEMJSS0424**, Course Type: **Major**

Hours			**Total Credits**	**Maximum Marks**				Time Allowed for Theory Examination
Lecture	Tutorial	Practical		Internal	End Term		**Total**	
					Theory	Lab		
3	0	2	4	20	60	20	**100**	1 ¾ Hrs

Course Objective:

1. *To understand the fundamental characteristics of signals and systems.*
2. *To understand signals and systems in terms of both the time and transform domains.*
3. *To develop the mathematical skills to solve problems involving convolution, filtering and sampling.*

Expected Learning Outcomes:

At the end of this course students will demonstrate the ability to:

1. *Analyze different types of signals.*
2. *Analyze linear shift-invariant (LSI) systems.*
3. *Represent continuous and discrete systems in time and frequency domain using Fourier series and transform.*
4. *Analyze discrete time signals in z-domain.*
5. *Study sampling and reconstruction of a signal.*

Detailed Syllabus

THEORY (3 Credits):

UNIT-I: Representation and Classification of Signals and Systems (15 HOURS)

Representation and Classifications of Continuous and Discrete Time Signals and Systems; Linear and Nonlinear systems, Causal and non-causal Systems, Time varying and Time Invariant systems, Singularity Functions; Convolution Operation of Continuous and Discrete Time Signals; Impulse Response and Its Properties.

Unit-II: Fourier Series and Frequency Analysis of Continuous Time Systems(15 HOURS)

Fourier Transform and its Properties; System Analysis Using Fourier Transform; Hilbert Transform; Representation and Analysis of Bandpass Signals and Systems: Review of Laplace Transform; Two-Sided Laplace Transform; System Analysis of I and II Order Systems; Transfer Function; Frequency Response of I and II Order Systems.

Unit-III: Discrete Time Systems (15 HOURS)

Sampling: Representation of a Continuous-Time Signal by its Samples, Sampling Theorem. Reconstruction of a Signal from its Samples, Aliasing, Discrete-Time Processing of Continuous-Time Signals: Arithmetic operations on discrete time signals. Solutions of Discrete time systems using Z-transform. Introduction to Random Variables; Probability Distribution and Probability Density Functions; Uniform, Gaussian, Exponential and Poisson Random Variables; Statistical Averages; Random Processes; Correlation; Power Spectral Density.

Recommended Books

1. Alan V, Oppenheim and A.S Wilsky, Signals and Systems, prentice Hall India
2. Simon Hykin, Signals and systems, John Wiley.
3. B. P Lathi, Signals and systems
4. Simon Hykin, Communication systems, John wiley
5. D. M. Etter, D.C, Kuncicky, H. Moore, Introduction to MATLAB 7, Pearson.

PRACTICAL 1 CREDIT: 30 HOURS)

Note: The student is required to attempt at least 10 experiments

1. Introduction to MATLAB for signal analysis.
2. Understanding Vectors and Matrices in MATLAB.
3. To study various MATLAB arithmetic operators and mathematical functions.
4. To create and use m-files.
5. To study various MATLAB commands for creating two and three-dimensional plots.
6. Write a MATLAB program to plot the following continuous time and discrete time signals. i. Step Function ii. Impulse Function iii. Exponential Function iv. Ramp Function v. Sine Function
7. Write a MATLAB program to perform amplitude-scaling and time-scaling on a given signal.
8. Convolution of two given signals using MATLAB.

9.	Write a MATLAB program to obtain Auto and Cross-Corelation of Signals.
10.	To calculate Fourier series coefficients associated with Square Wave.
11.	To Sum the first 30 terms and plot the Fourier series as a function of time.
12.	Calculate and plot the Fourier transform of a given signal.
13.	Calculate and plot the Z-transform of a given signal.
14.	Write a MATLAB program to find the impulse response and step response of a system from its difference equation.
15.	Compute and plot the response of a given system to a given input.
16.	To Study sampling of continuous signals using MATLAB.

Semester - 4

Course Name: **Applied Mathematics and Programming**, Course Code: **IELEMJMP0424**, Course Type: **Major**

Hours			**Total Credits**	**Maximum Marks**				Time Allowed for Theory Examination
Lecture	Tutorial	Practical		Internal	End Term		**Total**	
					Theory	Lab		
4	0	4	6	30	80	40	**150**	2 ½ Hrs

Course Objective:

1. *To understand Fourier series and its applicability in different fields of electronics.*
2. *To understand the Fourier transform and its application in electronics.*
3. *To use Laplace transform methods to solve differential equations.*
4. *To understand various numerical techniques for the solution of algebraic equations.*
5. *To develop programming skills using C-programming.*

Expected Learning Outcomes:

At the end of this course students will demonstrate the ability to:

1. *Familiarize with the concept of Fourier transform & Fourier series*
2. *Understand the utility of Laplace transform*
3. *Develop algorithms for arithmetic and logical problems and write programs in C language*

Detailed Syllabus

THEORY (4 Credits):

UNIT-I: Fourier Series and Fourier Transform (15 HOURS)

Dirichlet's Condition, Determination of Fourier Coefficients, Fourier Series for functions of arbitrary period, Half-wave expansion, Fourier Integral Theorem, Fourier Sine and Cosine integrals, Fourier Transforms: Properties of Fourier Transforms, Fourier Transform and Dirac delta function, Application of Fourier Transformation in Electronics.

Unit-II: Laplace Transformation (15 HOURS)

Integral transforms, Laplace transforms, Properties of Laplace transforms, Laplace transform of some elementary functions, Shifting theorems, Laplace Transform of a derivative, Laplace transforms of integrals, Inverse of Laplace transform by partial fractions, Heavisize's expansion formula, Solving differential equation using Laplace transform, Applications of Laplace transform in the field of Electronics.

Unit-III: Numerical Methods (15 HOURS)

Empirical laws & Curve fitting methods: Method of group averages, Method of least squares Solution of Algebraic & transcendental equations: Bisection Method, Method of False Position, Iteration Method, Newton –Raphson Method, Solution of Simultaneous Algebraic equations: Cramer's rule, Matrix Inversion method, Gauss Elimination method, Gauss-Jordan Method.

Unit-IV: C Programming (15 HOURS)

Character set, Variables and Identifiers, Data Types, Variables, operators and Expressions, Constants and Literals, assignment and Basic input/output statement, Conditional Statements and Loops- Relational Operators, Logical, Switch Statement, Arrays and their processing; Functions and their processing, Pointer Arithmetic. Introduction to files and their processing.

Recommended Books

1. Advanced Engineering Mathematics by Edwin Kreyzing, Wiley Eastern Ltd.
2. Applied Mathematics for Engineers and Physicist by Pipes and Harvill, McGraw Hill Book Company.
3. Fourier Transformation and Laplace Transformations, Schaum Series Book, TMH Course
4. Numerical Methods, E. Balaguruswamy, TMH
5. Introductory Methods of Numerical Analysis, S.S.Sastry, PHI
6. Computer Oriented Numerical Methods, R.S. Salaria, Khanna Publishing House
7. Numerical Methods in Engineering and Science, B. S. Grewal
8. Numerical Methods, Khandasamy, K. Thilagavathy, K. Gunavathy.
9. Numerical Methods for Scientific and Engineering Computation by M. K. Jain, S. R. K. Iyengar, R. K. Jain. New Age International Publisher.
10. Numerical Methods for Engineers by Steven C. Chapra and Raymond P. Canale, TMH
11. C How to Program by Deitel
12. Programming with C by Byron S Gottfried

PRACTICAL (2 CREDITS: 60 HOURS)

Note: The student is required to attempt at least 10 experiments

1. Write a C program to Generate the Fibonacci series up to the given limit N and also print the number of elements in the series.
2. Write a C program to Find minimum and maximum of N numbers.
3. Write a C program to Find the GCD of two integer numbers.
4. Write a C program to Calculate factorial of a given number.
5. Write a C program to Generate and print prime numbers up to an integer N.
6. Write a C program to Sort given N numbers in ascending order.
7. Write a C program to add two Matrices Using Multi-Dimensional Arrays.
8. Write a C program to multiply two Matrices Using Multi-Dimensional Arrays.
9. Write a C program to multiply two Matrices by passing Matrix to a Function.
10. Write a C Program to Find Largest Element in an Array
11. Write a program to evaluate the sine series using recursive and non-recursive functions.
12. Write programs using structures, and unions for selected cases.
13. Write programs employing pointers instead of the use of arrays.
14. Write programs to create files, and read and write on these files.
15. Write a program to evaluate the sine series using recursive and non-recursive functions.
16. Write a C program to find the solution of a non-linear equation using repetitive substitution method.
17. Write a C program to find the solution of a non-linear equation using Bisection method.
18. Write a C program to find the solution of a non-linear equation using Regula Falsi method.
19. Write a computational program for solving algebraic equations by Newton Rapson method.
20. Write a computational program for solving simultaneous algebraic equations by Gaussian Elimination method.
21. Write a C program of fitting a straight line, exponential curve, geometric curve, hyperbola and a polynomial

Semester - 4

Course Name: **Electromagnetic Waves and Antennas**, Course Code: **IELEMJEM0424**, Course Type: **Major**

Hours			**Total Credits**	**Maximum Marks**				Time Allowed for Theory Examination
Lecture	Tutorial	Practical		Internal	End Term		**Total**	
					Theory	Lab		
4	0	4	6	30	80	40	**150**	2 ½ Hrs

Course Objective:

1. *Use Maxwell's equations to calculate fields from dynamic charge/current distributions.*
2. *Analyze plane waves in lossless and lossy media.*
3. *Calculate fields from antennas and antenna systems.*
4. *To study various polarization techniques.*

Expected Learning Outcomes:

At the end of this course students will demonstrate the ability to:

1. *Understand the radiation mechanism of EM waves by antennas and their radiation patterns.*
2. *Analyze the power radiated by different antennas and their radiation characteristics.*
3. *Interpret the relationships between antenna parameters.*
4. *Design and analyze different antennas and antenna arrays.*
5. *Understand the wave propagation mechanism at different frequencies.*

Detailed Syllabus

THEORY (4 Credits):

UNIT-I: Electromagnetic Fields and Maxwell's Equations (15 HOURS)

Introduction, Coulomb's law of forces, Principle of Superposition of Maxwell's Equations in differential and integral form. fields, Electric scalar potential, Relation of Electric field lines and equi-potential contours, The electric dipole and dipole moment, Gauss's law, Characteristics of dielectrics. Boundary relations, Capacitance, Divergence of flux density, Divergence Theorem, Poisson's and Laplace Equations, Equations of continuity for time varying fields, inconsistency of Amperes law, Boundary condition, Boundary Conditions at media interface (Dielectric and Conducting interface). Homogenous unbounded medium, Wave equation for time harmonic fields, solution of the wave equation, uniform plane wave.

Unit-II: Wave Polarization and Communication (15 HOURS)

Biot Savart law, Force between two parallel linear conductors, Magnetic flux and flux density, Magnetic field relations, Torque of a loop, Energy stored in a magnetic field, Inductance, Ampere's law, Maxwell's First curl equation, Comparison of divergence and curl, The vector potential, permeability, Analogies between electric and magnetic fields. M wave polarization, power flow and pointing vector (Physical interpretation), plane wave at dielectric interface, reflection and refraction of waves in dielectric interface, Normal Incidence on a layered medium, Total Internal Reflection, Wave Polarization at Media interface.

Unit-III: Antenna Fundamentals (15 HOURS)

Basics of antenna radiation, Potential functions, solution of potential functions, radiation from the hertz dipole, total power radiated by the hertz dipole, radiation resistance of the hertz dipole, radiation pattern of the hertz dipole, directivity, antenna gain, effective area of antenna. Folded dipole antennas, modification of folded dipoles, loop antennas, far-field patterns of circular loop antennas, Antenna Theorems – Applicability and Proofs for equivalence of directional characteristics, Loop Antennas: Small Loops - Field Components, Comparison of far fields of small loop and short dipole, Concept of short magnetic dipole, D and Rr relations for small loops.

Unit-IV: Antenna Arrays and Special Structures (15 HOURS)

Two element arrays – different cases, Principle of Pattern Multiplication, N element Uniform Linear Arrays – Broadside, Endfire Arrays, EFA with Increased Directivity, Derivation of their characteristics and comparison; Concept of Scanning Arrays, Yagi-Uda Arrays, Folded Dipoles and their characteristics, Introduction, Traveling wave radiators – basic concepts, Long wire antennas – field strength calculations and patterns, Microstrip Antennas-Introduction, Features, Advantages and Limitations, Rectangular Patch Antennas.

Recommended Books

1. Antennas and Wave propagation: John D Kraus, Ronald J Marhefka, Ahmad S Khan McGraw Hill, 4th edition.
2. Electromagnetic Waves: R. K. Shevgaonkar Tata McGraw Hill.
3. Transmission and Propagation – E.V.D. Glazier and H.R.L. Lamont, The Services Text Book of Radio, vol. 5, Standard Publishers Distributors, Delhi
4. Antenna Theory - C.A. Balanis, John Wiley and Sons, 2nd Edition, 2001.

PRACTICAL (2 CREDITS: 60 HOURS)

Note: The student is required to attempt at least 10 experiments

1. Generate Electromagnetic Wave using MATLAB or other software
2. To study propagation of wave using Rectangular Waveguide
3. To study impedance match using MATLAB or other software
4. To calculate phase & group velocity using MATLAB or other software
5. Measurement of Antenna Parameters using Microwave Antenna Training System
6. Plot of Polarization (Horizontal and Vertical).
7. Design of dipole antenna system using waveguide.
8. Some experiments using Microwave Antenna Trainer and CST Tool or HFSS.
9. To plot radiation pattern of dipole antenna using MATLAB or other software
10. To plot radiation pattern of monopole antenna using MATLAB or other software
11. To plot radiation pattern of Array antenna
12. To calculate power radiated by the ideal dipole
13. To Measure the power division in the E-Plane Tee, H-Plane Tee and Magic Tee.
14. To design a Halfwave dipole antenna at a frequency of 1GHz and simulate its behaviour using HFSS or CST
15. To design and simulate a microwave patch antenna at a frequency of 2.5GHz in HFSS or CST

Semester - 5

Course Name: **Microprocessors & Microcontrollers**, Course Code: **IELEMJMM0524**, Course Type: **Major**

<table>
<tr><th colspan="3">Hours</th><th rowspan="3">Total Credits</th><th colspan="4">Maximum Marks</th><th rowspan="3">Time Allowed for Theory Examination</th></tr>
<tr><td rowspan="2">Lecture</td><td rowspan="2">Tutorial</td><td rowspan="2">Practical</td><td rowspan="2">Internal</td><td colspan="2">End Term</td><td rowspan="2">Total</td></tr>
<tr><td>Theory</td><td>Lab</td></tr>
<tr><td>3</td><td>0</td><td>2</td><td>4</td><td>20</td><td>60</td><td>20</td><td>100</td><td>1 ¾ Hrs</td></tr>
</table>

Course Objective:

1. *To understand the differences in architecture and applications between Microprocessors and Microcontrollers*
2. *To understand basic architecture of 8085 microprocessor*
3. *To understand the 8085-instruction set and write programs in assembly language*
4. *To understand basic architecture of 8051 microcontroller*
5. *To understand the 8051-instruction set and write programs in assembly language*

Expected Learning Outcomes:

On completion of this course the students will be:

1. *Familiar with the components and functioning of a computer system, gaining an understanding of how a computer system operates.*
2. *Familiar with the fundamental concepts and architecture of 8085 microprocessor and 8051 Microcontroller.*
3. *Familiar with the addressing modes, computer instructions and its types.*
4. *Able to write assembly language programs for microprocessors and microcontrollers.*
5. *Able to interface different peripherals with 8051 Microcontrollers.*

Detailed Syllabus

THEORY (3 Credits):

UNIT-I: Introduction to Microprocessors and Microcontrollers (15 HOURS)

Computer System: Central Processing Unit, Memory, I/O, System Bus; Functions of a computer system. Introduction/History/Evolution and Applications of Microprocessors, types and Characteristics of a Microprocessors, Programmer's Model of Microprocessors, Von Neumann and Harvard Architectures, CISC and RISC Architectures. Introduction/Evolution and Applications of Microcontrollers, Comparison of Microprocessor and Microcontroller, Microcontrollers for embedded system, Criteria for choosing a Microcontroller, Programming Languages.

Unit-II: 8085 Architecture and Programming (15 HOURS)

Introduction and Architecture of 8085 Microprocessor, 8085 Bus Structure, Addressing Modes, 8085 instructions set (Data transfer including stacks. Arithmetic, logical, branch, and control instructions), Subroutines, delay loops, Instruction and Data Formats. Instruction Timing Diagram, Memory read/write Timing Diagrams. 8085 Interrupts. Programming of 8085 using Data Transfer, Arithmetic and logic Instructions.

Unit-III: 8051 Architecture and Programming (15 HOURS)

Introduction and Architecture of 8051 microcontroller, Pin description of 8051 microcontroller, Input/Output Ports and Port circuits, Timers and counters, Serial data input/output Interrupts, register set and Addressing Modes of 8051, Instruction set of 8051 (data transfer/arithmetic/logic/bit level and byte control transfer instructions), 8051 Assembly Language Programming: I/O port programming, bit manipulation, programming using Data Transfer, Arithmetic and logic Instructions. Interfacing of LED.

Recommended Books

1. Microprocessor Architecture Programming & applications with 8085, 2002, R.S. Goankar, Prentice Hall.
2. Microprocessors and Microcontrollers: Architecture, Programming & Interfacing using 8085, 8086, and 8051, S.K Mandal, Tata Mcgraw Hill Education.
3. The 8051 Microcontroller and Embedded Systems Using Assembly and C, M.A. Mazidi, J.G. Mazidi, and R.D. McKinlay, 2nd Ed., 2007, Pearson Education India.
4. Microprocessor Theory and Applications, M. Rafiq-u Zaman, McGraw Hill Publishing Company
5. Microprocessor Techniques by A. P. Godse, 2nd Ed., Technical Publications

PRACTICAL (2 CREDITS: 60 HOURS)

Note: The student is required to attempt at least 10 experiments

Programs using 8085 Microprocessor:

1. Arithmetic and logical operations of 8-bit/16-bit numbers.
2. Count number of 1's/0's in a given number.
3. Multiplication by repeated addition.
4. Division by repeated subtraction.
5. Block Data transfer.
6. Programs handling 32-bit numbers.
7. Calculate the sum of series of Even/Odd numbers
8. Find larger/smaller of two 8 and 16-bit numbers
9. Find the square of given number.
10. Delay loops.

Programs using 8051 Microcontroller:

11. Arithmetic and logical operations of 8-bit/16-bit numbers.
12. Data Transfer and shift operations.
13. Program to toggle the bits of port with some delay
14. Find the Largest/smallest number in a series of 10 numbers.
15. Sort Numbers in Ascending/Descending Order.
16. Singly and Multibit Shifting, Rotation and manipulation.
17. To find the factorial of a number.
18. Program to make the two numbers equal by increasing the smallest number and decreasing the largest number.

Semester - 5

Course Name: **Digital System Design and VHDL**, Course Code: **IELEMJDD0524**, Course Type: **Major**

Hours			**Total Credits**	**Maximum Marks**				Time Allowed for Theory Examination
Lecture	Tutorial	Practical		Internal	End Term		**Total**	
					Theory	Lab		
4	0	4	6	30	80	40	**150**	2 ½ Hrs

Course Objective:

1. *To impart basic concepts of computer architecture and organization.*
2. *To explain key skills of constructing cost-effective computer systems.*
3. *To familiarize the basic CPU organization.*
4. *To help students in understanding various memory devices.*
5. *To facilitate students in learning IO communication.*

Expected Learning Outcomes:

At the end of this course students will demonstrate the ability to:

1. *Identify various components of computer and their interconnection*
2. *Identify basic components and design of the CPU: the ALU and control unit.*
3. *Compare and select various Memory devices as per requirement.*
4. *Compare various types of IO mapping techniques*
5. *Critique the performance issues of cache memory and virtual memory.*

Detailed Syllabus

THEORY (4 Credits):

UNIT-I: Introduction to VHDL programming (15 HOURS)

Fundamental units of VHDL, Library declaration, Entity declaration, Architecture declaration, Data types, Primitive programming Data flow programming, Structural Programming, Signals and variables, Test benches, State machines.

Unit-II: Structure of Computers (15 HOURS)

Computer types, Functional units, Basic operational concepts, Von-Neumann Architecture, Bus Structures, Software, Performance, Multiprocessors and Multicomputer, Data representation, Fixed and Floating point, Computer Arithmetic's: Addition and Subtraction, Multiplication and Division algorithms, Floating-point Arithmetic. Implementation of Arithmetic circuits in VHDL. Computer types, Functional units, Basic operational concepts, Von-Neumann Architecture, Bus Structures, Software, Performance, Multiprocessors and Multicomputer, Data representation, Fixed and Floating point, Computer Arithmetic's: Addition and Subtraction, Multiplication and Division algorithms, Floating-point Arithmetic. Implementation of Arithmetic circuits in VHDL.

Unit-III: Register Transfer, Micro-Operations & Memory Systems (15 HOURS)

Register Transfer Language, Register Transfer, Bus and Memory Transfers, Arithmetic Micro-Operations, Logic Micro-Operations, Shift Micro-Operations, Arithmetic logic shift unit. MICRO-PROGRAMMED CONTROL: Control Memory, Address Sequencing, Micro-Program example, Design of Control Unit. Semiconductor Memories, RAM (Random Access Memory), Read Only Memory (ROM), Types of ROM, Cache Memory, Performance considerations, Virtual memory. Implementation of registers in VHDL

Unit-IV: Basic Computer Organization and Design (15 HOURS)

Instruction codes, Computer Registers, Computer Instructions and Instruction cycle. Timing and Control, Memory-Reference Instructions, Input-Output and interrupt. Central processing unit: Stack organization, Instruction Formats, Addressing Modes, Data Transfer and Manipulation, Complex Instruction Set Computer (CISC) Reduced Instruction Set Computer (RISC), CISC vs RISC. Implementation of simple CPU in VHDL.

Recommended Books

1. William Stallings (2010), Computer Organization and Architecture- designing for performance, 8th edition, Prentice Hall, New Jersy.
2. M. Moris Mano (2006), Computer System Architecture, 3rd edition, Pearson/PHI, India.

3. Carl Hamacher, Zvonks Vranesic, SafeaZaky (2002), Computer Organization, 5th edition, McGraw Hill, New Delhi, India.
4. Anrew S. Tanenbaum (2006), Structured Computer Organization, 5th edition, Pearson Education Inc,
5. John P. Hayes (1998), Computer Architecture and Organization, 3rd edition, Tata McGraw Hill
6. Nikrouz Faroughi, (2015), Digital Logic Design and Computer Organization with computer architecture for security, 1st edition, McGraw Hill Education.

PRACTICAL (2 CREDITS: 60 HOURS)

Note: The student is required to attempt at least 10 experiments

1. Design the Data path of a computer from its register transfer language transcription
2. Implement a simple instruction set computer with a control unit and a data path.
3. Design a control unit of a computer using the Microprogrammed logic based on its RTL.
4. Design an 8-bit ALU using VHDL.
5. Implement the HALF Adder using VHDL.
6. Implement the FULL Adder using VHDL.
7. Implement the Binary to Gray and Gray to Binary code converters using VHDL.
8. Design a 3 x 8-line decoder using VHDL.
9. Implement the 4 x 1 and 8 x 1 Multiplexer using VHDL.
10. Implement the various flip-flops using VHDL and verify the excitation tables.
11. Implementation of various logic gates using VHDL.
12. Implementation of Booth's Algorithm using VHDL.
13. Implementation of direct mapped cache design using VHDL.
14. Implementation of restoring division algorithm using VHDL.
15. Implementation of synchronous counters using VHDL.
16. Implementation of Ripple Carry Ahead (RCA) using VHDL.
17. Design an 8-bit Barrel Shifter using VHDL.
18. Using VHDL to implement Subtractors circuits using 2's compliment method.
19. Implementation of Moore's Machines using VHDL.
20. Implementation of Melay Machine using VHDL.
21. Verification of the designed circuits using FPGA.

Semester - 5

Course Name: **Microwave Engineering**, Course Code: **IELEMJME0524**, Course Type: **Major**

Hours			Total Credits	Maximum Marks				Time Allowed for Theory Examination
Lecture	Tutorial	Practical		Internal	End Term		Total	
					Theory	Lab		
4	0	4	6	30	80	40	**150**	2 ½ Hrs

Course Objective:

1. *To understand and gain complete knowledge about microwave devices and components.*

2. *To learn about transmission lines and analysis of wave guides.*
3. *To learn the importance of S parameters and VSWR in microwave measurements.*

Expected Learning Outcomes:

At the end of this course students will be able to demonstrate the:

1. *Use of different types of waveguides and their respective modes of propagation.*
2. *Analyze typical microwave networks using impedance, admittance, transmission and scattering matrix representations.*
3. *Design microwave matching networks using L section, single and double stub and quarter wave transformer.*
4. *Explain working of microwave passive circuits such as isolator, circulator, Directional couplers, attenuators etc.*
5. *Describe and explain working of microwave tubes and solid-state devices.*
6. *Perform measurements on microwave devices and networks using power meter and VNA.*

Detailed Syllabus

THEORY (4 Credits):

UNIT-I: Microwave Transmission Lines (15 HOURS)

Transmission Line and Distributed parameters, Basic Transmission line equations, Solutions of Transmission line equations, Physical significance of Transmission line equations, Distortions in Transmission line, Condition for Distortion less line, Characteristic impedance, Propagation Constant, Reflection and Transmission coefficients, Velocity of propagation, Standing wave and Standing wave ratio, Reflection of line terminated in impedance other than characteristic impedance, Single stub impedance matching, Smith Chart.

Unit-II: Microwave Network Analysis (15 HOURS)

Impedance and Equivalent Voltages and Currents, Equivalent Voltages and Currents, The Concept of Impedance, Even and Odd Properties of Z(ω) and (ω), Impedance and Admittance Matrices, Reciprocal Networks Lossless Networks, The Scattering Matrix , Reciprocal Networks and Lossless Networks, A Shift in Reference Planes , Power Waves and Generalized Scattering Parameters, The Transmission (ABCD) Matrix, Relation to Impedance Matrix, Equivalent Circuits for Two-Port Networks, Signal Flow Graphs, Decomposition of Signal Flow Graphs, Application to Thru-Reflect-Line Network Analyzer Calibration.

Unit-III: Microwave Waveguides (15 HOURS)

Rectangular Waveguides, Solution of Wave Equations in Rectangular Coordinates, TE modes in rectangular magnitudes, TM Modes in Rectangular waveguide, Power Transmission in Rectangular Waveguides, Power Losses in Rectangular Waveguides, Excitations of Modes in Rectangular waveguides, Circular Waveguides, TEM Modes in Circular Waveguide.

Unit-IV: Microwave Devices and Strip lines (15 HOURS)

Klystrons: Multi-cavity Klystron and Reflex Klystron, Microwave Tunnel Diode Gunn Oscillator, Travelling Wave Tube, Characteristic Impedance of Micro strip Lines and Quality factor of Micro-strip lines, Characteristic impedance of Parallel strip lines and Attenuation losses, MMIC Fabrication techniques.

Recommended Books

1. G. S. Raghuvanshi, Microwave Engineering; Cengage
2. S.Y. Liao, Microwave Devices & Circuits; PHI 3rd Ed.
3. A Das and S.K. Das, Microwave Engineering; McGraw Hill Education
4. S. Vasuki, D Margaret Helena, R Rajeswari, Microwave Engineering; MHE
5. Om P. Gandhi, Microwave Engineering and Applications; Pergamon Press
6. Microwave Engineering Fourth Edition David M. Pozar University of Massachusetts at Amherst, John Wiley & Sons, Inc 4th Edition.

PRACTICAL (2 CREDITS: 60 HOURS)

Note: The student is required to attempt at least 10 experiments

Laboratory Work I:

1. Study of different Microwave guide components.
2. Determination the frequency and wavelength in a rectangular wave guide working on TE10 mode.
3. Finding the standing wave ratio and reflection coefficient.
4. Measurement of an unknown impedance with smith chart.

Laboratory Work II:

5. Study the VI characteristics of Gunn diode.
6. Finding the O/P power and frequency as a function of voltage in case of Gunn diode.
7. Finding the O/P power and frequency as a function of voltage in case of Magic tee.
8. To study insertion loss and attenuation of an attenuator.

9. To calculate the impedance of the given load of the Klystron. To determine the frequency and wavelength in a rectangular wave guide working in TE10 mode.
10. Study the Characteristics of Klystron tube and determination of its electronic tuning range, various experiments using MATLAB and HFSS Tool.
11. To study the function of multihole directional coupler by measuring the following parameters. 1. Mainline and auxiliary line VSWR. 2. The coupling factor and directivity of the coupler.
12. To determine the standing wave ratio and reflection coefficient of X-band waveguide.
13. To study the scattering parameters of magic tee.
14. To study Vector Network Analyzer.

Semester - 6

Course Name: **Communication Electronics – I**, Course Code: **IELEMJCE0624**, Course Type: **Major**

Hours			Total Credits	Maximum Marks				Time Allowed for Theory Examination
Lecture	Tutorial	Practical		Internal	End Term		Total	
					Theory	Lab		
3	0	2	4	20	60	20	**100**	1 ¾ Hrs

Course Objective:

1. *To understand the transmission of signals through communication channels.*
2. *To understand analog communication systems using amplitude modulation and demodulation.*
3. *To learn about analog communication systems using angle modulation and demodulation.*
4. *To know about various types of noise in communication systems.*

Expected Learning Outcomes:

At the end of this course students shall be able to demonstrate:

1. *Basic working of communication system*
2. *Analog Modulation Techniques and their comparative analysis and applications suitability*
3. *Process of Modulation and Demodulation*
4. *Types, characterization and performance parameters of transmission channels*
5. *Multiplexing Techniques*
6. *Basic working principles of existing and advanced communication technologies*
7. *Conversion of analog speech into digital speech using PCM.*

Detailed Syllabus

THEORY (3 Credits):

UNIT-I: Amplitude Modulation and Demodulation (15 HOURS)

Introduction to Signals and its classification, Basic Mathematical theory of A. M modulation, Time domain and Frequency domain representation, Generation and demodulation of AM Signal, Double Side band Suppressed Carrier, (DSB- SC) System, Generation and Demodulation of DSB- SC signals, Advantages of SSB transmission, Generation of SSB; Vestigial Side-Band Modulation (VSB). SSB and VSB demodulation, independent sideband transmission and reception.

Unit-II: FM Modulation, Reception and Noise (15 HOURS)

Concept of Angle Modulation: Mathematical theory, Bandwidth calculation, Generation of FM by Direct Methods. Indirect Generation of FM; The Armstrong Method, FM Receiver Direct Methods of Frequency Demodulation; Slope Detector, FM Detector using PLL, Noise in Communication System, Time-domain representation of Narrow band Noise, Filtered White Noise, Noise figure. AM Receiver model, Noise analysis of DSBSC and SSBSC using coherent detection, Noise in AM using Envelope detection, Noise in FM using Limiter-discriminator detection, FM threshold effect, Pre- emphasis and De-emphasis in FM.

Unit-III: Pulse Modulation (15 HOURS)

Introduction to PCM, PAM and PWM. Review of Sampling Theorem, Signal Reconstruction: The Interpolation Formula, Elements of Pulse Code Modulation (PCM), Quantization: Uniform and Non-uniform Quantization, Companding Characteristics, Encoding, Bandwidth and Noise in PCM Systems, Differential PCM, Delta modulation and Adaptive DM.

Recommended Books

1. P.Z. Peebles.Jr., Probability, Random Variables and Random Signal Principles, Tata McGraw Hill Education, 3rd edition, 2002.
2. A.Papoulis, Probability, Random variables and Stochastic Processes, McGraw Hill, 3rd edition, 1991.
3. Modern Digital and Analog Communication Systems, by B. P. Lathi, Oxford Press.
4. George Kennedy, “Electronic Communication System”, McGraw- Hill.
5. Gary M. Miller and Jeffery S. Beasley, “Modern Electronic Communications “, PHI.
6. Simon Haykin, “Communication Systems”, 8th edition, Wiley Publishers.

PRACTICAL (1 CREDITS: 30 HOURS)

Note: The student is required to attempt at least 10 experiments

1. Study of ICs (AD633/AD734).

2. Design and realize AM modulator using Square Law modulator and calculate its modulation index and power.
3. Design and realize AM detector using Square Law detector and Envelope detector.
4. Design and realize DSB-SC signal Modulator using Analog Multiplier.
5. Design and realize DSB-SC signal demodulator using Coherent detection and Squaring loop.
6. Simulation of SSB-SC modulator and demodulator using MATLAB/Simulink.
7. Simulation of Hilbert transformer and VSB filter using MATLAB/Simulink.
8. Derivation of modulation index in case of FM signal.
9. To design and realize FM generation and Detection.
10. To study & realize Op- amp based Pre-Emphasis & De-Emphasis circuits.
11. Field study/visit to place such as Radio Kashmir Srinagar.

Semester - 6

Course Name: **Advanced Microprocessors and Microcontrollers**, Course Code: **IELEMJAM0624**, Course Type: **Major**

Hours			**Total Credits**	**Maximum Marks**				Time Allowed for Theory Examination
Lecture	Tutorial	Practical		Internal	End Term		**Total**	
					Theory	Lab		
4	0	4	6	30	80	40	**150**	2 ½ Hrs

Course Objective:

1. *To understand basic architecture of 8086 microprocessor*
2. *To understand 8086 instruction set and write programs in assembly language*
3. *To understand interrupt system of 8086 microprocessor*
4. *To study PIC microcontroller family.*

Expected Learning Outcomes:

On completion of this course the students will be able to:

1. *Write programs for 8086 microprocessors.*
2. *Interface memory and I/O devices with 8086 microprocessors.*
3. *Write programs for PIC microcontrollers.*
4. *Design and implement PIC microcontroller-based systems.*

Detailed Syllabus

THEORY (4 Credits):

UNIT-I: Introduction to x86 Microprocessor family (15 HOURS)

Introduction to 8086 Microprocessor, Working and Architecture of 8086, Register organization of 8086 Microprocessor, Addressing Modes and memory segmentation in 8086. Pin Description of

8086. Features and comparison of 80186, 80286, 80386, 80486 and Pentium Processors. Recent trends in microprocessor design.

Unit-II: 8086 Instructions set and Assembly language Programming (15 HOURS)

Instruction set of 8086 Microprocessor: Data transfer instructions, Arithmetic and Logical instructions, Branch Instructions, Processor control instruction, String operation instructions. Assembly language Programming for 8086 microprocessors. Use of Macros and Procedures in ALP.

Unit-III: Interrupts, Timing and Peripheral Devices (15 HOURS)

Interrupts and interrupt service subroutines, 8086 Interrupt Structures, Interrupt Vector table, various types of Interrupts. ALP using interrupts, 8259 Programmable Interrupt Controller, Interfacing & Programming, Architecture and operation of 8284A Clock Generator, Buffering and Latching of 8086 Microprocessor, Bus timings, Timing Diagrams, Wait States, Minimum and Maximum Mode 8086 System, 8288 Bus Controller. 8086 Memory Interfacing.

Unit-IV: PIC Microcontrollers (15 HOURS)

Introduction to PIC Microcontroller families (8/16 and 32 bit), PIC 16F series family overview of architecture and peripherals, Pin diagram and Architecture of PIC16F84/PIC16F84A Microcontroller, Memory organization, configuration, memory addressing, and special function registers, parallel and serial ports, timer and counters, Interrupts, Watchdog Timer. Instruction set of PIC16F84 Microcontroller. Programming of PIC16F84 Microcontroller. Introduction to 18F, 24F and 32F series of PIC microcontrollers.

Recommended Books

1. Introduction to 8086, 80186,80286, 80386, 80486, Pentium and Pentium Pro Processors, B. Bray, TMG
2. Advanced Microprocessors by Daniel Tabak McGraw-Hill.
3. Advanced Microprocessors by A. P. Godse, D. A. Godse Technical Publications.
4. Advanced Microprocessors and Peripherals by K. M. Burchandi, A. K. Ray Tata McGraw Hill Education
5. Designing Embedded Systems with PIC Microcontrollers: Principles and Applications, 2nd Edition, Tim Wilmshurst, Elsevier Publication.
6. Interfacing PIC Microcontrollers Embedded Design by Interactive Simulation by Martin Bates, Elsevier Publication.

PRACTICAL (2 CREDITS: 60 HOURS)

Note: The student is required to attempt at least 10 experiments

Experiments using 8086 Microprocessor:

1. WAP for Arithmetic and logic operations of 8-bit/16-bit and 32- bit numbers.
2. WAP for signed multiplication of 16-bit numbers.
3. WAP to add a series 10-byte array stored in Data Segment.
4. WAP to find square/cube of a given number.
5. WAP to transfer a block of 10 bytes from Data Segment to Extra Segment.
6. WAP to find whether a given number is positive or negative.
7. WAP to Convert a Hex number into Decimal Number.
8. WAP to find whether a given number is Even or Odd.
9. WAP to find whether a given byte is bit wise Palindrome.
10. WAP to find Factorial of a number.
11. WAP to SORT a series of 10 numbers in ascending/ descending order.
12. WAP to find Maximum/Minimum in a given series of 10 numbers.

Experiments using PIC16F84 microcontroller:

13. WAP for Arithmetic and logic operations of 8-bit and 16-bit numbers.
14. WAP for Multiplication and Division.
15. WAP to add a series 10-byte array stored in data memory.
16. WAP to find square/cube of a given number.
17. WAP to find Factorial of a number.
18. WAP to SORT a series of 10 numbers in ascending/ descending order
19. Interfacing of LED with PIC16F84 Microcontroller.
20. Interfacing a Switch with PIC16F84 Microcontroller.
21. Interfacing of both LED and Switch with 16F84 Microcontroller.
22. PIC 16F84 Microcontroller and Seven segment interfacing.
23. WAP to generate a square waveform with PIC16F84 Microcontroller
24. 8-bit ADC Interfacing.
25. PWM signal generation at various frequencies.

Semester - 6

Course Name: **Digital Signal Processing**, Course Code: **IELEMJSP0624**, Course Type: **Major**

Hours			Total Credits	Maximum Marks				Time Allowed for Theory Examination
Lecture	Tutorial	Practical		Internal	End Term Theory	End Term Lab	Total	
4	0	4	6	30	80	40	**150**	2 ½ Hrs

Course Objective:

1. *Introduce the fundamentals of discrete-time signals, including sampling, quantization, and encoding processes.*

2. *Classify and manipulate discrete-time signals and systems, with a focus on Linear Time-Invariant (LTI) systems.*
3. *Explore Fourier and Z transforms for frequency domain analysis of discrete signals.*
4. *Study efficient computation techniques for the Discrete Fourier Transform (DFT) using Fast Fourier Transform (FFT) algorithms.*
5. *Provide foundational knowledge of digital filter design, including IIR and FIR filters, and compare their characteristics.*

Expected Learning Outcomes:

At the end of this course students will demonstrate the ability to:

1. *Describe the A/D conversion process and analyze discrete-time signal classification.*
2. *Apply Fourier and Z transforms for frequency analysis of discrete-time signals.*
3. *Demonstrate understanding of DFT properties and compute DFT efficiently using FFT algorithms.*
4. *Design basic IIR and FIR digital filters and understand their frequency responses.*
5. *Compare the properties and applications of FIR and IIR filters in digital signal processing*

Detailed Syllabus

THEORY (4 Credits):

UNIT-I: Discrete Time Signals and Systems (15 HOURS)

Review of Signals and Discrete Time Systems, A/D Conversion Process: Sampling, Frequency Relationships, Aliasing, Quantization, Encoding, Anti-Aliasing Filter. Classification of Discrete Time Signals, Manipulation of Discrete time signals. Systems: Introduction to LTI systems, Correlation**:** Cross- Correlation and Auto- Correlation, Properties of Auto-Correlation and Cross-correlation.

Unit-II: Discrete Time Signal Transforms (15 HOURS)

Introduction to Fourier Series and Fourier Transform, Frequency Domain Sampling, DTFT, Introduction to DFT, Properties of DFT, Spectrum Analysis using DFT, Efficient Computation of DFT: FFT algorithms, Properties of WN, Radix- 2 FFT algorithms: Decimation in Time and Decimation in Frequency FFT algorithms, Z transform and its properties.

Unit-III: Infinite Impulse Response (IIR) Filter Design (15 HOURS)

Frequency response for rational system functions, Basic structures for IIR systems: Direct Form Structures, Cascade form structures, Parallel form structures, Design of IIR from continuous time filters, IIR filter design by approximation of derivatives, Impulse Invariance method, Bilinear transformation. Design examples of all IIR implementation methods.

Unit-IV: Finite Impulse Response (FIR) Filter Design (15 HOURS)

Linear systems with generalized linear phase; Basic network structures for FIR filters: Direct form structures, Frequency Sampling structures, Cascade Structures, Lattice structures, Symmetric and Asymmetric FIR filters, Design of linear phase FIR filters using Window functions. Comparison of FIR and IIR filters,

Recommended Books

1. Digital Signal Processing, A. V. Oppenheim and R. W. Shafer, Prentice Hall, 1985
2. Introduction to digital Signal Processing, J. G. Proakis and DG Manolakis, Prentice Hall
3. Introduction to Digital Signal Processing, Roman Kue, McGraw Hill Book Co.

PRACTICAL (2 CREDITS: 60 HOURS)

Note: The student is required to attempt at least 10 experiments

1. Generation of basic signals (sine, cosine, square, sawtooth)
2. Sampling and quantization of a signal
3. Demonstration of Aliasing
4. Operations on a signal: Amplitude scaling, Time shifting, Time reversal, Time scaling
5. Signal addition and subtraction, multiplication and division
6. Convolution of two signals
7. Cross-correlation of two signals
8. Auto-correlation of a signal
9. Discrete Fourier Transform (DFT) of a signal and Inverse Discrete Fourier Transform (IDFT)
10. Fast Fourier Transform (FFT) and Inverse FFT
11. Power spectral density calculation
12. Signal filtering using low-pass filter
13. Signal filtering using high-pass filter
14. Study various Window functions
15. Demonstrate Gibbs phenomena using MATAB
16. FIR filter design (using window method)
17. FIR filter design (using frequency sampling method)
18. IIR filter design (Butterworth filter)
19. IIR filter design (Chebyshev filter)
20. IIR filter design (Elliptic filter)

Semester - 7

Course Name: **Electronic Instrumentation**, Course Code: **IELEMJEI0724**, Course Type: **Major**

Hours			**Total Credits**	**Maximum Marks**				Time Allowed for Theory Examination
Lecture	Tutorial	Practical		Internal	End Term		**Total**	
					Theory	Lab		
3	0	2	4	20	60	20	**100**	1 ¾ Hrs

Course Objective:

1. *To introduce students to the use of various electrical/electronic instruments, their construction, applications, principles of operation, standards and units of measurements.*
2. *To expose the students to various types of sensors and their applications.*
3. *To expose the students to various measuring and analyzing instruments.*

Expected Learning Outcomes:

After going through this course, the student shall be able to use different instruments and measure different electrical parameters. Besides, the students shall be able to design sensory systems for measuring different physical parameters.

Detailed Syllabus

THEORY (3 Credits):

UNIT-I: Measurement and Meters (15 HOURS)

Measurement and its Significance, methods of measurement. Basic definitions of instruments, Classification of instruments, Performance parameters: Accuracy, Precision, Sensitivity, Resolution, Errors, Significant figure. D'Arsonval movement: Construction and working, DC ammeter and voltmeter, Ammeter and Voltmeter loading, DC ohmmeters (Series and Shunt type). Rectifier type of instruments (half wave and full wave), Multi range AC voltmeter, Peak to peak AC voltmeter, Single phase wattmeter and single phase watt-hour meter. Digital frequency meters and time meters, Digital Voltmeter: General Characteristics, Ramp type DVM, Staircase ramp DVM, Successive approximation type DVM, Integrating type DVM Digital ohm meter, Digital capacitance meter, Digital modulation index meter, Digital quality factor meter.

Unit-II: Bridges and Sensors (15 HOURS)

Bridges: Types, Condition for Bridge balance. DC Bridges: Wheatstone Bridge, Kelvin double Bridge. AC Bridges: Maxwell Bridge, Hay bridge, Schering Bridge, Wein bridge, Sensors: Classification of sensors, characteristics and choice of sensors; Resistance, Capacitance, Inductive, Piezoelectric, Thermoelectric, Hall effect, Photoelectric, Techogenerators, Measurement of displacement, velocity, acceleration, force, torque, strain, speed, and sound, temperature, pressure, flow, humidity, thickness, pH, position.

Unit-III: Oscilloscope and Signal Analyzers (15 HOURS)

Block diagram of CRO, Electrostatic and electromagnetic focusing (Qualitative), Horizontal and vertical deflection system, Vertical amplifier, Horizontal amplifier, Sweep generators, vertical input and sweep generator, Signal synchronization, Measurement of voltage, Frequency and phase angle. Dual trace Oscilloscope, Dual beam Oscilloscope, Sampling Oscilloscope, Digital Storage Oscilloscope. Function generator, Harmonic distortion analyzer, Wave analyzer, Spectrum Analyzer, Spectrum Analyzer characteristics.

Recommended Books

1. W. D. Cooper, A. D. Helfrick, Modern Electronic Instrumentation and Measurement Techniques, PHI.
2. David E. Bell, Instrumentation.
3. Goldein, Instrumentation
4. T. S. Rathore, Digital Measurement Techniques, Narosa Publishing House, New Delhi.

PRACTICAL (1 CREDITS: 30 HOURS)

Note: The student is required to attempt at least 10 experiments

1. Design of single and multi-range ammeters.
2. Design of single and multi-range voltmeters.
3. Design of single and multi-range ohmmeters.
4. Measurement of Resistance by Wheatstone bridge.
5. Measurement of small resistances using Kelvin double bridge
6. Measurement of Inductance using Maxwell bridge.
7. Measurement of Capacitance using Hay bridge.
8. Measurement of Capacitance using Schering bridge.
9. Measurement of Frequency using Wein bridge,
10. Study of Oscilloscope.
11. Measurement of voltage, Frequency and phase angle using Oscilloscope.
12. Measurement of pressure using Strain gauge.
13. Measurement of Force using Piezo- electric transducer,
14. Measurement of Temperature using Thermistor/Thermocouple.
15. Measurement of Displacement using Linear Variable Differential Transformer (LVDT).

Semester - 7

Course Name: **Embedded Systems and Internet of Things**, Course Code: **IELEMJES0724**, Course Type: **Major**

Hours			Total Credits	Maximum Marks				Time Allowed for Theory Examination
Lecture	Tutorial	Practical		Internal	End Term		Total	
					Theory	Lab		
4	0	4	6	30	80	40	**150**	2 ½ Hrs

Course Objective:

1. *To introduce the Building Blocks of Embedded Systems.*
2. *To Educate in Various Embedded Development Strategies.*
3. *To introduce Basics of Real time operating system.*
4. *To understand the Internet of Things and various technologies and architectures involved in it.*
5. *To understand various platforms and sensors employed in Internet of Things.*

Expected Learning Outcomes:

On completion of this course the students will be able to:

1. *Understand the embedded systems and its applications.*
2. *Design strategy of embedded systems for real time applications.*
3. *Understand the prime aspects of real time embedded system design.*
4. *understand the applications of IoT.*
5. *Realize the internet of things cloud, sensors and various platforms.*
6. *Design real time applications of IoT*

Detailed Syllabus

THEORY (4 Credits):

UNIT-I: Introduction to Embedded Systems (15 HOURS)

Embedded Systems and general-purpose computer systems, Classifications, applications and purpose of embedded systems. Core of Embedded Systems, Application specific ICs, Programmable logic devices, COTS, sensors and actuators, communication interface, embedded firmware, Characteristics and quality attributes of embedded systems: Characteristics, Operational and non-operational quality attributes. Hard and Soft Real time systems, Hardware-software Co-design.

Unit-II: Real Time Embedded Systems (15 HOURS)

Introduction to Real Time Embedded Systems. Real-time operating system for embedded systems., Real time design issues with examples, Hardware considerations (logic states, CPU, Memory, Architectures), Real time building blocks, Real time case studies (Micro C/OSII, RT Linux, VxWorks, Tiny OS).

Unit-III: Introduction to Internet of Things (IoT) (15 HOURS)

IoT fundamentals, IoT Architecture and protocols, Overview of IoT networks, components (Hardware & Software) of IoT, IoT Communication Technologies (3G, 4G & 5G, IEEE 802.15.4, IEEE 802.11), Challenges in IoT. Layering concepts, IoT Services and Standards. Application of IoT.

Unit-IV: IoT Platforms and Cloud Computing (15 HOURS)

Introduction to IoT supported hardware platforms - Arduino, ESP32, Raspberry Pi, Beagle bone and ARM Cortex processors and SparkFun. Operating system for IoT, Cloud Enabling Technologies, Characteristics of Cloud Computing - Benefits of Cloud Computing, Cloud Service Models, Cloud Deployment models, Cloud computing Infrastructure.

Recommended Books

1. Introduction to Embedded Systems, K. V. Shibu Mc. Graw Hills.
2. Embedded Systems, Raj kamal, Tata Mc Graw Hill
3. Embedded Systems, Lyla B. Das, Pearson
4. Internet of Things, Kamlesh Lakhwani, BPB Publications.
5. Internet of Things with Raspberry Pi, Packet Publications.
6. Raspberry Pi, Tyler Goldberg

PRACTICAL (2 CREDITS: 60 HOURS)

Note: The student is required to attempt at least 10 experiments

Embedded System Design Laboratory:

1. Fundamentals of Embedded C, Data-types, variables, logic structures, etc.
2. Use of if-else, loops, nested loops, and conditional statements.
3. Writing Embedded C programs for microcontrollers.
4. Using Timer mode for blinking an LED using polling and interrupt methods (8051 μc).
5. Writing Programs to generate the delays using Timers,
6. Writing Programs for the generation of PWM wave, stepper motor control, LCD interface.
7. Writing the Embedded C code for AVR microcontrollers.

Internet of Things Laboratory:

1. Acquiring familiarization of Arduino, ESP32, Raspberry Pi, etc. and perform necessary installations.
2. Blinking an LED on various platforms.
3. To interface the various sensors on Node MCU.
4. To interface various types of sensors (DHT11/DHT22, LDR, Rain Sensor, Particulate sensor, Pressure Sensor) with Arduino and Raspberry Pi.
5. To collect the data from various sensor and integrate with cloud (ThingSpeak cloud/etc.) for data analytics using node RED.
6. To install the SQL database on Raspberry Pi and perform basic SQL queries.
7. Configuration of Arduino and Raspberry Pi to subscribe to MQTT broker for various topics.
8. To configure Raspberry Pi as DHCP Server.

Semester - 7

Course Name: **Communication Electronics – II**, Course Code: **IELEMJCE0724**, Course Type: **Major**

Hours			**Total Credits**	**Maximum Marks**				Time Allowed for Theory Examination
					End Term		**Total**	
Lecture	Tutorial	Practical		Internal	Theory	Lab		
4	0	4	6	30	80	40	**150**	2 ½ Hrs

Course Objective:

1. *To learn the basic concepts of information theory and coding.*
2. *To understand the building blocks of digital communication system.*
3. *To prepare mathematical background for communication signal analysis.*
4. *To understand spread spectrum modulation techniques.*

Expected Learning Outcomes:

At the end of this course students will be able to demonstrate:

1. *Understand basic science of information theory and its applications*
2. *Design and implement base band transmission schemes*
3. *Design and implement band pass signalling schemes*
4. *Analyze the spectral characteristics of band pass signalling schemes and their noise performance*
5. *Design error control coding schemes*
6. *Understand Spread spectrum modulation schemes*
7. *Understand basic concepts of Computer Communications*

Detailed Syllabus

THEORY (4 Credits):

UNIT-I: Information Theory (15 HOURS)

Introduction to Information Theory, Measure of information, Information content of Messages, Information Inequalities; Discrete Memoryless source, Information, Entropy, Mutual Information — Discrete Memoryless channels — Binary Symmetric Channel, Channel Capacity — Hartley — Shannon law — Source coding theorem — Shannon — Fano & Huffman codes.

Unit-II: Base Band Transmission & Reception (15 HOURS)

Inter Symbol Interference (ISI), Nyquist criterion for distortion less transmission, Pulse shaping, Correlative coding, Eye pattern, Receiving Filters- Matched Filter, Correlation receiver, Adaptive Equalization.

Unit-III: Band Pass Digital Carrier Modulation and Channel Coding (15 HOURS)

Digital modulation techniques: Generation and Detection of Amplitude Shift Keying (ASK), frequency Shift keying (FSK), Phase Shift Keying, and Differential Phase Shift Keying (PSK and DPSK), base band receiver Optimum Filter, Co-relator, Probability of Error in each Scheme, Error Control Coding: Linear Block codes, (7, 4) Linear Block Coding, matrix representation of linear block codes, Cyclic Codes, polynomial representation (examples).

Unit-IV: Wide Band Digital Communications & Computer Communication (15 HOURS)

Basics of Wide band Systems, Generation of Spreading Codes (PN Codes, Gold Codes), Properties of PN codes, Theory of Spread Spectrum Modulation, Model of Spread Spectrum Digital Communication System, Direct-Sequence Spread Spectrum (DSSS): Processing Gain, Performance and Generation and Detection, Frequency Hopping Spread- Spectrum (FHSS): Generation and Detection, Data Communications: Components, Representations, Data Flow, Networks: Physical Structures, Network Types: LAN, WAN, Switching, Internet.

Recommended Books

1. Digital Communication by Simon Hykin.
2. Digital and Analog Communication by K. Shan Mugam.
3. Digital and Analog Communication by Tomasi.
4. Digital Communications by Bernard Sklar, Pearsons Education.
5. Digital Communications by John G. Proakis McGraw- Hill International Editions.
6. Information Theory Coding and Cryptography by Ranjan Bose, TMH.

PRACTICAL (2 CREDITS: 60 HOURS)

Note: The student is required to attempt at least 10 experiments

1. Study of Entropy using Simulation
2. Plot of Graph between Entropy and Probability
3. Study of Digital Communication Channels
4. Study of Mutual Information
5. Study of Schanon Hartley Theorem.
6. Study of ISI problem using Equalization and Nuquist Criterion
7. Study of Block and Cyclic Codes
8. Study of different digital Modulation Techniques
9. Study of PN Codes
10. Study of Spread Spectrum Modulation System
11. Configuration of Arduino and Raspberry Pi to subscribe to MQTT broker for various topics.
12. To configure Raspberry Pi as DHCP Server.

Semester - 8

Course Name: **Power Electronics & Photonics**, Course Code: **IELEMJPE0824**, Course Type: **Major**

Hours			**Total Credits**	**Maximum Marks**				Time Allowed for Theory Examination
Lecture	Tutorial	Practical		Internal	End Term		**Total**	
					Theory	Lab		
3	0	2	4	20	60	20	**100**	1 ¾ Hrs

Course Objective:

1. *To introduce students to the basic theory of power semiconductor devices and passive components, their practical applications in power electronics.*
2. *To familiarize students to the principle of operation, design and synthesis of different power conversion circuits and their applications.*
3. *To introduce students to the basic theory of photonic devices and their practical applications.*
4. *To familiarize students with the principle of operation of various photonic devices.*

Expected Learning Outcomes:

1. *Explain the characteristics and operating principles of power semiconductor devices such as diodes, transistors, and thyristors.*
2. *Analyze and design basic power electronic circuits, including rectifiers, inverters, and converters, considering efficiency and power losses.*
3. *Explain the operating principle of various photonic devices.*
4. *Demonstrate a comprehensive understanding of the fundamental principles underlying Light-Emitting Diodes (LEDs).*
5. *Explain the operating principles of lasers and other light sources, as well as their applications in communications, sensing, and manufacturing*

Detailed Syllabus

THEORY (3 Credits):

UNIT-I: Introduction to Power Devices and Converters (15 HOURS)

Review of switching characteristics of Power diodes, BJTs, Characteristics of an ideal switch, Types of electronic switches. Thyristor construction and characteristics, Methods of turning ON, Turn-off, effect of high di/dt and dv/dt, Snubber circuits, Gate triggering circuits, Device specifications and ratings, DIAC, TRIAC, Controlled rectifiers, AC voltage controllers, Principle of ON- OFF control, Principle of phase control, Single phase bi- directional controllers with resistive loads, Natural commutation, Impulse commutation, complementary commutation, external pulse commutation, Load side and line side commutation, Series and Parallel combination of SCRs.

Unit-II: DC to DC converters, Inverters and Cyclo-converters (15 HOURS)

Principle of step down and step- up operation, Performance parameters of DC-DC converters, Design of BUCK converters, BOOST converters, BUCK–BOOST converters, Forward converter, Half-Bridge converter and Full Bridge converter. Inverter: Principle of operation, performance parameters, Pulse width modulation techniques, Design of inverters, Single-phase half bridge inverter, Single phase full bridge inverter, Analysis in each case (for resistive and inductive loads), Cyclo-converters: step up and step down, design of single-phase step down Cycloconverters, Power supplies: SMPS, UPS.

Unit-III: Photonics (15 HOURS)

Band structure, Direct and Indirect Transitions, Spontaneous and Stimulated Recombination, P-N junctions: Heterojunctions, Carrier injection and Quasi Fermi energy, LED: Spontaneous emission spectrum - Gaussian approximation. Current - Output Power dependence and Peak Emission wavelength. Surface and Edge emitting LEDs. Efficiency Calculation of LEDs. Emission Intensity Pattern of LEDs. Diode Lasers: Gain, Fabry-Perrot Cavity. Types of semiconductor diode lasers. Noise in semiconductor lasers, Introduction to photo detectors: PIN photo diode, Avalanche Photodiode.

Recommended Books

1. Power Electronics, Circuits, Devices and Applications by M. H. Rashid, PHI
2. Power Electronics by Mohan, Undeland, Robbins, John Wiley and Sons
3. Power Electronics by P. C. Sen, Tata McGraw Hill, Pub. Co
4. Introduction to Thyristors and their Applications, by M. Ramamorty

5. J. Wilson & J.F.B. Hawkes, "Optoelectronics – An Introduction", Prentice Hall, India, 1996
6. P. Bhattacharya, "Semiconductor optoelectronic devices", Second Ed. Pearson Education, Singapore, 2002.

PRACTICAL (1 CREDITS: 30 HOURS)

Note: The student is required to attempt at least 10 experiments

1. Verify switching action of a Power BJT.
2. Study characteristics of MOSFET.
3. Study IV characteristics of SCR.
4. Study IV characteristics of DIAC.
5. Study IV characteristics of TRIAC.
6. Study IV characteristics of UJT.
7. Calculation of Holding and latching currents of SCR.
8. Study various Commutation Techniques.
9. Study Half wave and full wave AC voltage Control.
10. Study Half wave and full wave-controlled rectification.
11. Design of BUCK Converter.
12. Design of BOOST Converter.
13. Design a Buck-Boost converter.
14. Study working of an Inverter with R and RL loads.
15. Study IV characteristics of LED and photodiode.
16. Study of laser diode.
17. Study of PIN diode.

Semester - 8

Course Name: **Control Systems**, Course Code: **IELEMJCS0824**, Course Type: **Major**

Hours			**Total Credits**	**Maximum Marks**				Time Allowed for Theory Examination
					End Term		**Total**	
Lecture	Tutorial	Practical		Internal	Theory	Lab		
4	0	4	6	30	80	40	**150**	2 ½ Hrs

Course Objective:

1. *To learn basics of control systems and to understand the purpose of control systems.*
2. *To analyze the control systems in time and frequency domain and to understand the purpose of control systems.*
3. *To analyze the stability of control systems.*
4. *To acquaint the students with the understanding of modern control theory*

Expected Learning Outcomes:

On completion of this course the students will be able to:

1. *Understand various types of Control Systems and their modelling*
2. *Understand time and frequency analysis of Control Systems*
3. *Analyze and apply the methods of stability to Control Systems*
4. *Perform state variables analysis for any Control Systems.*

Detailed Syllabus

THEORY (4 Credits):

UNIT-I: Introduction to Control (15 HOURS)

Introduction to Systems & Control, Types of control systems, Feedback & its effects, Cascade and feed-forward control, Modeling of systems, Elements of modeling, Transfer function modeling, Block diagram representation, Block diagram reduction and Signal Flow Graph, Transfer function calculation using block diagram algebra and signal flow graph methods.

Unit-II: Time Domain Analysis (15 HOURS)

Time Domain Analysis of Control Systems: Standard test signals, Time response of first order and second control systems, Steady- state and transient response, Time response specifications, S-plane root location & the transient response, Error analysis, Static and dynamic error coefficients, Controllers: Basics of control design, Proportional, PI, PD and PID controllers.

Unit-III: Stability and Frequency Analysis (15 HOURS)

Stability: Conditional and absolute stable systems, Routh- Hurwitz criterion, Closed loop system and stability, Root-locus technique, Introduction to frequency response, Frequency domain analysis: advantages and disadvantages, Frequency domain specifications, Relative stability, Polar plot, Bode plot, Gain margin and Phase margin, Nyquist criterion.

Unit-IV: Introduction to Modern Control Theory (15 HOURS)

State equations, Advantages of state space techniques, State space representation of electrical networks, state transition matrix, state transition equations, state diagrams, Block diagram representation of state equations, state space representation from ordinary differential equations.

Recommended Books

1. Modern Control Engineering by K-Ogata.
2. Automatic Control systems by B. C. Kuo.
3. Analog and Digital Control Systems by Ramakant A. Gayakwad, Leonard Sokoloff, Prentice-Hall, 1988

4. Feedback and Control Systems by Joseph J. DiStefano, Allen R. Stubberud, Ivan J. Williams, McGraw-Hill Education, 2012
5. Linear Control System Analysis & Design by D. Azzo, Houfi.

PRACTICAL (2 CREDITS: 60 HOURS)

Note: The student is required to attempt at least 10 experiments

1. Calculate RC time constant using RC circuit on bread board.
2. Time domain analysis of 1st order system (Impulse and Step Response)
3. Time domain analysis of 2nd order system (Impulse and Step Response)
4. Calculate rise time, peak time, maximum overshoot and settling time of a second order under damped circuit
5. Study PI controller using op-amp on breadboard
6. Study PD controller using op-amp on breadboard
7. Study PID controller using op-amp on breadboard
8. Design and analyze P, PI, PD and PID controllers using MATLAB
9. To study the effect of addition of poles and zeros on Root locus using MATLAB
10. To study frequency response using bode plot in MATLAB
11. To study frequency response using polar plot in MATLAB
12. Study of Gain Margin and Phase Margin using MATLAB.
13. To obtain & study the root locus plot for a given transfer function using MATLAB.
14. To carry out the stability analysis of linear systems using Routh-Hurwitz method using MATLAB
15. To determine the transfer function for the given state space representation using MATLAB.

Semester - 8

Course Name: **Material Sciences and VLSI Technology**, Course Code: **IELEMJMS0824**, Course Type: **Major**

Hours			Total Credits	Maximum Marks				Time Allowed for Theory Examination
Lecture	Tutorial	Practical		Internal	End Term Theory	End Term Lab	**Total**	
4	0	4	6	30	80	40	**150**	2 ½ Hrs

Course Objective:

1. *To make students grasp the basic concepts of various steps involved in the fabrication of an integrated circuit.*
2. *To expose the students to the digital system design.*
3. *To expose the students to the layout and its rules*

Expected Learning Outcomes:

After going through this course, the student will be able to select the process steps for the fabrication of ICs. Besides, the students will get hold on the design strategies of digital ICs.

Detailed Syllabus

THEORY (4 Credits):

UNIT-I: Materials and Their Properties (15 HOURS)

General classification of Materials, An overview of Electrical, Dielectric, Magnetic and Optical properties of materials. Introduction to nanotechnology, Classification of Low Dimensional Materials, Influence of physical dimension on different properties. Emerging materials for future Devices: Graphene, Carbon Nano tubes (CNT), ZnO, SiC etc.

Unit-II: IC Fabrications Steps (15 HOURS)

IC fabrication: Crystal Growth and Wafer Preparation, Epitaxy, Oxidation, Diffusion, Lithography, Etching.

Unit-III: VLSI and Characterization Techniques (15 HOURS)

Isolation Methods, Metallization, Bonding. MOS technology and VLSI, scaling of MOS devices, NMOS and CMOS structures and fabrication. Characterization Techniques: XRD, TEM, SEM, EDX.

Unit-IV: CMOS Design (15 HOURS)

Characteristics of MOS transistors and threshold voltage. Switching characteristics of inverter (Fall Time, Rise Time, Delay Time), Dynamic Characteristics. CMOS Logic Structures (Static and Dynamic Design). Stick diagrams, Layout: Design Rules/Floor planning. Simple Layout Examples.

Recommended Books

1. S. M. Sze, VLSI Technology, Mcgraw Hill Publishing Company.
2. Azeroff and Brophy, Electronic Processes in Semiconductors, McGraw Hill Publishing company.
3. Digital Intended Circuits: A Design Perspective by Jan M. Rabaey
4. CMOS VLSI Design: A Circuits & Systems Perspective by N Weste. D Hams & A. Bannerper.

PRACTICAL (2 CREDITS: 60 HOURS)

Note: The student is required to attempt at least 10 experiments

1. Finding the Electrical, magnetic and optical properties of material.
2. Study about Microwind tool and λ (Lambda) Rules for Layout Generation.
3. Study the temperature dependence of resistivity of a semiconductor using four probe method.
4. Study C-V characteristics of MOSFET.
5. Finding the performance parameters of CMOS inverter.
6. Design of basic and universal gates using static design technique.
7. Design of basic and universal gates using dynamic design technique.
8. Design of combinational logic circuits using static design technique.
9. Design of combinational logic circuits using dynamic design technique.
10. Design of sequential logic circuits using static design technique.
11. Design of sequential logic circuits using dynamic design technique.
12. Design of arithmetic circuits using static design technique.
13. Design of arithmetic logic circuits using dynamic design technique.
14. Learning Layout in simulation tool kit.
15. To determine the transfer function for the given state space representation using MATLAB.

Semester - 8

Course Name: **Research Project**, Course Code: **IELEMJRP0824**, Course Type: **Major**

Hours			**Total Credits**	**Maximum Marks**				Time Allowed for Theory Examination
					End Term			
Lecture	Tutorial	Practical		Internal	Theory	Lab	**Total**	
0	0	24	12	60	0	240	**300**	0

Course Objective:

Upon completion of this course, graduates will be able to:

1. *Formulate and Test Hypotheses: Define research problems, create relevant questions and hypotheses, analyze data, and establish cause-and-effect relationships.*
2. *Design Research Proposals: Problematize issues, synthesize information, and articulate research proposals clearly.*
3. *Develop Data Collection Tools: Create effective tools for data collection aligned with research objectives.*
4. *Apply Research Ethics: Understand and apply ethical practices in research.*
5. *Make Informed Judgments: Critically evaluate evidence and generate solutions to complex, real-life problems.*
6. *Demonstrate Accountability: Take responsibility for outcomes in both individual and team-based research.*

Expected Learning Outcomes:

The graduates should be able to demonstrate:

1. *A keen sense of observation, enquiry, and capability for asking relevant/ appropriate questions,*
2. *The ability to problematize, synthesize and articulate issues and design research proposals,*
3. *The ability to define problems, formulate appropriate and relevant research questions, formulate hypotheses, test hypotheses using quantitative and qualitative data, establish hypotheses, make inference based on the analysis and interpretation of data, and predict cause-and effect relationships,*
4. *The capacity to develop appropriate tools for data collection,*
5. *The ability to plan, execute and report the results of an experiment or investigation,*
6. *The ability to acquire the understanding of basic research ethics and skills in practicing/doing ethics in the field/ in own research work, regardless of the funding authority or field of study,*
7. *Examine and assess the implications and consequences of emerging developments and issues relating to the chosen fields of study based on empirical evidence.*

The graduates should be able to:

1. *Make judgement in a range of situations by critically reviewing and consolidating evidences,*
2. *Exercise judgement based on evaluation of evidence from a range of sources to generate solutions to complex problems, including real-life problems, associated with the chosen field(s) of learning requiring the exercise of full personal responsibility and accountability for the initiatives undertaken and the outputs/outcomes of own work as well as of the group as a team member.*

PRACTICAL (12 CREDITS: 360 HOURS)

Students are required to take up research projects under the guidance of a faculty member. The students are expected to complete the Research Project in the eighth semester. The research outcomes of their project work may be published in peer-reviewed journals or may be presented in conferences /seminars or may be patented.

Semester - 9

Course Name: **Physics of Semiconductor Devices**, Course Code: **IELEMJSD0924**, Course Type: **Major**

Hours			Total Credits	Maximum Marks				Time Allowed for Theory Examination
Lecture	Tutorial	Practical		Internal	End Term Theory	End Term Lab	Total	
3	0	1	4	20	60	20	**100**	**1 ¾ Hours**

Course Objective:

1. *To establish solid understanding of crystal structure and semiconductor devices.*
2. *To understand the basic physics governing the semiconductors.*

3. *To acquaint the students with the general understanding of analyzing a semiconductor device.*
4. *To analyze BJT, FET and MOSFET for their comparative analysis.*
5. *To study the physics and operation of high frequency devices.*

Expected Learning Outcomes:

After studying the course, the students shall be able to:

1. *Understand the basic physics of semiconductor devices and the basics theory of PN junction.*
2. *Understand the basic theory of Bipolar Junction Transistor.*
3. *Understand the basic theory of Field Effect transistors.*
4. *Understand the basic theory of MOS transistors.*
5. *Understand the basic theory of microwave devices.*
6. *Understand the basic theory of optoelectronic devices.*

Detailed Syllabus

THEORY (3 Credits):

UNIT-I: Solid-state Materials, Crystal Structure and Carrier Transport (15 HOURS)

Introduction to solid-state materials-optical and thermal properties, Crystal Structure: Space lattices, Primitive and Unit Cell, Index system for crystal planes, Separation between the parallel planes of a cubic crystal, Description of Schrodinger wave equation: Physical interpretation of wave function, Kroning Penney Model, K-space diagram, Effective mass, Concept of Hole, Derivation of Density of state functions, Fermi-Dirac Distribution function, Carrier concentration at thermal equilibrium, Carrier transport Equation, Decay of photo excited carriers, carrier lifetime, Hall effect.

Unit-II: Semiconductor Diodes and Bipolar Junction Transistor (15 HOURS)

Semiconductor junctions: Homo and hetero Junction, Abrupt and Graded junction, P-N Junction: depletion region, diffusion, generation-recombination, Current-Voltage characteristics of PN junction, Depletion capacitance, Diffusion capacitance, Junction breakdown phenomenon, Metal-Semiconductor Contacts: equilibrium, idealized metal semiconductor junctions, non-rectifying (ohmic) contacts, Schottky diode, tunneling.

Bipolar junction transistors: transistor action and dependence on device structure, current gain parameters, minority carrier distribution and terminal currents, Eber-Moll model.

Unit-III: Field Effect Transistors, Microwave and Opto Electronic Devices (15 HOURS)

Metal-Oxide-Silicon System: MOS structure, capacitance, oxide and interface charge (charging of traps, tunneling through oxide), MOS Field-Effect Transistor: threshold voltage, derivation of current-voltage characteristics, dependence on device structure.

Small-geometry effects: mobility degradation due to channel and oxide fields, velocity saturation, ballistic transport, hot-electron effects, State-of-the-Art MOS Technology: Fin-FETs.

Microwave Devices: IMPATT-Static and Dynamic Characteristics, Small signal analysis, Transferred Electron Device, Negative differential resistivity, Transferred Electron Model, Modes of operation,

Opto-Electronic Devices: LED: Radiative transition, Emission spectra, Luminous efficiency and LED materials, Solar cell and photodetectors: Ideal conversion efficiency, Fill factor, Equivalent circuit, Voc, Isc and Load resistance, Spectral response. Reverse saturation current in photodetector.

Recommended Books

1. Ben G. Streetman, Solid State Electronic Devices, Prentice Hall of India Ltd, N. Delhi.
2. Donald E. Neaman, Semiconductor Physics and Devices, Basic Principles, McGrawHill Publishing, 3rd Edition, 2003.
3. S. M. Sze, Physics of Semiconductor Devices, Wiley eastern Ltd.
4. Azeroff and Brophy, Electronic Processes in Semiconductors, McGraw Hill Publishing Company.
5. A. S. Grove, Physics and Technology of Semiconductor Devices, John Wiley and Sons, New York.

PRACTICAL (1 CREDITS: 30 HOURS)

Note: The student is required to attempt at least 10 experiments.

Note: The laboratory work shall include minimum 10 experiments on characterization, fabrication, simulation and modelling of devices.

1. Study of Hall Effect.
2. Study of the effect of material parameters on the conductivity of the material.
3. Design a diode in ATLAS TCAD/Synopsis Sentaurus and study its I-V characteristics.
4. Study of depletion and diffusion capacitances of a diode in ATLAS TCAD/Synopsis Sentaurus.
5. Design a Schottky diode in ATLAS TCAD/Synopsis Sentaurus and study its I-V characteristics.
6. Design a BJT in ATLAS TCAD/Synopsis Sentaurus and study its I-V characteristics.
7. Study of the effect of parameters of three regions on the characteristics of BJT.

8.	Design a MOSFET in ATLAS TCAD/Synopsis Sentaurus and study its I-V characteristics.
9.	Study of the effect of parameters of different regions on the characteristics of MOSFET.
10.	Study the characteristics of Nano-MOSFET.
11.	Study the characteristics of IMPATT diode.
12.	Study the characteristics of Gunn diode.
13.	Design a Solar cell in ATLAS TCAD/Synopsis Sentaurus and study its I-V characteristics.
14.	Design a photodetector in ATLAS TCAD/Synopsis Sentaurus and study its I-V characteristics.

Semester - 9

Course Name: **Mini Project**, Course Code: **IELEMJMP0924**, Course Type: **Major**

Hours			**Total Credits**	**Maximum Marks**				Time Allowed for Theory Examination
Lecture	Tutorial	Practical		Internal	End Term		**Total**	
					Theory	Lab		
0	0	8	4	20	0	80	**100**	0 Hrs

Course Objective:

1. *Enable students to apply theoretical concepts to design and develop functional electronic systems*
2. *Cultivate analytical and creative thinking by identifying and solving real world problems using electronics*
3. *Provide hands on experience in circuit design, prototyping, and testing of electronic systems. Foster teamwork, communication, and collaboration skills through group-based project execution.*
4. *Encourage innovation and exploration of emerging technologies in the field of electronics*
5. *Develop skills in technical writing and effective project presentations.*

Expected Learning Outcomes:

1. *Demonstrate the ability to design, implement, and test electronic circuits or systems.*
2. *Apply analytical and creative approaches to solve real world electronics problems.*
3. *Gain in-depth knowledge of specific electronic components, tools, and techniques.*
4. *Exhibit effective teamwork and communication in collaborative project settings.*
5. *Explore and integrate emerging technologies into project design.*
6. *Deliver clear and concise project presentations to an audience.*
7. *Build confidence and skills for future industry or research-oriented projects.*

Detailed Syllabus

PRACTICAL (4 CREDITS: 120 HOURS)

Students are required to take up mini-projects under the guidance of a faculty member. The students are expected to complete the Project in the 9th semester. The research outcomes of their project work may be published in peer-reviewed journals or may be presented in conferences /seminars or may be patented.

Semester - 9

Course Name: **Mobile Communication and Networks**, Course Code: **IELEMJMC0924**, Course Type: **Major**

Hours			Total Credits	Maximum Marks				Time Allowed for Theory Examination
					End Term			
Lecture	Tutorial	Practical		Internal	Theory	Lab	**Total**	
3	0	1	4	20	60	20	**100**	1 ¾ Hrs

Course Objective:

1. *To understand the concept of frequency reuse*
2. *To understand the characteristics of wireless channels*
3. *To know the fundamental limits on the capacity of wireless channels*
4. *To Know more about future mobile networks*

Expected Learning Outcomes:

1. ***Understanding wireless networks**: Students can explain and compare wireless networks, identify issues, and plan networks for specific applications x*
2. ***Understanding cellular networks**: Students can explain the evolution of cellular networks, calculate signal loss, and understand network traffic congestion x*
3. ***Understanding wireless communication technologies**: Students can understand the basics of wireless communication, including different generations of mobile communication technologies x*
4. ***Understanding wireless communication standards and Networks**: Students can understand and compare wireless network standards*

Detailed Syllabus

THEORY (3 Credits):

UNIT-I: Cellular Communication Fundamentals and Architecture (15 HOURS)

Cellular Communication Fundamentals: Cellular system design, Frequency reuse, cell splitting, handover concepts, Co channel and adjacent channel interference, interference reduction. techniques and methods to improve cell coverage, Frequency management and channel assignment. GSM architecture and interfaces, GSM architecture details, GSM subsystems, GSM Logical Channels, Data Encryption in GSM, Mobility Management, Call Flows in GSM.2.5 G Standards: High speed Circuit Switched Data (HSCSD), General Packet Radio Service (GPRS), 2.75 G Standards: EDGE.

Unit-II: Wireless System Planning (15 HOURS)

Spectral efficiency analysis based on calculations for Multiple access technologist, FDMA and CDMA, Comparison of these technologies based on their signal separation techniques, advantages, disadvantages and application areas. Wireless network planning (Link budget and power spectrum calculations. Mobile Radio Propagation: Large Scale Path Loss, Free Space Propagation Model, Reflection, Ground Reflection (Two-Ray) Model, Diffraction, Scattering, Practical Link Budget Design using Path Loss Models, Outdoor Propagation Models, Indoor Propagation Models, Signal Penetration into Buildings. Small Scale Fading and Multipath Propagation.

Unit-III: Wireless Networks and Equalization (15 HOURS)

Equalization, Diversity: Equalizers in a communications receiver, Algorithms for adaptive equalization, diversity techniques, space, polarization, frequency diversity, Interleaving. Module 5: Code Division Multiple Access. Higher Generation Cellular Standards:3G Standards: evolved EDGE, enhancements in 4G standard, Architecture and representative protocols, call flow for LTE, VoLTE, UMTS, introduction to 5G.

Recommended Books

1. V.K.Garg, J.E.Wilkes, "Principle and Application of GSM", Pearson Education, 5th edition, 2008
2. V.K.Garg, "IS-95 CDMA & CDMA 2000", Pearson Education, 4th edition, 2009
3. T.S.Rappaport, "Wireless Communications Principles and Practice", 2nd edition, PHI,2002

PRACTICAL (1 CREDITS: 30 HOURS)

Note: The student is required to attempt at least 10 experiments

1. Hand on training on Mobile communications using kits
2. To simulate wireless channels
3. To study BER using different channel models
4. Study of Link and power budgets
5. To study different propagation models
6. To study fading
7. To study diversity
8. To Study equalizers
9. To study polarization
10. To study signal processing in 5G
11. To study FBMC and NOMA
12. To study various 4G and 5G standards
13. Some communication experiments using LabView

Semester - 9

Course Name: **Industrial Training and Seminar Work**, Course Code: **IELEMJIT0924**, Course Type: **Major**

Hours			Total Credits	Maximum Marks				Time Allowed for Theory Examination
Lecture	Tutorial	Practical		Internal	End Term		Total	
					Theory	Lab		
0	2	4	4	20	40	40	**100**	0

Course Objective:

1. *To get acquainted with the industry system.*
2. *To learn state state-of-the-technologies.*
3. *To learn the art of working as a team.*
4. *Learn the exploration of new jobs.*
5. *To know the contemporary topics of electronics in the modern world.*

Expected Learning Outcomes:

After the completion of the course, the students shall:

1. *Know state-of-the technologies for selecting future endeavors.*
2. *Be able to systematically apply for the jobs in the industries.*
3. *Be able work in a team.*
4. *Be able to select an area for future study of research.*

Detailed Syllabus

THEORY (2 Credits):

Seminar Work (15 HOURS)

The student shall prepare a comprehensive topic on any contemporary technology and present in front of all the faculty members of the department at the end of the semester.

PRACTICAL (2 CREDITS: 60 HOURS)

Industrial Training

The students shall conduct a two-week training/internship in a state-of-the-art industry/institution.

Semester - 9

Course Name: **Neuromorphic Computing**, Course Code: **IELEMJNC0924**, Course Type: **Major Specialization S1 (Elective E1)**

Hours			Total Credits	Maximum Marks			
Lecture	Tutorial	Practical		Internal	End Term	Total	

					Theory	Lab		Time Allowed for Theory Examination
4	0	4	6	30	80	40	**150**	2 ½ Hrs

Course Objective:

1. *To introduce students to the concept and importance of neuromorphic computing.*
2. *To acquaint students with biological inspiration and brain-inspired computational models.*
3. *To familiarize students with key materials and devices used in neuromorphic systems.*
4. *To introduce students to energy-efficient circuit design for neuromorphic applications.*
5. *To introduce students to fundamental algorithms for Spiking Neural Networks (SNNs).*
6. *To acquaint students with applications of neuromorphic computing in AI, robotics, IoT, and sensory systems.*

Expected Learning Outcomes:

After studying the course, the students shall be able to:

1. *Understand and explain the principles and significance of neuromorphic computing.*
2. *Describe the biological inspiration behind neuromorphic computing and basic neuron models such as the Leaky Integrate-and-Fire (LIF) model.*
3. *Identify and assess key materials and devices suitable for neuromorphic computing applications.*
4. *Design basic neuromorphic circuits using CMOS and crossbar architectures with a focus on energy efficiency.*
5. *Apply fundamental SNN algorithms to simple spike-based learning tasks.*
6. *Analyze applications of neuromorphic computing in robotics, AI, and wearable devices, emphasizing real-time and low-power processing benefits.*

Detailed Syllabus

THEORY (4 Credits):

UNIT-I: Introduction to Neuromorphic Computing (15 HOURS)

Overview and Motivation – Neuromorphic Computing, Importance in modern technology and potential impact on computing, Challenges of traditional computing and the Von Neumann bottleneck.

Biological Inspiration and Principles – Basic neuroscience concepts: structure and function of neurons and synapses, Understanding brain-inspired computing models and biological processing, Differences between neuromorphic and conventional computing.

Computational Models – Introduction to neuron models: Leaky Integrate-and-Fire (LIF) model, Hodgkin-Huxley, Spiking Neural Networks (SNNs), Learning in spiking neural networks –

Stochastic computing – Convolutional spiking neural networks – Reservoir computing – Computing with spikes.

Unit-II: Materials and Devices for Neuromorphic Computing (15 HOURS)

Materials for Neuromorphic Systems – Introduction to key materials: phase-change memory (PCM), ferroelectric and spintronic materials, 2D materials, organic materials, and nanowires used in neuromorphic devices.

Neuromorphic Device Basics – Basics of device functionality in brain-inspired computing systems, General introduction to devices capable of spiking behaviour and emulating neuron functions.

Energy Efficiency and Power Optimization – Importance of low-power design in neuromorphic computing, Basic strategies for energy-efficient neuromorphic circuits.

Unit-III: Neuromorphic Circuits and Systems (15 HOURS)

Circuit Design for Neuromorphic Computing – CMOS-based circuit design principles for implementing neuromorphic systems, Crossbar arrays for neuromorphic computation: matrix-vector multiplication.

Integrated Neuromorphic Systems – Overview of neuromorphic chips and hardware architectures – Intel Loihi, IBM TrueNorth.

Unit-IV: Applications of Neuromorphic Computing (15 HOURS)

Applications in AI and Robotics – Neuromorphic computing for robotics and autonomous systems, Role in self-driving cars and real-time sensor data processing. Event-based sensors and neuromorphic sensory systems – Visual, Olfactory, and Gustatory. Neuromorphic computing in IoT and wearable devices.

Recommended Books

1. Sabina Spiga, Abu Sebastian, Damien Querlioz and Bipin Rajendran, Memristive Devices for Brain-Inspired Computing: From Materials, Devices, and Circuits to Applications—Computational Memory, Deep Learning, and Spiking Neural Networks, Elsevier, 2020
2. Min Gu, Yangyundou Wang, Yibo Dong and Haoyi Yu Neuromorphic Photonic Devices and Applications, Elsevier, 2023
3. Farooq A. Khanday, Energy-Efficient Devices and Circuits for Neuromorphic Computing, Elsevier, 2024

4. Neuromorphic Devices for Brain-inspired Computing: Artificial Intelligence, Perception, and Robotics, Qing Wan, Yi Shi, Wiley-VCH 2022.
5. Neuronal Dynamics-From single neurons to networks and models of cognition and beyond, Cambridge University Press in July 2014
6. Elishai Ezra Tsur, Neuromorphic Engineering-The Scientist's, Algorithms Designer's and Computer Architect's Perspectives on Brain-Inspired Computing, CRC Press, 2023.
7. Dennis V. Christensen, 2022 Roadmap on Neuromorphic Computing and Engineering, Neuromorphic Computing and Engineering Journal (IOP publishing), 2022.

PRACTICAL (2 CREDITS: 60 HOURS)

Note: The student is required to attempt at least 10 experiments

To design, simulate, and analyze spiking neurons, synapses, and networks using tools like Python and Cadence.

1. Design Mc Cullock Pitts Neuron model in Cadence/HSPICE/FPGA.
2. Design Axon Hillock circuit in Cadence/HSPICE.
3. Using the Axon Hillock circuit, reason what happens to the membrane potential, Vmem, when a DC input current is injected in the node Vmem itself, and charges up the membrane. Also explain how the spike output Vout of the circuit behaves.
4. Design a FDSOI based single spiking neuron in ATLAS TCAD/Synopsis Sentaurus and study relationship of spiking frequency with different parameters.
5. Design a TFET based single spiking neuron in ATLAS TCAD/Synopsis Sentaurus and study relationship of spiking frequency with different parameters.
6. Analysis of a memristor/RRAM/MTJ based 1T1M crossbar architecture
7. Design and analysis of crossbar arrays for neuromorphic computation in Cadence/HSPICE/FPGA.
8. Design of Spiking Neural Network for image classification using python.
9. Design of Spiking Neural Network for signal classification using python.
10. Design of Spiking Neural Network for image classification on FPGA.
11. Design of Spiking Neural Network for signal classification on FPGA.
12. Design of artificial Visual system for in-sensor computing.
13. Design of artificial Olfactory system for in-sensor computing.
14. Design of artificial Gustatory system for in-sensor computing.

Semester - 9

Course Name: **Embedded System Design with ARM Cortex Microcontrollers**, Course Code: **IELEMJES0924**, Course Type: **Major Specialization S1 (Elective E1)**

Hours			Total Credits	Maximum Marks				Time Allowed for Theory Examination
					End Term			
Lecture	Tutorial	Practical		Internal	Theory	Lab	Total	
4	0	4	6	30	80	40	**150**	2 ½ Hrs

Course Objective:

1. *Understanding of the design methods, tools and flows in developing embedded systems.*

2. *Understand modern embedded processor architectures.*
3. *Learn the advantages of modern ARM Cortex M processors for faster/better design, debug and execution.*
4. *To be able to use modern software frameworks for embedded systems including CMSIS-DSP and CMSIS-RTOS.*

Expected Learning Outcomes:

1. *Articulate key design methods, tools, and development flows for embedded systems.*
2. *Understand modern embedded processor architectures, particularly ARM, and analyze the benefits of ARM Cortex M processors for efficiency and speed.*
3. *Explain the integration of sensors and actuators in embedded systems and evaluate the role of networking in enhancing performance.*
4. *Gain hands-on experience with CMSIS-DSP and CMSIS-RTOS, and develop skills in debugging and optimizing embedded systems.*
5. *Analyze real-world case studies to identify challenges and solutions, and complete a project demonstrating the design and implementation of an embedded system.*
6. *Enhance teamwork skills through group projects focused on embedded system design.*

Detailed Syllabus

THEORY (4 Credits):

UNIT-I: Introduction to ARM (15 HOURS)

A brief history of ARM, evolution, Architecture versions and Thumb ISA, Processor naming and ARM ecosystem, Cortex - M processor family, Advantages of the Cortex -M processors, Applications of the ARM Cortex-M processors, Introduction to Cortex-M3 and Cortex-M4 processors (Processor architecture, Instruction set, Block diagram, Memory system, Interrupt and exception support).

Unit-II: Architecture of Cortex M3 and M4 Processors (15 HOURS)

Programmer's model, Operation modes, Registers, Memory System, features, stack memory, memory requirements, endianness, bit band operations, access permissions and attributes, memory barriers, Low power design and features, low power application development, overview of exceptions and interrupts, exception types and interrupt management, vector table, exception sequence, use of NVIC register, SCB register and other special registers for exception and interrupt control, configuration control and auxiliary control registers. Review of other Cortex M Processor Architectures.

Unit-III: Instruction Set of Cortex M3 and M4 Processors (15 HOURS)

Evolution of ARM ISA, Comparison of the instruction set in ARM Cortex-M Processors, Unified Assembly Language, Addressing modes, Instruction set, Program flow control (branch, conditional branch, conditional execution, and function calls), Multiply accumulate (MAC) instructions, Divide instructions, Memory barrier instructions, Exception-related instructions, Sleep mode-related instructions, Other functions, Introduction to Cortex-M4 processor support for Enhanced DSP instructions, Writing C and Assembly language programs.

Unit-IV: Cortex OS Support and Memory Protection & Floating-Point Operations (15 HOURS)

OS support features, Shadowed stack pointer, SVC and PendSV exception, Context switching, Exclusive accesses and embedded OS, MPU overview, MPU registers (type, control, region number, region base attribute, region base address, alias), Overview of memory barrier configuration, memory management faults, fault handlers, exception handling faults.

Review of floating-point numbers, Cortex M4 floating point unit (FPU), floating point registers, Lazy stacking, interrupt of lazy stacking, Floating point exceptions. Introduction to advanced features of Cortex M3 and M4 processors. Introduction to Debug and trace, Debug architectures, modes and events.

Recommended Books

1. The Definitive Guide to ARM Cortex M3 and Cortex-M4 Processors, Third Edition, Joseph Yiu, Elsevier Publication, 2015.
2. Assembly Language Programming ARM Cortex-M3 by Vincent Mahout Wiley Publication, 2012.
3. Embedded Systems with ARM Cortex-M Microcontrollers in Assembly Language and C, Yifeng Zhu, 2nd Edition, E-Man Press LLC Publication, 2015.
4. ARM Assembly Language Fundamentals and Techniques, William Hohl and Christopher Hinds, CRC Press, 2015.
5. Embedded Systems: Introduction to Arm(r) Cortex -M Microcontrollers: 1, Jonathan W Valvano, 2015.

PRACTICAL (2 CREDITS: 60 HOURS)

Note: The student is required to attempt at least 10 experiments

1. Exploring GPIO lines of LPC1768 and interfacing it with LEDs and blinking it in different fashion.
2. Interface Switch and Relay to LPC1768. If a switch is pressed then the relay would be ON and if another switch is pressed relay would be OFF.
3. Interface 16X2 LCD to LPC1768 and display a string on it.

4. Study UART protocol and perform following experiments in polling mode as well as Interrupt mode. a) Transmit a string of characters on UART; b) Receive a string of characters on UART.
5. Interfacing Seven Segment Display to LPC1768.
6. Write a program to show digital values using on chip ADC.
7. Interfacing TFT display to LPC1768.
8. Implementing ETHERNET protocol using LPC1768.
9. Explore GPIO lines of ARM Cortex M4 and interface Matrix Keypad to it and display key code of the corresponding key pressed.
10. Study I2C protocol and interface I2C based EEPROM to ARM Cortex M4 and write and read a character on EEPROM.
11. Study SPI protocol and interface SPI based EEPROM to ARM Cortex M4 and write and read a character on EEPROM.
12. Write a program to set and display date and time of on chip RTC.
13. Write a program to generate different wave form like square, triangular, Sine wave using DAC.
14. Study CAN protocol and write a program for CAN self-test
15. Write a program to understand watch dog timer.

Semester - 9

Course Name: **Digital Image Processing**, Course Code: **IELEMJIP0924**, Course Type: **Major Specialization S1 (Elective E1)**

Hours			**Total Credits**	**Maximum Marks**				Time Allowed for Theory Examination
Lecture	Tutorial	Practical		Internal	End Term		**Total**	
					Theory	Lab		
4	0	4	6	30	80	40	**150**	2 ½ Hrs

Course Objective:

1. *Introduce digital image fundamentals, including image representation, perception, sampling, and quantization.*
2. *Review matrix theory and image transforms essential for image processing, such as DFT and FFT.*
3. *Explore spatial and frequency domain techniques for enhancing image quality.*
4. *Provide a foundation in image compression, covering both lossless and lossy techniques, with an introduction to JPEG and MPEG standards.*
5. *Familiarize students with Image restoration and Noise models.*

Expected Learning Outcomes:

1. *Understand the principles of image formation, sampling, quantization, and pixel relationships.*
2. *Apply spatial and frequency domain methods for image enhancement.*
3. *Analyze and implement image compression techniques, understanding key concepts like redundancy and fidelity.*
4. *Perform image compression using various lossy and lossless approaches.*

5. *Utilize knowledge of noise models for better Image restoration.*

Detailed Syllabus

THEORY (4 Credits):

UNIT-I: Digital Image Fundamentals (15 HOURS)

Digital image fundamentals: representation - elements of visual perception - simple image formation model – Image sampling and quantization - basic relationships between pixels – imaging geometry. Review of matrix theory results: Row and column ordering. Review of Image transforms: 2D-DFT, FFT.

Unit-II: Image Enhancement (15 HOURS)

Image enhancement: Spatial domain methods: point processing - intensity transformations, histogram processing, image subtraction, image averaging; Spatial filtering- smoothing filters, sharpening filters. Frequency domain methods: low pass filtering, high pass filtering.

Unit-III: Image Restoration (15 HOURS)

Image Degradation/ Restoration Model. Noise models, Spatial and Frequency properties of Noise. Probability density functions, Gaussian Noise, Gamma Noise, Exponential Noise, Salt and Pepper Noise, Uniform Noise, Estimation of noise parameters. Restoration Filters: Order Statistic Filters., Arithmetic and Geometric mean Filters, Max-Min Filter.

Unit-IV: Image Compression (15 HOURS)

Image compression: fundamentals- redundancy: coding, inter pixel, psychovisual, fidelity criteria, Models, Elements of information theory, Error free compression- variable length, bit plane, lossless predictive, Lossy compression-lossy predictive, transform coding. Fundamentals of JPEG and MPEG. Image Compression using MATLAB.

Recommended Books

1. Gonzalez and Woods, “Digital Image Processing”, 2 Ed, Pearson Education, 2002.
2. Anil K. Jain “Fundamentals of Digital Image Processing”, Pearson Education, 2003.
3. Mark Nelson, Jean-Loup Gailly “The Data compression Book” 2 Ed, bpb Publications.
4. Pratt William K.,”Digital Image Processing”, John Wiley & sons
5. M.Sonka,V. Hlavac, R. Boyle, “Image Processing, Analysis and Machine Vision”, Vikas Publishing House.

PRACTICAL (2 CREDITS: 60 HOURS)

Note: The student is required to attempt at least 10 experiments

1. Read and display an image.
2. Implement arithmetic, logical, and geometric operations on images.
3. Implement relationships between pixels.
4. Apply transformations to an image.
5. Image thresholding (binary conversion)
6. Morphological operations (dilation, erosion)
7. Perform contrast stretching on a low-contrast image.
8. Compute and display the histogram, and perform histogram equalization.
9. Display bit planes of an image.
10. Compute and display the FFT (1-D & 2-D) of an image.
11. Compute and display the DCT of an image.
12. Calculate the mean, standard deviation, and correlation coefficient of a given image.
13. Apply image smoothing filters (mean and median filtering).
14. Implement image sharpening filters and edge detection using gradient filters.
15. Convert image formats.
16. Implement image compression techniques.
17. Implement image restoration techniques.
18. Apply intensity slicing techniques for image enhancement
19. Implementation of basic image segmentation techniques
20. To fill the region of interest for the image.
21. Noise addition (Gaussian, salt & pepper)
22. Image denoising using filters

Semester - 9

Course Name: **Computational Intelligence and Wireless Communications**, Course Code: **IELEMJCI0924**, Course Type: **Major Specialization S1 (Elective E1)**

Hours			**Total Credits**	**Maximum Marks**				Time Allowed for Theory Examination
Lecture	Tutorial	Practical		Internal	End Term		**Total**	
					Theory	Lab		
4	0	4	6	30	80	40	**150**	2 ½ Hrs

Course Objective:

1. *Improve efficiency: AI can help optimize wireless communication systems in areas such as channel modeling, channel state estimation, beamforming, code book design, and signal processing*
2. *Improve effectiveness: AI can help enhance the overall effectiveness of communication strategies, including in crisis management*
3. *Improve personalization: AI can help improve targeting and personalization*

Expected Learning Outcomes:

1. *Learning to identify when AI techniques can be applied to wireless communications*
2. *Applying AI techniques: Applying basic AI techniques and judging the applicability of more advanced techniques in wireless networks*
3. *Designing intelligent wireless systems: Participating in the design of systems that can learn from experience and act intelligently*

Detailed Syllabus

THEORY (4 Credits):

UNIT-I: Computational Intelligence for Wireless Communications (15 HOURS)

Basics of Computational Intelligence, searching algorithms, Probability basics — Bayes Rule and its Applications — Bayesian Networks — Exact and Approximate Inference in Bayesian Networks — Hidden Markov Models — Forms of Learning — Supervised Learning — Learning Decision Trees — Regression and Classification with Linear Models — Artificial Neural Networks — Nonparametric Models — Support Vector Machines — Statistical Learning — Learning with Complete Data — Learning with Hidden Variables- The EM Algorithm — Reinforcement Learning. Natural language processing-Morphological Analysis-Syntax Analysis-Semantic Analysis-AIl applications — Language Models — Information Retrieval — Information Extraction — Machine Translation — Machine Learning — Symbol-Based — Machine Learning: Connectionist — Machine Learning.

Unit-II: Principles of Wireless Communications (15 HOURS)

The wireless communication environment, modelling of wireless systems, system model for narrowband signals, Rayleigh Fading Wireless channels, baseband model of a wireless systems, BER performance of wireless systems, Diversity in Wireless communications, BER in multi-antenna systems. Channel estimation in wireless systems.

Unit-III: Multiple-Input Multiple-Output Wireless Communications (15 HOURS)

Introduction to MIMO Wireless Communications, MIMO System model, MIMO Zero-forcing (ZF) Receiver, MIMO MMSE Receiver, Singular value Decomposition (SVD) of the MIMO Channel, SVD and MIMO Capacity, OSTBC.

Unit-IV: Wireless System Planning and AI Driven Future Networks (15 HOURS)

Free Space Propagation Model, Ground-Reflection Scenario, Okumura Model, Hatta Model, Log-Normal Shadowing Receiver Noise Computation, Link-Budget Analysis, Signal Estimation and Detection: AL/ML based Parameter estimation, STO and CFO estimation, MIMO/OFDM/OTFS detectors. Spectrum sharing and resource allocation: Resource allocation, Spectrum sharing, Power allocation using reinforcement learning (RL) and deep RL.

Recommended Books

1. Artificial Intelligence for Wireless Communication Systems: Technology and Applications Hardcover – 16 October 2024, Samarendra Nath Sur, Agbotiname Lucky Imoize
2. Wireless Communication with Artificial Intelligence 1st Edition 2022 Softbound by Singal, Anuj, Taylor and Francis Ltd
3. MIMO and Wireless communications by Jaganthan Wiley, 2020

PRACTICAL (2 CREDITS: 60 HOURS)

Note: The student is required to attempt at least 10 experiments

1. Explore the methods of implementing algorithms using artificial intelligence techniques with special applications in wireless communications.
2. Write a program to implement A* Algorithm.
3. Write a program to implement DFS.
4. Write a program to implement BFS.
5. Study of channel estimation in wireless systems.
6. Study of BER in Multi-antenna systems.
7. To develop MIMO model.
8. To study various MIMO receivers like Zero forcing, MMSE.
9. To study SVD for MIMO systems.
10. To study MIMO capacity using SVD.
11. To study OSTBC Receivers.
12. To study Machine learning models for Channel estimation.
13. To study Machine learning models for MIMO Receivers.
14. To study Machine learning models for MIMO Capacity.
15. To study Machine learning models for statistical distribution functions.

Semester - 10

Course Name: **Digital and Analog IC Design**, Course Code: **IELEMJIC1024**, Course Type: **Major**

Hours			**Total Credits**	**Maximum Marks**				Time Allowed for Theory Examination
Lecture	Tutorial	Practical		Internal	End Term		**Total**	
					Theory	Lab		
3	0	1	4	20	60	20	**100**	1 ¾ Hours

Course Objective:

4. *To study the quality metrics of digital design.*
5. *To acquaint the students with various techniques of digital design*
6. *To discuss about the issues of digital IC design and their solutions.*
7. *To acquaint the students with the design of higher order digital systems.*
8. *To acquaint students with the importance and applications of analog and mixed design.*
9. *To make students learn about the fundamentals of analog and mixed CMOS design.*
10. *To acquaint students with the analysis and design of CMOS amplifiers, voltage references and data converters etc.*
11. *To acquaint students with the issues related to the fabrication of analog and mixed ICs.*

Expected Learning Outcomes:

After studying the course, the students shall be able to:

4. *Explain the basics of MOS devices, DC transfer characteristics and tristate inverters.*
5. *Design CMOS inverters with specified noise margin and propagation delay.*
6. *Design and analyze the various logic circuit layouts for both static and dynamic CMOS circuits*
7. *Design combinational and sequential circuits meeting time constraints.*
8. *Design memories with efficient architectures to improve access times, power consumption.*
9. *Design all basic building blocks like sources, sinks, mirrors, up to layout level.*
10. *Comprehend the stability issues of the systems and should be able to design OpAmp fully.*
11. *Design Analog integrated system completely upto tape-out including parasitic effects.*
12. *Identify, formulates, and solves engineering problems in the area of mixed-signal design.*
13. *Understand the different architectures of data converters.*
14. *Use EDA tools like Cadence, HSPICE and other open-source software tools like Ngspice.*

Detailed Syllabus

THEORY (3 Credits):

UNIT-I: CMOS Combinational Logic Design (15 HOURS)

Digital IC: Quality metrics of Digital Design – Trends in IC Technology; Review of MOSFET – Static C-MOS Inverter and its characteristics, CMOS Design Consideration Transistor Sizing, Power Dissipation – Dynamic Design and its issues – Ratioed Logic – Pass Transistor Logic.

Unit-II: CMOS Sequential Logic Design and Implementation Strategies for Digital ICs (15 HOURS)

Static Latches and registrars, Dynamic Latches and Registers, Alternative Register Styles, Pipelining, Memory Classification, Memory Architecture and Building Block, Read only Memories, Read Write Memories, Digital VLSI design methodologies, Stick Diagrams and Layout, Introduction to PLA, PAL, CPLD, FPGA.

Unit-III: CMOS Analog and Mixed Blocks (15 HOURS)

Current Mirrors: The Basic Current Mirror, Cascoding the Current Mirror; Single stage Amplifier: Common Source Amplifier (CSA) with resistance load, diode connected load, current source load, CSA with source degeneration, source follower. Differential Amplifier, Operational Amplifier, Voltage and Current References.

Sample-and-Hold (S/H) Characteristics; Digital-to-Analog Converter (DAC) and Analog-to-Digital Converter (ADC) Specifications; DAC Architectures: R-2R Ladder Network DAC, Cyclic DAC, Pipeline DAC; ADC Architectures: Flash ADC; Two-Step Flash ADC, Pipeline ADC.

Recommended Books

1. J. M. Rabaey, A. Chandrakasan and B. Nikolic: Digital Integrated Circuits- A Design Perspective, 2nd ed., PHI, 2003
2. N.H.E. Weste and K. Eshraghian, Principles of CMOS VLSI Design - a System Perspective, 2nd ed., Pearson Education Asia, 2002
3. D. A. Pucknell and K. Eshraghian, Basic VLSI Design, PHI, 1995
4. R. Jacob Baker, CMOS, Circuit Design, Layout, and Simulation, JOHN WILEY & SONS, 2010.
5. Behzad Razavi, Design of Analog CMOS Integrated Circuits, TMH, 2007.
6. Allen, CMOS Analog Circuit Design, Oxford, 2005.

PRACTICAL (1 CREDITS: 30 HOURS)

Note: The laboratory work shall include minimum 10 practical's.

1. Design and simulate CMOS logic gates using static technique in Cadence/HPICE.
2. Design the layout of CMOS logic gates using static technique in Cadence/HPICE.
3. Design and simulate CMOS logic gates using dynamic technique in Cadence/HPICE.
4. Design the layout of CMOS logic gates using dynamic technique in Cadence/HPICE.
5. Design and simulate CMOS logic gates using ratioed logic technique in Cadence/HPICE.
6. Design and simulate CMOS logic gates using pass transistor logic technique in Cadence/HPICE.
7. Design and simulate SRAM cell and design the layout in Cadence/HPICE.
8. Design and simulate static latches in Cadence/HPICE.
9. Design and simulate basic and cascade current mirror and design the layout in Cadence/HPICE.
10. Design and simulate common source amplifier with different loads and source degeneration design the layout in Cadence/HPICE. Analyze the input impedance, output impedance, gain and bandwidth.

11. Design and simulate common drain amplifier in Cadence/HPICE. Analyze the input impedance, output impedance, gain and bandwidth.
12. Design and simulate common gate amplifier in Cadence/HPICE. Analyze the input impedance, output impedance, gain and bandwidth.
13. Design and simulate differential amplifier and design the layout in Cadence/HPICE. Analyze the input impedance, output impedance, gain and bandwidth.
14. Design and simulate two-stage operational amplifier and design the layout in Cadence/HPICE. Analyze Gain, Bandwidth and CMRR.
15. Design and simulate architectures of DAC.
16. Design and simulate architectures of ADC.

Semester - 10

Course Name: **Nanoelectronics**, Course Code: **IELEMJNA1024**, Course Type: **Major Specialization S2 (Elective E2)**

Hours			**Total Credits**	**Maximum Marks**				Time Allowed for Theory Examination
Lecture	Tutorial	Practical		Internal	End Term		**Total**	
					Theory	Lab		
4	0	4	6	30	80	40	**150**	2 ½ Hours

Course Objective:

1. *To make students learn about the fundamentals of nano-technology.*
2. *To acquaint students with the issues of conventional MOS device at nanoscale.*
3. *To introduce to students the various alternative devices proposed to replace MOSFET at nanoscale.*
4. *To learn the application of the concepts of physics in nano-technology.*
5. *To study the physics of nano-structures and devices.*
6. *To study various alternative techniques for CMOS technology.*
7. *To study the structure, operation, physics and characteristics of various opto-electronic devices.*

Expected Learning Outcomes:

After studying the course, the students shall be able to:

1. *Understand the basic science behind the design and fabrication of nano scale systems.*
2. *Understand and formulate new engineering solutions for current problems and competing technologies for future applications.*
3. *Identify the issues of conventional MOS devices at nanoscale.*
4. *Realize the alternative devices for the replacement of MOSFET at nanoscale.*
5. *Comprehend operation and applications of various opto-electronic devices.*

Detailed Syllabus

THEORY (4 Credits):

UNIT-I: Nanotechnology and Nano-Electronics (15 HOURS)

Introduction to Nanotechnology: size dependant physical properties, Melting point, solid state phase transformations, The Physics of Low-Dimensional Semiconductors: Overview of Schrodinger wave equation, Square quantum well of finite depth, Parabolic and triangular quantum wells, Quantum wires, Quantum dots, Strained layers, band-gap variations-quantum confinement, excitons.

Unit-II: Semiconductor Quantum Nanostructures (15 HOURS)

Hetero-junctions - Modulation-doped heterojunctions, SiGe strained heterostructures; Quantum wells - Modulation-doped quantum well, Multiple quantum wells (MQW), Super-lattices, Electric Field Transport in Nanostructures: Parallel transport, Perpendicular transport, Quantum transport in nanostructures, Transport in Magnetic Fields and the Quantum Hall Effect.

Unit-III: Electronic Devices Based on Nanostructures (15 HOURS)

Introduction, Nano scale MOSFET – MODFETs - Heterojunction bipolar transistors, Resonant Tunnelling Transistor, Hot electron transistors, Single-Electron Transistor, 2D FET, Carbon nanotube (CNT) FET, Organic Field Effect Transistor (OFET), Magnetic Tunnel Junction (MTJ), Spin-FET and silicon nanowire (SiNW) FET. Quantum Dots and Quantum Cellular Automata (QCA).

Unit-IV: Optoelectronic Devices Based on Nanostructures (15 HOURS)

Introduction, Heterostructure semiconductor lasers, Quantum well semiconductor lasers, Vertical cavity surface emitting lasers (VCSELs), Strained quantum well lasers, Quantum dot lasers, Quantum well and superlattice photodetectors, Quantum well modulators.

Recommended Books

1. Hari Singh Nalwa, Encyclopedia of Nanotechnology.
2. J. M. Martínez-Duart, R.J. Martín-Palma and F. Agulló-Rueda, Nanotechnology for Microelectronics and Optoelectronics, Elsevier B.V.
3. Bharat Bhusan, Handbook of Nanotechnology, Springer.
4. A. A. Balandin, K. L. Wang, Handbook of Semiconductor Nanostructures and Nanodevices.

PRACTICAL (2 CREDITS: 60 HOURS)

Note: The laboratory work shall include minimum 10 practicals.

1. Study the Band-diagrams and Density of State (DOS) Function of Bulk Semiconductor for different nano-materials.

2. Study the Band-diagrams and DOS of Quantum Well Structure for different nano-materials.
3. Study the Band-diagrams and DOS of Quantum Wire Structure for different nano-materials.
4. Study the Band-diagrams and DOS of Quantum Dot Structure for different nano-materials.
5. Study of Quantum Hall Effect.
6. Study the I-V characteristics of Resonant Tunnelling FET.
7. Study the I-V characteristics of Single- Electron Transistor.
8. Study the I-V characteristics of CNTFET.
9. Study the I-V characteristics of Organic Field Effect Transistor (OFET).
10. Study the I-V characteristics of silicon nanowire (SiNW) FET.
11. Study the I-V characteristics of HEMT.
12. Study the operation and characteristics of MTJ and Spin-FET.
13. Design logic structures in QCA.
14. Study the efficiency of different solar cells.
15. Study the characteristics of Photodetector.

Semester - 10

Course Name: **Light Weight Cryptography** Course Code: **IELEMJCS1024**, Course Type: **Major Specialization S2 (Elective E2)**

Hours			Total Credits	Maximum Marks				Time Allowed for Theory Examination
					End Term			
Lecture	Tutorial	Practical		Internal	Theory	Lab	**Total**	
4	0	4	6	30	80	40	**150**	2 ½ Hrs

Course Objective:

To introduce students to lightweight cryptographic techniques optimized for IoT devices, emphasizing various algorithms suited for constrained environments. The course will cover the principles, design, and implementation of cryptographic protocols tailored for IoT, including standards emerging from NIST.

Expected Learning Outcomes:

1. *Understand the principles and need for lightweight cryptography in IoT.*
2. *Compare and analyze different lightweight cryptographic algorithms based on suitability for IoT.*
3. *Implement and test lightweight cryptographic protocols for real-world IoT applications.*
4. *Apply standard lightweight encryption, hashing, and authentication protocols in IoT applications.*
5. *Explore future trends and emerging standards in lightweight cryptography, including NIST-recommended protocols.*

Detailed Syllabus

THEORY (4 Credits):

UNIT-I: Introduction to Lightweight Cryptography (15 HOURS)

- Overview of IoT architecture and constraints in IoT devices
- Importance of lightweight cryptography in IoT for resource-limited environments
- Overview of NIST's Lightweight Cryptography Standardization Process
- Introduction to key algorithms and standards: ASCON, PRESENT, and GIFT

Unit-II: Core Lightweight Cryptographic Algorithms (15 HOURS)

- Block Ciphers: PRESENT, GIFT, and LED (Lightweight Encryption Device) - Design principles, encryption modes, and performance metrics, Comparison of security levels and efficiency across IoT applications
- Stream Ciphers: Grain, Trivium, and Spritz - Analysis of lightweight stream ciphers for constrained environments, Security evaluation and application-specific performance
- Authenticated Encryption with Associated Data (AEAD): ASCON, TinyJAMBU, and PHOTON-Beetle - Use of AEAD for secure IoT communications, Evaluating authentication and integrity capabilities

Unit-III: Advanced Lightweight Cryptography (15 HOURS)

- Implementation and benchmarking: microcontroller and hardware-software performance
- Resistance to side-channel and fault attacks in lightweight cryptography
- Exploring other cryptographic protocols: SPARX (lightweight block cipher) and PRINCE
- Practical considerations in deploying lightweight algorithms: energy efficiency, memory footprint, and processing speed.

Unit-IV: Emerging Trends and Standards (15 HOURS)

- Overview of post-quantum security in lightweight cryptography
- Extended functionalities: hashing, eXtendable Output Functions (XOF), and key exchange
- NIST profiles for lightweight cryptography in IoT and constrained applications
- Ethical considerations and best practices for securing IoT devices

Recommended Books

1. Cryptography and Network Security by William Stallings

2. Lightweight Cryptography for Security and Privacy by by Tim Güneysu (Editor), Gregor Leander (Editor), Amir Moradi (Editor)
3. Security and Privacy in Internet of Things (IoTs): Models, Algorithms, and Implementations by Fei Hu
4. NIST Internal Reports on Lightweight Cryptography (IR 8454)

PRACTICAL (2 CREDITS: 60 HOURS)

Note: The student is required to attempt at least 10 experiments

1. To write basic ALP and C programming using Keil µVision IDE for ARM Cortex processors.
2. To demonstrate debug windows with a simple C program using simulation and hardware platforms in Keil µVision IDE.
3. To demonstrate the interfacing of NXP LPC 1768 and LPC 1857 with debug adaptors such as Ulinkme, Ulinkplus, J-link, and Ulinkpro in Keil µVision IDE.
4. To evaluate the performance analysis of a simple blinky program with the Ulinkpro debug adaptor on NXP LPC 1768 and LPC 1857 using Keil µVision IDE.
5. To perform power analysis of a simple C program on NXP LPC 1768 and NXP LPC 1857 using Ulinkplus debug adaptor in combination with Keil µVision IDE.
6. To demonstrate the use of Simplicity Studio software development platform with simple C programs.
7. To demonstrate the interfacing of EFM32PG12 Pearl Gecko and EFR32 Flex Gecko from Silicon Labs with Simplicity Studio.
8. To demonstrate debugging windows and Energy Profiler with simple C programs in Simplicity Studio.
9. To demonstrate the use of power modes in Silicon Labs hardware boards by performing wireless communication between two nodes.
10. To evaluate the use of mbedTLS cryptographic library in Keil µVision IDE and perform encryption/decryption of lightweight cryptographic algorithms using various hardware platforms and debug adaptors.
11. Compare the performance of lightweight hashing algorithms, such as PHOTON and SPONGENT, on an NXP LPC 4300 board. Implement each algorithm and measure execution time and memory usage using ULINKpro in KEIL MDK IDE.
12. Compare the energy consumption of different lightweight cryptographic algorithms, such as PRESENT, GIFT, and ASCON, on the NXP LPC 1768 board.
13. Implement a lightweight AEAD protocol (e.g., TinyJAMBU) for secure communication between two IoT nodes. Program the protocol on two EFR32 Silicon Labs boards and enable data exchange with encryption and authentication.
14. Compare the performance of lightweight stream ciphers (e.g., Trivium and Grain) on the EFM32 Giant Gecko board. Implement both ciphers, and measure speed, memory usage, and energy using the Energy Profiler in Simplicity Studio.
15. Monitor and analyze power consumption for encryption events. Use the Event Recorder on the LPC1857 board to record power usage for encryption and decryption in lightweight protocols like PHOTON-Beetle.

16. Implement TinyJAMBU on a low-power IoT device (e.g., EFM32PG12 Pearl Gecko) to optimize for minimal energy use. Profile power consumption during encryption cycles and compare power savings when encryption is enabled vs. disabled.
17. Implement an authentication mechanism using the ASCON AEAD for secure pairing between IoT devices. Program the authentication protocol on two Nucleo-F401RE boards, using ASCON for data integrity and encryption during device pairing.
18. Compare the performance of lightweight hashing algorithms, such as PHOTON and SPONGENT, on a NXP LPC 1857 board. Implement each algorithm, and measure execution time and memory usage using ULINKpro in KEIL MDK IDE.
19. Measure latency and data throughput of lightweight encryption algorithms (e.g., PRESENT and GIFT-COFB) on EFM32GG Giant Gecko. Encrypt and decrypt data blocks, and measure latency and throughput under different data sizes using Simplicity Studio's Energy Profiler.
20. Compare the execution of a lightweight cipher (e.g., PRESENT) across multiple platforms like LPC1768, Nucleo-F401RE, and EFM32GG. Implement PRESENT on each platform, profile execution time and memory usage, and compare performance across boards.

Semester - 10

Course Name: **Multimedia Signal Coding and Communication**, Course Code: **IELEMJSC1024**, Course Type: **Major Specialization S2 (Elective E2)**

Hours			**Total Credits**	**Maximum Marks**				Time Allowed for Theory Examination
Lecture	Tutorial	Practical		Internal	End Term		**Total**	
					Theory	Lab		
4	0	4	6	30	80	40	**150**	2 ½ Hrs

Course Objective:

1. *Introduce multimedia fundamentals, and various multimedia types.*
2. *Explore color science and color models in image and video processing.*
3. *Understand image compression and its need.*
4. *Explain video compression algorithms and standards.*
5. *Provide a foundation in multimedia communication and security.*

Expected Learning Outcomes:

1. *Describe multimedia concepts and various multimedia types.*
2. *Apply color models and transformations in images and videos.*
3. *Implement basic image compression algorithms for bandwidth reduction and saving memory space.*
4. *Implement basic image and video compression techniques.*
5. *Understand and evaluate video compression standards like MPEG.*

Detailed Syllabus

THEORY (4 Credits):

UNIT-I: Introduction to Multimedia (15 HOURS)

Introduction to Multimedia: Various types of multimedia: Audio, Images, Video, etc. Applications of multimedia in contemporary world. Image Data Types, and File Formats. Binary, Grayscale and Color images, Image formation model., XYZ to RGB Transform, Color Models: RGB, CMY, CMYK. Interconversion of color spaces.

Unit-II: Image Compression (15 HOURS)

Need for multimedia compression, Lossless Compression Algorithms: Run Length Coding, Variable Length Coding, Arithmetic Coding, Lossless JPEG, Image Compression. Lossy Image Compression Algorithms: Transform Coding: KLT and DCT Coding, Wavelet Based Coding. Image Compression Standards: JPEG and JPEG2000.

Unit-III: Video Compression Techniques (15 HOURS)

Introduction to Video Compression, Video Compression Based on Motion Compensation, Search for Motion Vectors, H.261- Intra-Frame and Inter-Frame Coding, Quantization, Encoder and Decoder, Overview of MPEG1 and MPEG2.

Unit-IV: Multimedia Communication (15 HOURS)

Multimedia information representation, multimedia networks, Introduction to multimedia standards. Need for multimedia security. Technologies for multimedia security and authentication: Watermarking and Steganography. Concepts of Payload, Imperceptivity, Payload. Conflict triangle. Subjective and objective evaluation of Multimedia security algorithms.

Recommended Books

1. Fundamentals of Multimedia – Ze- Nian Li, Mark S. Drew, PHI, 2010.
2. Multimedia Signals & Systems – Mrinal Kr. Mandal Springer International Edition 1st Edition, 2009
3. Multimedia Communications, Fred Halsall, Pearson education, 2002
4. Multimedia Communication Systems – Techniques, Stds & Netwroks K.R. Rao, Zorans. Bojkoric, Dragorad A.Milovanovic, 1st Edition, 2002.
5. Fundamentals of Multimedia Ze- Nian Li, Mark S.Drew, Pearson Education (LPE), 1st Edition, 2009.
6. Multimedia Systems, John F. KoegelBufond Pearson Education (LPE), 1st Edition, 2003.

PRACTICAL (2 CREDITS: 60 HOURS)

Note: The student is required to attempt at least 10 experiments

1. Convert an image from RGB to grayscale
2. Convert RGB image to different color spaces (e.g., HSV, CMYK)
3. Perform color balancing on an image
4. Detect and correct white point in images
5. Explore and manipulate image histograms
6. Convert image format (e.g., PNG to JPEG)
7. Compress an image using JPEG standard
8. Compress an image using JPEG2000 standard
9. Analyze image quality after compression (PSNR, SSIM)
10. Resize and scale an image
11. Perform edge detection using Canny and Sobel operators
12. Detect regions of interest in an image
13. Apply spatial filtering to smooth an image
14. Perform histogram equalization
15. Extract color channels from an RGB image
16. Read and play an audio file
17. Display waveform and spectrogram of an audio signal
18. Read and play video file.
19. Extract frames from a video file
20. Apply color transformations on video frames
21. Convert video from RGB to grayscale
22. Create a video from a sequence of images

Semester - 10

Course Name: **Wearable Electronics and Antennas**, Course Code: **IELEMJWE1024**, Course Type: **Major Specialization S2 (Elective E2)**

Hours			Total Credits	Maximum Marks				Time Allowed for Theory Examination
					End Term			
Lecture	Tutorial	Practical		Internal	Theory	Lab	Total	
4	0	4	6	30	80	40	**150**	2 ½ Hrs

Course Objective:

1. *Understand measurement of antenna parameters and application of basic theorems in*
2. *Analyze radiation characteristics of antenna.*
3. *Design and implement antennas using EM simulation tools*

Expected Learning Outcomes:

1. *Demonstrate the structure and operation of various antennas and to describe their parameters.*
2. *Apply basic theorems to analyze the variation of field strength of radiated waves.*
3. *Measure the radiation pattern of wired, aperture, planar, wearable and array antennas.*

4. *Familiar with EM simulation tools to implement antenna prototypes*

Detailed Syllabus

THEORY (4 Credits):

UNIT-I: Radiation and Basic Antennas (15 HOURS)

Source of radiation, Potential functions and the electromagnetic field, the Hertzian dipole, power radiated by the Hertzian dipole, Basic antenna parameters, pattens, beam area, beam efficiency, directivity, gain, antenna efficiency, resolution, Friss transmission formula, Reciprocity theorem, antenna effective length, , antenna arrays

Unit-II: Planer Antennas (15 HOURS)

Printed Antennas, slot antennas, Quasi-Yagi antennas, bow-tie antennas, reflector antennas, horn antennas, dielectric antennas, lens antennas, multiple antennas, advanced antenna materials.

Unit-III: Wearable Antennas (15 HOURS)

Basic Approaches for Printing and Weaving Wearables; Wearable Electronics with Flexible, Transferable, and Remateable Components; Wearable Antennas; Wearable Sensors; Wearable RF Harvesting; Radiofrequency Finger Augmentation Devices for Tactile Internet; Wearable Imaging Technologies; Wearable Wireless Power Transfer Systems.

Unit-IV: Bio-Inspired Wearable Antenna Design (15 HOURS)

Bio-inspired antenna design, Gielis formula, Procedure to design antenna via Gielis formula, Electrical characterization of wearable substrate, Bio-inspired wearable antennas, Wearable monopole antenna bio-inspired in jasmine flower shape, Wearable bio-inspired antennas built in polyamide, some recent innovations in Wearable Antennas.

Recommended Books

1. Paulo Fernandes da Silva Júnior, Alexandre Jean René Serres1 , Raimundo Carlos Silvério Freire , Georgina Karla de Freitas Serres , Edmar Candeia Gurjão , Joabson Nogueira de Carvalho and Ewaldo Eder Carvalho Santanax
2. Kao-Cheng, Huang, David J. Edwards Millimeter wave antennas for Gigabit Wireless Communications: A practical approach guide to design and analysis in a system context, Wiley

PRACTICAL (2 CREDITS: 60 HOURS)

Note: The student is required to attempt at least 10 experiments

1. Study of the structure and operation of wired, aperture, planar and array antennas.
2. Proof of Inverse square law
3. Proof of Reciprocity theorem
4. Measurement of radiation pattern of all wired and aperture antennas
5. Measurement of radiation pattern of planar antennas
6. Measurement of radiation pattern of reflector antennas
7. Measurement of radiation pattern of array antennas
8. Design and simulation of microstrip antenna using HFSS or CST
9. Design and simulation of wearable Antennas
10. Study of optimization tools for wearable antennas
11. Study and design of Bio- Medical antennas
12. Study of SAR analysis of Bio- Medical antennas
13. Study of Metamaterials for Bio-Medical Antennas
14. Study of 3D printing for Bio-Medical Antennas

Semester - 10

Course Name: **Research Project/Internship**, Course Code: **IELEMJRP1024**, Course Type: **Major**

Hours			**Total Credits**	**Maximum Marks**				Time Allowed for Theory Examination
Lecture	Tutorial	Practical		Internal	End Term		**Total**	
					Theory	Lab		
0	0	24	12	60	0	240	**300**	0

Course Objective:

Upon completion of this course, graduates will be able to:

1. *Formulate and Test Hypotheses: Define research problems, create relevant questions and hypotheses, analyze data, and establish cause-and-effect relationships.*
2. *Design Research Proposals: Problematize issues, synthesize information, and articulate research proposals clearly.*
3. *Develop Data Collection Tools: Create effective tools for data collection aligned with research objectives.*
4. *Apply Research Ethics: Understand and apply ethical practices in research.*
5. *Make Informed Judgments: Critically evaluate evidence and generate solutions to complex, real-life problems.*
6. *Demonstrate Accountability: Take responsibility for outcomes in both individual and team-based research.*

Expected Learning Outcomes:

The graduates should be able to demonstrate:

1. *A keen sense of observation, enquiry, and capability for asking relevant/ appropriate questions,*
2. *The ability to problematize, synthesize and articulate issues and design research proposals,*
3. *The ability to define problems, formulate appropriate and relevant research questions, formulate hypotheses, test hypotheses using quantitative and qualitative data, establish hypotheses, make inference based on the analysis and interpretation of data, and predict cause-and effect relationships,*
4. *The capacity to develop appropriate tools for data collection,*
5. *The ability to plan, execute and report the results of an experiment or investigation,*
6. *The ability to acquire the understanding of basic research ethics and skills in practicing/doing ethics in the field/ in own research work, regardless of the funding authority or field of study,*
7. *Examine and assess the implications and consequences of emerging developments and issues relating to the chosen fields of study based on empirical evidence.*

The graduates should be able to:

1. *Make judgement in a range of situations by critically reviewing and consolidating evidences,*
2. *Exercise judgement based on evaluation of evidence from a range of sources to generate solutions to complex problems, including real-life problems, associated with the chosen field(s) of learning requiring the exercise of full personal responsibility and accountability for the initiatives undertaken and the outputs/outcomes of own work as well as of the group as a team member.*

PRACTICAL (12 CREDITS: 360 HOURS)

Students are required to take up research projects under the guidance of a faculty member. The students are expected to complete the Research Project in the 10th semester. The research outcomes of their project work may be published in peer-reviewed journals or may be presented in conferences /seminars or may be patented.

PG Department of ELECTRONICS *and* INSTRUMENTATION TECHNOLOGY

Five-Year Integrated Master's Programme (FYIMP) in Electronics under NEP 2020

Detailed Syllabus (Minor Courses)

Related Discipline Centric Courses (Minor) courses are chosen from any other discipline/subject, intending to seek exposure beyond Electronics subject courses. Ordinarily, all minor courses shall be offered by the related department. In the absence of a university department offering Minor Courses, the Department shall float minor courses/make appropriate arrangements to make these courses available to the students from either Artificial Intelligence or other subjects depending upon relevance and resource availability. Also, the students can take permissible number of minor credits from other universities or institutions or online as permitted under NEP2020.

Semester	Course Type & Credits	Course Code	Course Title	Hours		Credits	Marks		
				Theory	Lab		Internal	End Term	Total
Minor: Artificial Intelligence									
1	Minor *(4+2 Credits)*	IELEMICI0124	Essential Mathematics for AI	4	4	6	30	120	150
2	Minor *(4+2 Credits)*	IELEMIAI0224	Programming for AI	4	4	6	30	120	150
3	Minor *(4+2 Credits)*	IELEMIPY0324	Introduction to AI and Machine Learning	4	4	6	30	120	150
4	Minor *(3+1 Credits)*	IELEMIDS0424	Introduction to Data Analytics	3	2	4	20	80	100
5	Minor *(3+1 Credits)*	IELEMIML0524	Neural Networks and Deep Learning	3	2	4	20	80	100
6	Minor *(3+1 Credits)*	IELEMIAI0624	Robotics and AI	3	2	4	20	80	100
7	Minor *(3+1 Credits)*	IELEMINN0724	Hardware Architectures for AI	3	2	4	20	80	100
8	Minor *(3+1 Credits)*	IELEMIAA0824	AI Ethics and Society	3	2	4	20	80	100

Note: These courses shall be modified/revised with the revision/availability.

Semester - 1

Course Name: **Essential Mathematics for AI**, Course Code: **IELEMICI0124**, Course Type: **Minor**

Hours			**Total Credits**	**Maximum Marks**				Time Allowed for Theory Examination
Lecture	Tutorial	Practical		Internal	End Term		**Total**	
					Theory	Lab		
4	2	0	6	30	80	40	**150**	2 ½ Hrs

Course Objectives:

1. *To provide foundational knowledge in linear algebra, calculus, probability, and statistics essential for Al and machine learning.*
2. *To develop an understanding of mathematical concepts used in optimization, data representation, and model training.*
3. *To equip students with the skills to interpret mathematical models and algorithms in Al applications.*
4. *To build the ability to integrate mathematical tools in practical Al systems for decision-making and predictions.*

Expected Learning Outcomes:

After going through this course, the student shall be able to:

1. *Demonstrate a solid understanding of linear algebra, calculus, and probability as applied to Al and machine learning.*
2. *Apply optimization techniques to train Al models and solve real-world problems.*
3. *Analyze and interpret data using statistical tools and probabilistic reasoning.*
4. *Critically evaluate Al systems using mathematical principles to ensure accuracy and reliability.*

Detailed Syllabus

THEORY (4 Credits):

UNIT-I: Basics of Linear Algebra (15 HOURS)

System of Linear Equations; Vector space and sub- spaces (definition, examples and concepts of basis); Linear mappings; Matrices – PSD Matrices and Kernal Functions; Eigenvalues and Eigenvectors Norms; Inner Product; Orthogonally; Spectral Decomposition; Singular value Decomposition – Algorithms and Methods; Low-rank Approximation; Projection; Principal Component Analysis and Generative Models

Unit-II: Gradient Descent (15 HOURS)

Gradient Descent Mathematics, programming basic optimization problems and their solutions ,Variants of Gradient Descent: Projected, Stochastic, Proximal, Accelerated, Coordinate Descent, Training a Neural Network: Theory, Newton's Method.

Unit-III: Optimization, Probability and Statistics (15 HOURS)

Notion of maxima and minima; Optimization using gradient descent; Constrained Optimization techniques; Convex optimization Algorithms.

Basic concepts of probability: conditional probability, Bayes' theorem, random variables, moments, moment generating functions.

Unit-IV: Distributions (15 HOURS)

Some useful distributions, Joint distribution, conditional distribution, transformations of random variables, covariance, correlation, random sample, statistics, sampling distributions, point estimation, MAP, MLE.

Information Theory: Entropy, cross-entropy, KL divergence, mutual information.

Tutorial: Case Studies (2 CREDITS: 30 HOURS)

Note: The student is required to perform case studies in the relevant domains of the course such as the following:

1. **Principal Component Analysis (PCA) for Dimensionality Reduction**
   Problem: Reduce the dimensions of a high-dimensional dataset while retaining variance.
   Solution: Using linear algebra techniques (eigenvectors/eigenvalues).
   Outcome: Improved computational efficiency in ML algorithms.
2. **Gradient Descent in Neural Network Training**
   Problem: Train a neural network to classify images.
   Solution: Implement gradient descent using calculus to minimize the loss function.
   Outcome: Efficient model convergence and accurate classification.
3. **Bayesian Networks for Medical Diagnosis**
   Problem: Use probabilistic reasoning to predict diseases based on symptoms.
   Solution: Applying Bayes' theorem for conditional probabilities.
   Outcome: Improved accuracy in medical diagnostics.
4. **Logistic Regression for Binary Classification**
   Problem: Predict customer churn in a dataset.

Solution: Use probability distributions and optimization to fit the model.

Outcome: Reliable predictions for customer retention strategies.

5. **Markov Chains in Natural Language Processing (NLP)**

   Problem: Generate text sequences based on given data.

   Solution: Using probability and transition matrices.

   Outcome: Coherent and probabilistic text generation models.

Recommended Books

1. M. P. Deisenroth, A. A. Faisal, C. S. Ong, Mathematics for Machine Learning, Cambridge University Press (1st edition), 2020.
2. S. Axler, Linear Algebra Done Right. Springer International Publishing (3rd edition), 2015.
3. J. Nocedal and S. J. Wright, Numerical Optimization. New York: Springer Science+Business Media, 2006.
4. E. Kreyszig, Advanced Engineering Mathematics, John Wiley and Sons, Inc., U.K. (10th Edition), 2015.
5. R. A. Johnson, I. Miller, and J. E. Freund, "Miller & Freund's Probability and Statistics for Engineers", Prentice Hall PTR, (8th edition), 2011.

Semester - 2

Course Name: **Programming for AI**, Course Code: **IELEMIAI0224**, Course Type: **Minor**

Hours			**Total Credits**	**Maximum Marks**				Time Allowed for Theory Examination
					End Term			
Lecture	Tutorial	Practical		Internal	Theory	Lab	**Total**	
4	0	4	6	30	80	40	**150**	2 ½ Hrs

Course Objectives:

1. *Develop a strong foundation in the basic Python programming language.*
2. *Master object-oriented programming concepts within Python.*
3. *Gain expertise in data analysis using NumPy and Pandas.*
4. *Acquire skills to visualize data effectively using Matplotlib and Seaborn.*
5. *Gain hands-on experience with advanced topics such as design patterns and Python web frameworks.*

Expected Learning Outcomes:

After going through this course, the student shall be able to:

1. *Design, implement, and debug AI algorithms using popular programming languages (e.g. Python).*
2. *Develop AI models using libraries and frameworks like TensorFlow, PyTorch, or Scikit-learn.*
3. *Implement machine learning workflows, including data preprocessing, model training, and evaluation.*

4. *Build intelligent systems for real-world applications such as computer vision, NLP, and robotics.*

Detailed Syllabus

THEORY (4 Credits):

UNIT-I: Basic Python Programming (15 HOURS)

Introduction to Development Environments: Familiarization with Jupyter Notebooks and Python IDEs like PyCharm and Visual Studio Code. Python Basics: Syntax, Variables, Data Types, and Control Structures. Functions and Modules: Defining Functions, Scope, and Importing Modules. Data Structures: Lists, Tuples, Sets, Dictionaries, and Comprehensions. File Handling: Techniques for Reading from and Writing to Files.

Unit-II: OOP and NumPy (15 HOURS)

Introduction to OOP Concepts, Classes and Objects, Attributes and Methods, Constructors (__init__ method), Encapsulation, Inheritance, Polymorphism, Special Methods (like __str__ and __repr__), Class and Static Methods, Property Decorators, Composition vs Inheritance.

NumPy: Understanding arrays, Data Types and Attributes, Array Creation and Properties, Indexing and Slicing, Array Mathematics (Addition, Subtraction, Scalar Multiplication, Division), Aggregation and Statistical Functions, Array Manipulation (Reshape, Concatenate, Split).

Unit-III: Data Operations and Plotting (15 HOURS)

Pandas: Series and DataFrames, Data Importing and Exporting, Data Cleaning and Preparation, Data Manipulation (Indexing, Selection, Filtering), Working with Missing Data, GroupBy Operations, Merging and Joining DataFrames, Reshaping and Pivoting.

Basic Plotting with Matplotlib (Line Graphs, Bar Charts, Histograms, Scatter Plots), Customizing Plots (Colors, Labels, Legends), Advanced Plotting Techniques (Subplots, 3D Plots, Interactive Visualizations), Introduction to Seaborn, Seaborn's Built-In Datasets, Statistical Plotting with Seaborn (Distribution Plots, Categorical Plots, Pair Plots, Heatmaps)

Unit-IV: Advanced Python Programming (15 HOURS)

Iterators and Generators, Decorators, Context Managers, Regular Expressions, Testing and Debugging (using unittest), Virtual Environments, Introduction to Python Web Frameworks (Flask), Design Patterns.

TensorFlow and Keras - TensorFlow Lite: Deploy machine learning systems on IoT device (Arduino Platform and Raspberry Pi based devices) (C/C++, Python)

Recommended Books

1. Downey, A. (2012). Think python. " O'Reilly Media, Inc.".
2. Shaw, Z. A. (2024). Learn Python The Hard Way. Addison-Wesley Professional.
3. Sweigart, A. (2016). Invent your own computer games with python.
4. Barry, P. (2016). Head first Python: A brain-friendly guide. " O'Reilly Media, Inc.".
5. Matthes, E. (2023). Python crash course: A hands-on, project-based introduction to programming.

PRACTICAL (2 CREDITS: 60 HOURS)

Note: The student is required to attempt at least 10 experiments

1. Basic Syntax and Script Writing - Experiment: Write a simple Python script that takes user input, processes it, and outputs a result, such as a script that calculates the area of a circle given its radius.
2. Data Types and Variables - Experiment: Create variables of different data types (integer, float, string, list, tuple, dictionary) and perform basic operations on them, like adding numbers or concatenating/joining strings.
3. Control Flow - Experiment: Write programs that use if, elif, and else statements to make decisions, and use for and while loops to iterate over sequences or repeat actions until a condition is met.
4. Functions and Modules - Experiment: Define functions to perform specific tasks. Also, learn to use Python modules by importing and using functions from the standard library.
5. File Handling - Experiment: Read from and write to files in Python. Create a script that reads a text file and counts the frequency of each word in the file.
6. Error Handling and Exceptions - Experiment: Write a program that handles different types of exceptions, such as handling division by zero or handling file operations when a file does not exist.
7. Classes and Object-Oriented Programming - Experiment: Create a class representing a simple concept, such as a Book with attributes like title and author, and methods to display book info.
8. List Comprehensions and Generators - Experiment: Use list comprehensions to create lists in a single line of code. For example, create a list of squares of the first 10 natural numbers. Also, experiment with generators to generate an infinite sequence.
9. Decorators and Higher-Order Functions - Experiment: Write decorators to modify existing functions, such as a decorator that logs function calls or measures the execution time of functions.
10. Regular Expressions - Experiment: Use regular expressions to perform complex string matching and extraction, such as extracting all email addresses from a large text.
11. Web Scraping - Experiment: Use libraries like BeautifulSoup or Scrapy to scrape data from web pages.

12. Web Development - Experiment: Build a simple web application using a framework like Flask.
13. Database Interaction - Experiment: Connect to a SQL database using sqlite3 or another database library and perform CRUD operations.
14. Data Analysis and Visualization - Experiment: Use pandas and matplotlib to analyze a dataset and create visualizations like histograms and scatter plots.
15. Asynchronous Programming - Experiment: Write asynchronous code using asyncio to perform multiple tasks concurrently.
16. Script Packaging and Distribution - Experiment: Package a Python script and distribute it as a package/installable module.

Semester - 3

Course Name: **Introduction to AI and Machine Learning**, Course Code: **IELEMIPY0324**, Course Type: **Minor**

Hours			Total Credits	Maximum Marks				Time Allowed for Theory Examination
Lecture	Tutorial	Practical		Internal	End Term		Total	
					Theory	Lab		
4	0	4	6	30	80	40	**150**	2 ½ Hrs

Course Objectives:

1. *To provide the foundational understanding of artificial intelligence and machine learning concepts.*
2. *To introduce key algorithms and techniques used in supervised, unsupervised and reinforcement learning.*
3. *To develop problem-solving skills by applying AI and ML methods to real-world challenges.*
4. *Introduce the concept of learning patterns from data and develop a strong theoretical foundation for understanding state of the art Machine Learning algorithms.*

Expected Learning Outcomes:

After going through this course, the student shall be able to:

1. *Design and implement machine learning solutions to classification, regression and clustering problems.*
2. *Evaluate and interpret the results of the different ML techniques.*
3. *Design and implement various machine learning algorithms in a range of Real-world applications.*

Detailed Syllabus

THEORY (4 Credits):

UNIT-I: Foundation of AI and Knowledge representation (15 HOURS)

Defining Artificial Intelligence, Defining AI techniques, Using Predicate Logic and Representing Knowledge as Rules, Representing simple facts in logic, Computable functions and predicates, Procedural vs Declarative knowledge, Logic Programming, Mathematical foundations: Matrix Theory and Statistics for Machine Learning.

Unit-II: Introduction to ML: Fundamentals and Linear regression (15 HOURS)

Idea of Machines learning from data, Classification of problem –Regression and Classification, Supervised and Unsupervised learning.

Linear Regression: Model representation for single variable, Single variable Cost Function, Gradient Decent for Linear Regression, Gradient Decent in practice.

Unit-III: Classification Algorithms (15 HOURS)

Logistic Regression: Classification, Hypothesis Representation, Decision Boundary, Cost function,

Decision Trees: Structure, splitting criteria, overfitting, and pruning; k-Nearest Neighbors (k-NN) algorithm; Support Vector Machines (SVM): Hyperplanes, kernels, and margin maximization

Advanced Optimization, Multi-classification (One vs All), Problem of Overfitting.

Unit-IV: Clustering Algorithms (15 HOURS)

Discussion on clustering algorithms and use-cases cantered around clustering and classification.

K-Means Clustering-Algorithm, applications, and evaluation; Hierarchical Clustering-Agglomerative vs. divisive approaches; Principal Component Analysis (PCA)-Concept and application.

Recommended Books

1. Saroj Kaushik, Artificial Intelligence, Cengage Learning, 1st Edition 2011.
2. Anindita Das Bhattacharjee, "Practical Workbook Artificial Intelligence and Soft Computing for beginners, Shroff Publisher-X team Publisher.
3. Yuxi (Hayden) Liu, "Python Machine Learning by Example", Packet Publishing Limited, 2017.
4. Tom Mitchell, Machine Learning, McGraw Hill, 2017.
5. Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer, 2011.
6. T. Hastie, R. Tibshirani, J. Friedman. The Elements of Statistical Learning, 2e, 2011.

PRACTICAL (2 CREDITS: 60 HOURS)

Note: The student is required to attempt at least 10 experiments

1. Implementation of logical rules in Python.
2. Using any data apply the concept of:

3. Liner regression
4. Gradient decent
5. Logistic regression
6. To add the missing value in any data set.
7. Perform and plot under fitting and overfitting in a data set.
8. Build a linear regression model to predict house prices using a dataset. Evaluate the model using Mean Squared Error (MSE).
9. Implement logistic regression to classify emails as spam or not spam. Visualize the decision boundary and evaluate accuracy.
10. Apply K-Means to cluster customer data based on purchasing behavior.
11. Use the Elbow Method to find the optimal number of clusters.
12. Build a decision tree model to classify iris flower species. Visualize the tree structure and analyze decision rules.
13. Train a random forest model on the MNIST dataset for digit recognition. Compare performance with a single decision tree.
14. Use Support Vector Machines (SVM) to classify two classes in a synthetic dataset. Experiment with different kernels (linear, polynomial, RBF).
15. Perform PCA for dimensionality reduction on a high-dimensional dataset. Visualize data in a reduced 2D or 3D space.
16. Apply Naive Bayes to classify text data (e.g., sentiment analysis on movie reviews) Calculate accuracy, precision, and recall metrics.
17. Perform hierarchical clustering on a dataset of countries based on economic indicators. Visualize the dendrogram and interpret cluster formations.

Semester - 4

Course Name: **Introduction to Data Analytics**, Course Code: **IELEMIPY0324**, Course Type: **Minor**

Hours			**Total Credits**	**Maximum Marks**				Time Allowed for Theory Examination
Lecture	Tutorial	Practical		Internal	End Term		**Total**	
					Theory	Lab		
3	0	1	4	20	60	20	**100**	1 ¾ Hrs

Course Objectives:

1. *Provide you with the knowledge and expertise to become a proficient data scientist.*
2. *Demonstrate an understanding of statistics and machine learning concepts that are vital for data science.*
3. *Produce Python code to statistically analyse a dataset.*
4. *Critically evaluate data visualisations based on their design and use for communicating stories from data.*

Expected Learning Outcomes:

1. *Explain how data is collected, managed and stored for data science;*
2. *Understand the key concepts in data science, including their real-world applications and the toolkit used by data scientists.*

3. *Implement data collection and management scripts using MongoDB.*

Detailed Syllabus

THEORY (3 Credits):

UNIT-I: Introduction to Data Science and Data Analytics (15 HOURS)

Introduction to Data Science, Different Sectors using Data science, Purpose and Components of Python in Data Science.

Data Analytics Process, Knowledge Check, Exploratory Data Analysis (EDA), EDA- Quantitative technique, EDA- Graphical Technique, Data Analytics Conclusion and Predictions.

Unit-II: Feature Generation and Selection in Data Science (15 HOURS)

Feature Generation and Feature Selection (Extracting Meaning from Data)- Motivating application: user (customer) retention- Feature Generation (brainstorming, role of domain expertise, and place for imagination)- Feature Selection algorithms.

Unit-III: Data Visualization and Ethical considerations of data Science (15 HOURS)

Data Visualization- Basic principles, ideas and tools for data visualization, Examples of inspiring (industry) projects- Exercise: create your own visualization of a complex dataset.

Applications of Data Science, Data Science and Ethical Issues- Discussions on privacy, security, ethics- A look back at Data Science- Next-generation data scientists.

Recommended Books

1. Joel Grus, Data Science from Scratch, Shroff Publisher Publisher /O'Reilly Publisher Media
2. Annalyn Ng, Kenneth Soo, Numsense! Data Science for the Layman, Shroff Publisher Publisher
3. Cathy O'Neil and Rachel Schutt. Doing Data Science, Straight Talk from The Frontline. O'Reilly Publisher Media.
4. Jure Leskovek, Anand Rajaraman and Jeffrey Ullman. Mining of Massive Datasets. v2.1, Cambridge University Press.
5. Jake VanderPlas, Python Data Science Handbook, Shroff Publisher Publisher /O'Reilly Publisher Media
6. Philipp Janert, Data Analysis with Open Source Tools, Shroff Publisher Publisher /O'Reilly Publisher Media.

PRACTICAL (1 CREDITS: 30 HOURS)

Note: The student is required to attempt at least 10 experiments

1. Python Environment setup and Essentials.
2. Mathematical computing with Python (NumPy).
3. Scientific Computing with Python (SciPy).
4. Data Manipulation with Pandas.
5. Prediction using Scikit-Learn
6. Data Visualization in python using matplotlib
7. Use Python libraries like Pandas to clean the data (removing duplicates, filling or dropping missing values, converting data types, etc.).
8. Calculate basic summary statistics (mean, median, mode), visualize data distributions, and identify trends or patterns.
9. Create scatter plots, line graphs, or heatmaps to visualize correlations of a dataset containing multiple variables (e.g., product price, customer age, and purchase frequency).
10. Analyze the frequency distribution of each category and visualize it using bar plots of a dataset with categorical variables (e.g., survey responses or product categories).
11. On a dataset with missing values, apply different strategies like imputing missing values using the mean/median, forward filling, or removing rows with missing data.
12. Provide Apply linear regression to predict sales on a dataset with independent variables like advertising budget and product price, and the dependent variable as sales.
13. Apply K-means clustering to group similar data points together (e.g., customer segmentation based on purchasing behavior) in a data set.
14. Apply time series analysis techniques like moving averages, and ARIMA models to forecast future values on stock market data.

Semester - 5

Course Name: **Neural Networks and Deep Learning**, Course Code: **IELEMIML0524**, Course Type: **Minor**

Hours			**Total Credits**	**Maximum Marks**				Time Allowed for Theory Examination
Lecture	Tutorial	Practical		Internal	End Term		**Total**	
					Theory	Lab		
3	0	1	4	20	60	20	**100**	1 ¾ Hrs

Course Objectives:

1. *To strengthen important Mathematical concepts required for Deep learning and neural network.*
2. *To get a detailed insight of advanced algorithms of ML*

Expected Learning Outcomes:

After completion of course, students would be able:

1. *To understand basic concepts of artificial neuron and its working principle.*
2. *To understand different kinds of Neural Networks based on architectures and learning rules.*

3. *To understand the basic concepts of Deep Neural Networks (DNN) and its different kinds with working principle.*
4. *To understand the various parameter tuning and optimization methods.*

Detailed Syllabus

THEORY (3 Credits):

UNIT-I: Introduction to Artificial Neural Networks (15 HOURS)

Introduction: Biological Neuron, Idea of computational units, McCulloch–Pitts unit and Thresholding logic, Linear Perceptron, Perceptron Learning Algorithm, Linear separability, Convergence theorem for Perceptron Learning Algorithm, Type of network architecture, Activation functions, Basic Learning rules.

Feedforward Networks: Multilayer Neural Network, Gradient Descent learning, Back propagation, Empirical Risk Minimization, regularization, Radial Basis Neural Network

Unit-II: Advanced Neural Networks and Deep Learning Models (15 HOURS)

Recurrent Neural Networks: Back propagation through time, Long Short Term Memory, Gated Recurrent Units, Bidirectional LSTMs, Bidirectional RNNs.

Deep Neural Networks: Introduction, Difficulty of training deep neural networks, Greedy layer wise training.

Introduction to Generative models: Restrictive Boltzmann Machines (RBMs), Introduction to MCMC and Gibbs Sampling, gradient computations in RBMs, Deep Boltzmann Machines.

Introduction to Convolutional Neural Networks: LeNet, AlexNet, ZF-Net, VGGNet, GoogLeNet, ResNet, Visualizing Convolutional Neural Networks, Guided Back propagation, Deep Dream, Deep Art, Fooling Convolutional Neural Networks; Auto Encoders; Deep Reinforcement Learning.

Unit-III: Deep Learning Frameworks and Optimization Techniques (15 HOURS)

Deep Learning Tools: Caffe, Theano, Torch.

Parameter Tuning: Newer optimization methods for neural networks (Adagrad, adadelta, rmsprop, adam, NAG), second order methods for training, Saddle point problem in neural networks, Regularization methods (dropout, drop connect, batch normalization).

Recommended Books

1. Goodfellow, I., Bengio,Y., and Courville, A., Deep Learning, MIT Press, 2016.
2. Bishop, C., M., Pattern Recognition and Machine Learning, Springer, 2006.

3. Yegnanarayana, B., Artificial Neural Networks PHI Learning Pvt. Ltd, 2009.
4. Golub, G., H., and Van Loan, C., F., Matrix Computations, JHU Press,2013.
5. Satish Kumar, Neural Networks: A Classroom Approach, Tata McGraw-Hill Education, 2004.

PRACTICAL (1 CREDITS: 30 HOURS)

Note: The student is required to attempt at least 10 experiments

1. Introduction to Kaggle and how it can be used to enhance visibility.
2. Build general features to build a model for text analytics.
3. Build and deploy your own deep neural network on a website using tensor flow.
4. Implement the perceptron learning algorithm for a simple binary classification problem, such as classifying linearly separable data.
5. Train a neural network with multiple layers using backpropagation to solve the XOR problem.
6. Build and train a CNN on a dataset like MNIST for handwritten digit classification.
7. Train a deep neural network with more than 5 hidden layers on the CIFAR-10 dataset, a benchmark for image classification.
8. Compare the performance of ReLU and Sigmoid activation functions in a neural network on a simple classification task.
9. Implement an RNN to predict the next word in a sentence or a character sequence (e.g., predicting text or time-series data).
10. Use a pre-trained CNN model (e.g., VGGNet or ResNet) on a new dataset for a classification task.

Semester - 6

Course Name: **Robotics and AI**, Course Code: **IELEMIAI0624**, Course Type: **Minor**

Hours			**Total Credits**	**Maximum Marks**				Time Allowed for Theory Examination
Lecture	Tutorial	Practical		Internal	End Term		**Total**	
					Theory	Lab		
3	0	1	4	20	60	20	**100**	1 ¾ Hrs

Course Objectives:

1. *Learn key concepts in robotics, including types, kinematics, dynamics, and control systems.*
2. *Integrate Artificial Intelligence and Machine Learning techniques for autonomous decision-making, perception, and control in robots.*
3. *Program embedded platforms (e.g., Arduino, Raspberry Pi) to design and control robotic systems.*
4. *Participate in practical experiments involving robot design, sensor integration, motion control, and AI applications.*
5. *Equip students with skills to design and deploy robotic solutions in diverse fields like automation, healthcare, and service robotics.*

Expected Learning Outcomes:

After completion of course, students would be able to:

1. *Apply kinematics, dynamics, and control systems to various robotic platforms.*
2. *Use PID, state-space, and other control strategies to manage robot motion and behavior.*
3. *Implement AI and ML algorithms for pathfinding, object recognition, and autonomous decision-making in robots.*
4. *Program embedded systems to control actuators, read sensors, and enable robot functionality.*
5. *Build, test, and troubleshoot functional robots with real-time control and decision-making capabilities.*

Detailed Syllabus

THEORY (3 Credits):

UNIT-I: Fundamentals of Robotics (15 HOURS)

Introduction to Robotics -Types of robots: Industrial, autonomous, mobile, and service robots. Key components: Sensors, actuators, controllers. Applications in various industries.

Kinematics and Dynamics - Forward and inverse kinematics for robotic arms (Denavit-Hartenberg notation). Differential drive kinematics for mobile robots. Robot dynamics: Newton-Euler methods, Lagrangian mechanics.

Control Systems for Robots - PID control for velocity, position, and trajectory tracking. Trajectory planning for robotic arms and mobile robots. Motion control algorithms and optimization techniques.

Unit-II: AI and Machine Learning in Robotics (15 HOURS)

Artificial Intelligence in Robotics - Search algorithms: A*, DFS, BFS. Decision-making in robotics: Markov Decision Processes (MDPs), decision trees, and policy search.

Machine Learning for Robotics - Supervised learning: Regression, classification for sensor data analysis. Unsupervised learning: Clustering for object recognition. Reinforcement learning: Q-learning, Deep Q Networks (DQN), applications in robot control.

Computer Vision for Robotics - Image processing: Edge detection, feature extraction. Object recognition: Templates, neural networks, and deep learning. Object tracking: Kalman filtering, optical flow.

Unit-III: Sensors, Actuators, and Advanced Control Techniques (15 HOURS)

Sensors & Actuators - Sensors: Ultrasonic, infrared, IMUs (Inertial Measurement Units), encoders, cameras. Actuators: DC motors, stepper motors, servos, and hydraulic actuators. Sensor fusion: Combining data from multiple sensors for improved accuracy.

Advanced Control Techniques - State-space control methods: Linear Quadratic Regulator (LQR), Model Predictive Control (MPC). Kalman filtering for real-time sensor fusion and state estimation. Simultaneous Localization and Mapping (SLAM): Algorithms like EKF-SLAM, FastSLAM.

Path Planning and Navigation Algorithms: A*, Dijkstra, Rapidly-exploring Random Trees (RRT). Localization techniques: Odometry, beacon-based, vision-based localization.

Recommended Books

1. Introduction to Robotics: Mechanics and Control" by John J. Craig, 5th Edition, Pearson, Published by Pearson (March 4, 2022) © 2018
2. Artificial Intelligence for Robotics: Build intelligent robots using ROS 2, Python, OpenCV, and AI/ML techniques for real-world tasks , Francis X. Govers III, Second Edition, 2024. ISBN13: 9781805124399
3. Learning Robotics using Python: Design, simulate, program, and prototype an autonomous mobile robot using ROS, OpenCV, PCL, and Python , Lentin Joseph, Second Edition, 2018. ISBN-13 : 9781788629973
4. Introduction to Robotics: Analysis, Control, Applications, Saeed B. Niku, 3rd Edition, John Wiley & Sons, 2020, ISBN: 1119527627, 9781119527626
5. Institution of Engineering and Technology; Nathan Ida, 2nd edition (26 March 2020), ISBN: 1785618350, 978-1785618352

PRACTICAL (1 CREDITS: 30 HOURS)

Note: The student is required to attempt at least 10 experiments

1. Build a basic mobile robot with Arduino or Raspberry Pi. Control motors using PWM (Pulse Width Modulation) and read sensor data (e.g., ultrasonic distance sensors).
2. Program forward and inverse kinematics for a 5-DOF robotic arm. Perform pick-and-place tasks using the arm with embedded controllers.
3. Implement PID control to regulate speed and position for a differential drive robot.
4. Interface ultrasonic sensors and IMUs to detect obstacles and measure robot orientation.
5. Implement Q-learning for autonomous robot navigation in a maze or environment.
6. Use Raspberry Pi camera to perform object recognition and tracking using OpenCV.
7. Implement basic SLAM algorithms (e.g., EKF-SLAM) for localization in a map.
8. Use A* algorithm to compute the shortest path for a robot to move through an environment.
9. Interface servos with Arduino to control robot arm movement for manipulation tasks.
10. Implement object tracking using a camera and basic tracking algorithms (e.g., Kalman filter).

11. Combine data from ultrasonic sensors and IMUs using complementary filters or Kalman filters.
12. Program a robot to follow a line using infrared sensors.
13. Use sensor feedback for real-time obstacle avoidance in dynamic environments.
14. Implement reinforcement learning for autonomous decision-making in an environment (e.g., maze solving).
15. Implement a Linear Quadratic Regulator (LQR) or Model Predictive Control (MPC) for autonomous robot control.

Semester - 7

Course Name: **Hardware Architectures for AI**, Course Code: **IELEMINN0724**, Course Type: **Minor**

Hours			**Total Credits**	**Maximum Marks**				Time Allowed for Theory Examination
Lecture	Tutorial	Practical		Internal	End Term		**Total**	
					Theory	Lab		
3	0	1	4	20	60	20	**100**	1 ¾ Hrs

Course Objectives:

1. *To explore the key components of Al hardware architectures, including processors and memory systems.*
2. *To analyze the architecture and programming models for parallel processing in Al hardware.*
3. *To explore specialized Al hardware accelerators such as TPUs, FPGAs, and ASICS.*
4. *To understand how these accelerators are designed and optimized for Al workloads.*
5. *To learn about the challenges of energy efficiency and optimization in Al hardware systems.*
6. *To explore techniques and strategies for improving the performance-to-power ratio in Al accelerators.*

Expected Learning Outcomes:

After completion of course, students would be able:

1. *Understand the basic concepts behind hardware systems used for Al workloads.*
2. *Identify different hardware components used in Al accelerators.*
3. *Be able to describe various parallel processing architectures for Al.*
4. *Understand the architecture and design principles of TPUs, FPGAs, and ASICS.*
5. *Design a basic Al workload on an FPGA/ASIC for optimization.*
6. *To explore techniques and strategies for improving the performance-to-power ratio in Al accelerators.*

Detailed Syllabus

THEORY (3 Credits):

UNIT-I: Introduction to Al Hardware Architectures (15 HOURS)

Overview of Al hardware requirements and challenges, Traditional processor architectures (CPUs, GPUs, and memory hierarchies), Al specific hardware accelerators: GPUs, TPUs, and FPGAs, Memory architecture for Al On chip vs. off chip memory, Introduction to parallel computing concepts, Data and model parallelism in Al, Hardware architectures for parallel processing SIMD, MIMD, and SPMD, Multi-core processing and GPU computing, CUDA programming

Unit-II: Specialized Al Accelerators (TPUs, FPGAs, and ASICs) (15 HOURS)

Tensor Processing Units (TPUs): Architecture and use cases in Al; Field Programmable Gate Arrays (FPGAs) in Al. Design and applications; Application Specific Integrated Circuits (ASICs) for Al; Trade-offs between GPUs, TPUs, FPGAs, and ASICs, Deep learning on FPGAs, Embedded System, Edge Devices (smartphones), ASIC, CPUs and manycore processor.

Unit-III: Memory, Optimization and Energy-Efficiency in Al Hardware (15 HOURS)

Memory-efficiency and reliability of DNN accelerators: Model size aware Pruning of DNNs, Hardware architecture-aware pruning of DNNs.

Memory related tradeoffs in DNN accelerators: Comparison of memory technologies (SRAM, DRAM, DRAM, STT RAM, PCM, Flash) and their suitability for designing memory elements in DNN accelerator, Neural branch.

Power consumption and performance trade-offs in Al hardware, Hardware optimization techniques for deep learning, Energy efficient Al hardware design, Power-aware computation for Al models.

Recommended Books

1. Hennessy, J. L. ,& Patterson, D. A., Computer Architecture: A quantitative approach (Sixth Edition), Elsevier https://www.google.co.in/books/edition/Computer_Architecture/cM8mDwAAQBAJ, 2017.
2. Brandon Reagen, Robert Adolf, Paul Whatmough, Gu-Yeon Wei, and David Brooks Deep Learning for Computer Architects Synthesis Lectures on Computer Architecture, August 2017, Vol. 12, No. 4, Pages 1-123, (https://doi.org/10.2200/S00783ED1V01Y201706CAC041).
3. Tor M. Aamodt, Wilson Wai Lun Fung, and Timothy G. Rogers General- Purpose Graphics Processor Architectures, Synthesis Lectures on Computer Architecture, May 2018, Vol. 13, No. 2 , Pages 1-140 (https://doi.org/10.2200/S00848ED1V01Y201804CAC044).
4. Goodfellow, I., Bengio, Y., Courville, A., & Bengio, Y. (2016). Deeplearning (Vol. 1, No. 2). Cambridge: MIT press.
5. Energy-Efficient Computing and Electronics by Kennesaw et al.
6. Energy efficiency in Neural Networks and Deep Learning by various authors.

PRACTICAL (1 CREDITS: 30 HOURS)

Note: The student is required to attempt at least 10 experiments

1. Implement a simple neural network model and compare the execution time and performance on CPU and GPU.
2. Write a simple Al application and implement it on an FPGA to understand hardware acceleration.
3. Train a neural network on both a single core processor and multi-core processor to compare execution time.
4. Implement a basic matrix multiplication algorithm using CUDA and optimize for performance.
5. Implement a simple Al inference model (e.g., linear regression) on an FPGA.
6. Set up and run a deep learning model on Google Cloud TPU and compare results with GPUs.
7. Measure and analyze the energy consumption of a neural network model on different hardware platforms (CPU, GPU, FPGA).
8. Implement optimization algorithms like pruning, quantization, and low-precision computing on neural networks for energy efficiency.

Semester - 8

Course Name: **AI Ethics and Society**, Course Code: **IELEMIAA0824**, Course Type: **Minor**

Hours			**Total Credits**	**Maximum Marks**				Time Allowed for Theory Examination
Lecture	Tutorial	Practical		Internal	End Term		**Total**	
					Theory	Lab		
3	1	0	4	20	60	20	**100**	1 ¾ Hrs

Course Objectives:

1. *Understand ethical principles and their application in AI*
2. *Analyze the societal impacts of AI systems and their deployment*
3. *Identify and critically evaluate biases and discrimination in AI algorithms.*
4. *Explore governance and regulatory frameworks for ethical AI.*
   Engage in ethical decision making through case studies.

Expected Learning Outcomes:

After completion of course, students would be able:

1. *Apply ethical frameworks to evaluate AI technologies.*
2. *Demonstrate awareness of AI's societal implications and advocate for equitable practices.*
3. *Assess the role of policies in shaping ethical AI systems.*
4. *Propose solutions to mitigate ethical concerns in AI design and implementation.*
5. *Effectively communicate ethical issues in AI through critical analysts.*

Detailed Syllabus

THEORY (3 Credits):

UNIT-I: Introduction to AI and Ethics (15 HOURS)

Overview of AI technology and its applications, Ethical frameworks and their relevance in AI development; Key Ethical Principles in AI- Transparency, fairness, accountability and privacy; Bias and discrimination in AI systems; Fairness and the Assessment tools, AI/ML techniques for Bias Mitigation.

Unit-II: Impacts of Al on Society and Critical Domains (15 HOURS)

Impact of Al on Employment, economic inequality, and societal disruption; Role of AI in Misinformation, surveillance, and personal freedoms; AI in Critical Domains- Healthcare, law enforcement, education, and military applications; Ethical concerns in autonomous systems and robotics.

Unit-III: AI Ethics in Policy, Regulation and Governance (15 HOURS)

Current AI governance frameworks; National and international policies addressing AI ethics;

Role of AI in shaping society and humanity; emerging ethical challenges in AI advancements.

Recommended Books

1. Artificial Intelligence: A guide to Intelligent systems by Micheal Negnevitsky.
2. The Ethical Algorithm: The science of socially aware algorithm design by Micheal Kearns and Aaron Roth.
3. Ethics of Artificial Intelligence and Robotics by Vincent C. Muller.
4. The IEEE global initiative on ethics of autonomous and intelligent systems by IEEE
5. Fairness and abstraction in sociotechnical systems by Selbst et al.

Tutorial: Case Studies (1 CREDITS: 15 HOURS)

Note: The student is required to perform case studies in the relevant domains of the course such as the following:

1. Analysis of real-world challenges in AI development.
2. Lessons learned from ethical challenges in AI development.
3. The role of AI in achieving SDGs (UN Report).
4. AI for Humanity and Ethics (European Commission)

PG Department of **ELECTRONICS** *and* **INSTRUMENTATION TECHNOLOGY**

Five-Year Integrated Master's Programme (FYIMP) in Electronics under NEP 2020

Detailed Syllabus (**Skill Enhancement Courses**)

Skill Enhancement Courses provide the opportunity and knowledge to develop and strengthen the necessary skills to gain, maintain, and advance in a chosen area. The conditions to opt for these courses in the first three semesters shall be that no course will be repeated and the student should have neither studied any of the opted courses (subjects) under this category at the +2 level nor has s/he taken any of these subjects as a major or minor at the undergraduate level. These courses are preferably aligned to major or minor subjects. Students can choose these courses from either parent or related departments. The department will offer the following courses to the enrolled students and students of allied departments.

Semester	**Course Type & Credits**	**Course Code**	**Course Title**	**Hours**		**Credits**	**Marks**		
				Theory	**Lab**		**Internal**	**End Term**	**Total**
1	SECs *(2+2 Credits)* SECs **Vertical - 1**	CEL122S	Consumer Electronics (Home Appliances) (2024)	2	4	4	20	80	100
2		CEL222S	Consumer Electronics (Office Appliance) (2024)	2	4	4	20	80	100
3		CEL322S	Consumer Electronics (Communication Appliances) (2024)	2	4	4	20	80	100
1	SECs *(2+2 Credits)* **Vertical - 2**	SRS122S	Surveillance Systems (DTH, Set-Top Box Installation and Service Techniques) (2024)	2	4	4	20	80	100
2		SRS222S	Surveillance Systems (Electronic Security) (2024)	2	4	4	20	80	100

3		SRS322S	Surveillance Systems (Installation Repair & Maintenance of IPABX and CCTV System) (2024)	2	4	4	20	80	100
1	SECs (2+2 Credits) **Vertical - 3**	RME122S	Repair and Maintenance of Electronic Appliances (Electrical Circuits and Networking Skills) (2024)	2	4	4	20	80	100
2		RME222S	Repair and Maintenance of Electronic Appliances (Repair and Maintenance of Power Supplies, Inverters and UPS) (2024)	2	4	4	20	80	100
3		RME322S	Repair and Maintenance of Electronic Appliances (Repair and Maintenance of Mobile Phones) (2024)	2	4	4	20	80	100

Note: These courses shall be modified/revised with the revision/availability.

Semester - 1

Course Name: **Consumer Electronics (Home Appliances) (2024)**, Course Code: **CEL122S,** Course Type: **SEC**

Hours			**Total Credits**	**Maximum Marks**				Time Allowed for Theory Examination
Lecture	Tutorial	Practical		Internal	End Term		**Total**	
					Theory	Lab		
2	0	4	4	20	40	40	**100**	1 ¼ Hrs

Course Objectives:

To train and develop professional skills for interaction, installation, problem diagnosis and rectification of minor and major malfunctioning of the air conditioner, refrigerator, washing machine and water purifier at customer's site or at factory/workshop.

Expected Learning Outcomes:

After going through this course, the student shall be able to:

1. *Develop the interactive and professional skills.*
2. *Identification of proper location for the appliances.*
3. *Installation and checking of accessories.*
4. *Checking appliance functioning.*
5. *Understand the symptoms and faults.*
6. *Repair and replacement of dysfunctional parts and check functionality.*

Detailed Syllabus

THEORY (2 Credits):

UNIT-I: Refrigerator (15 HOURS)

Refrigeration cycle, types of compressors, functioning of various electromechanical parts of the refrigerator, Air Conditioner: types, features and functions of various electromechanical parts, frequently occurring faults, Induction cook top: Working principle of Induction cook top.

Unit-II: Washing Machines (15 HOURS)

Working principle of washing machines, Microwave oven: Functioning and Block diagram of microwave oven, Vacuum cleaner: Block diagram and working principle, parts of Vacuum cleaner.

PRACTICAL (2 CREDITS: 60 HOURS)

Laboratory Component - I

Studying the parts, control circuits and sensors of refrigerators, Troubleshoot and rectifying the faults; studying various controls used in Air-conditioning system, fault Identification and rectification, studying various parts, wiring, and electronic circuits in induction cook top, fault Identification and rectification.

Laboratory Component - II

Studying the parts, control circuits and sensors of washing machines, Troubleshoot and rectifying the faults, studying various parts, wiring and control mechanism of Microwaves, fault Identification and rectification, Identification of various parts, wiring, and electronic circuits in Vacuum cleaner, fault Identification and rectification.

Recommended Books

1. Bali S.P. Consumer Electronics, Pearson Education India, 2010 , latest edition.
2. R.S. Khandpur, Troubleshooting Electronic Equipment: Includes Repair and Maintenance, Second Edition, McGraw Hill Education (India) Private Limited.
3. Lal A. K, Trouble Shooting and Maintenance of Electronics Equipment, McGraw Hill Education.
4. Eric Kleinert, Troubleshooting and Repairing Major Appliances, McGraw Hill

Semester - 2

Course Name: **Consumer Electronics (Office Appliances) (2024)**, Course Code: **CEL222S**, Course Type: **SEC**

Hours			Total Credits	Maximum Marks				Time Allowed for Theory Examination
					End Term			
Lecture	Tutorial	Practical		Internal	Theory	Lab	**Total**	
2	0	4	4	20	40	40	**100**	1 ¼ Hrs

Course Objectives:

To train and develop professional skills for interaction, installation, problem diagnosis and rectification of minor and major malfunctioning of the air conditioner, refrigerator, washing machine and water purifier at customer's site or at factory/workshop.

Expected Learning Outcomes:

After going through this course, the student shall be able to:

1. *Develop the interactive and professional skills.*
2. *Identification of proper location for the appliances.*
3. *Installation and checking of accessories.*
4. *Checking appliance functioning.*
5. *Understand the symptoms and faults.*
6. *Repair and replacement of dysfunctional parts and check functionality.*

Detailed Syllabus

THEORY (4 Credits):

UNIT-I: Theory Component - I (15 HOURS)

Printers: types, working Principle and operation- Thermal, Inkjet Printer and Laser Printers, Different Parts: Printer Cartridges, toner, drum, their use and replacement , Principle of Operation of Photocopier, Paper feed mechanism and the sensors used for paper movement, Thermal unit and Toner Unit, sensors used in the copier and their fixtures.

Unit-II: Theory Component - II (15 HOURS)

Troubleshoot the fault in the given SMPS unit, rectify the defect and verify the output with load, Troubleshoot the fault in the given inverter unit, rectify the defects and verify the output with load. Testing of the paper sensor, print head coils, home position sensor, print head needle coil & cleaning of ribbon mask, paper feed motor gears, printer head movement gears & print head guide, identification & use of controls/ switches/ sockets of a Laser printer. Identify the faults & rectify.

PRACTICAL (2 CREDITS: 60 HOURS)

Laboratory Component:

Visiting factory, workshop and customer's site, counseling and dealing with the customer, site checking, installation and assembling of parts, functional testing, fault identification and repair/remedy thereof at customer and workshop/factory sites. Studying the parts, control circuits and sensors of washing machines, Troubleshoot and rectifying the faults, Studying various parts, wiring and control mechanism of Microwaves, fault Identification and rectification, Identification of various parts, wiring, and electronic circuits in Vacuum cleaner, fault Identification and rectification.

On Job Training

Visiting hospitals, workshop; medical imaging equipment checking, installation and assembling of parts, functional testing, fault identification and repair/remedy thereof at workshop sites.

Recommended Books

1. Stephen Bigelow, Easy Laser Printer Maintenance and Repair, Windcrest McGraw Hill Inc
2. Stephen J. Bigelow Printer Troubleshooting Pocket Reference, McGraw Hill Inc
3. Eric Kuaimoku, Photocopier Maintenance and Repair Made Easy, TAB Books Inc
4. Eric Kuaimoku, Professional Photocopier Troubleshooting and Repair, TAB Books Inc
5. R.S. Khandpur, Troubleshooting Electronic Equipment: Includes Repair and Maintenance, Second Edition, McGraw Hill Education (India) Private Limited

Semester - 3

Course Name: **Consumer Electronics (Communication Appliances) (2024)**, Course Code: **CEL322S**, Course Type: **SEC**

Hours			**Total Credits**	**Maximum Marks**				Time Allowed for Theory Examination
					End Term			
Lecture	Tutorial	Practical		Internal	Theory	Lab	**Total**	
2	0	4	4	20	40	40	**100**	1 ¼ Hrs

Course Objectives:

To train and develop professional skills for interaction, installation, problem diagnosis and rectification of minor and major malfunctioning of DTH set-top box, LCD & LED TV's, Digital Camera and CCTV systems at customer's site or at factory/workshop.

Expected Learning Outcomes:

After going through this course, the student shall be able to:

1. *Develop the interactive and professional skills.*
2. *Identification of proper location for the appliances.*
3. *Installation and checking of accessories.*
4. *Checking appliance functioning.*
5. *Understand the symptoms and faults.*
6. *Repair and replacement of dysfunctional parts and check functionality.*

Detailed Syllabus

THEORY (2 Credits):

UNIT-I: Theory Component - I (15 HOURS)

DTH set-top box: - Block diagram and functions, optimum signal strength for good reception, cable-parameters and the implications on signal, functions of tuners, remote control, LCD and LED TV: Principle of working and functions of its different sections, Basic principle and working of 3D TV. IPS panels and their features.

Unit-II: Theory Component - II (15 HOURS)

Digital Image formation, Digital camera- working of digital cameras, Types - Floppy Disc type, Flash Card type, Hard Disc type, Overview of current digital cameras, CCTV: Types of cameras and their specifications used in CCTV systems, CCTV setup, Working of and types of Digital Video Recorders.

PRACTICAL (2 CREDITS: 60 HOURS)

Laboratory Component

Studying the parts, control circuits and sensors of washing machines, Troubleshoot and rectifying the faults, studying various parts, wiring and control mechanism of Microwaves, fault Identification and rectification, Identification of various parts, wiring, and electronic circuits in Vacuum cleaner, fault Identification and rectification.

On Job Training

Visiting factory, workshop and customer's site, counseling and dealing with the customer, site checking, installation and assembling of parts, functional testing, fault identification and repair/remedy thereof at customer and workshop/factory sites.

Recommended Books

1. Phillip Krejcarek Digital Photography-A hands on Introduction, Delmer Publishers.
2. Jon Torrant Understanding Digital Cameras Focal Press.
3. Imran Ashraf Khan, Masters LCD LED TV Repairing And Screen Bypassing Book, Saz Publication
4. Prabhu, CCTV Camera installation, Chip Systems.
5. Herman Kruegle, CCTV Surveillance: Video Practices and Technology, Butterworth-Heinemann.

Semester - 1

Course Name: **Surveillance Systems (DTH, Set-Top Box Installation and Service Techniques) (2024)**, Course Code: **SRS122S,** Course Type: **SEC**

Hours			Total Credits	Maximum Marks				Time Allowed for Theory Examination
Lecture	Tutorial	Practical		Internal	End Term		Total	
					Theory	Lab		

2	0	4	4	20	40	40	**100**	1 ¼ Hrs

Course Objectives:

To train the person who installs the set-top box at customer's premises; addresses the field acceptable complaints and coordinates with the technical team for activation of new connections.

Expected Learning Outcomes:

After going through this course, the student shall be able to:

1. *Collect the customer's site details and carry the necessary equipment and products*
2. *Install the set-top box (DTH) at a customer's site*
3. *Provide field service and resolve faults in case of a complaint*
4. *Basic TV Working*

Detailed Syllabus

THEORY (2 Credits):

UNIT-I: Install and Repair DTH Set-Top Box (15 HOURS)

Optimum signal strength/ signal quality for good reception. Basics of input/output functions and block diagram of the set-top box functions of the set-top box and remote-control structure of cable, parameters and the implications on the fundamental signal functioning of tuners. Basics of digital signals and difference in analogue and digital.

Unit-II: TV Broadcasting and Working (15 HOURS)

Transmission of television signals and functioning of television sets specifications of different kind of inputs available on TV sets such as RF, AV, RGB, VGA, USB and HDMI digital signal processing chain including CAS and SMS basics of Digital TV signal distribution through HFC network including elements of fibre, coaxial chain and devices such as nodes, amplifier, taps, splitter, etc., from head ends to input point of consumer premises for DASK.

PRACTICAL (2 CREDITS: 60 HOURS)

Laboratory Component

Installation of DTH set-top box, proper alignment and checking signal strength. Troubleshooting the set-top box. signal ingress, cross modulation, tuning, amplifying, coupling, attenuation, equalization, digitizing, etc., and their purposes.

On the Job Training

Company's policies on customer care Company's code of conduct organization culture and typical customer profile. company's reporting structure company's documentation policy company's products and recurring problems reported in consumer appliances how to communicate with customers in order to put them at ease basic electrical and mechanical modules of various products electronics involved in the type of product models of different appliances and their common and distinguishing features etiquette to be followed at customer's premises precautions to be taken while handling field calls and dealing with customers relevant reference sheets, manuals and documents to carry in the field.

Recommended Books

1. The Essential Guide to Digital Set-Top Boxes and Interactive TV, Gerard O'Driscoll.
2. Modern Television Practice: principles, technology and servicing, R. R. Gulati

Semester - 2

Course Name: **Surveillance Systems (Electronic Security) (2024)**, Course Code: **SRS222S,** Course Type: **SEC**

Hours			**Total Credits**	**Maximum Marks**				Time Allowed for Theory Examination
Lecture	Tutorial	Practical		Internal	End Term		**Total**	
					Theory	Lab		
2	0	4	4	20	40	40	**100**	1 ¼ Hrs

Course Objectives:

Understanding the customer's requirements for installing the various types of electronic security systems and configuring the system for security functions.

Expected Learning Outcomes:

The essential purpose of the course is to train the professionals for ensuring security during the installation and maintenance of the electronic and surveillance systems

Detailed Syllabus

THEORY (2 Credits):

UNIT-I: CCTV and IP Systems (15 HOURS)

Introduction to CCTV Systems, Types of CCTV Systems, Camera Selection and Design Concepts, Camera Types Camera Specifications & Features, Analog & IP Camera, Introduction to Digital Video Recorder, Setting Up a DVR, DVR Structure and Sections, Classification of DVR, Special DVRs, Networking (Local Access Configuration, Remote Access Configuration), Crimping Practice, System troubleshooting.

Unit-II: Access Control System (15 HOURS)

Introduction to Access Control System Topology, Credentials(Pin, Card, Biometric), Card Types, Biometric System (Behavioral, Physical) , Reader Types, Locking Devices, Exit Switch & Status Detectors, Panel Communication Protocols, Panel Programming, Trouble Shooting.

PRACTICAL (2 CREDITS: 60 HOURS)

Laboratory Component

Connect CCTV camera and DVR with the system, Setup the CCTV system, ensure system functioning and perform a demo, complete the installation task and report, Interact with customer, Interact with superior, achieve productivity and quality as per company's norms, Procure the hardware required for installation. Test the hardware before installation. Connect the cables—install and setup the detectors, devices & Control Panels. Setup the Video Door Phone system, Use appropriate tools and equipment for installation. Achieve productivity and quality standards.

On the Job Training

Procure the hardware required for installation, Test the hardware before installation, Connect the cables, Install and setup the indoor and outdoor units. Use appropriate tools and equipment's for installation, achieve productivity and quality standards, connect outdoor units and lock with the Indoor unit, Setup the Video Door Phone system, ensure system functioning and perform a demo, complete the installation task and report, Interact with a customer.

Recommended Books

1. CCTV Camera installation, Chip Systems, Prabhu.
2. CCTV Surveillance: Video Practices and Technology, Butterworth-Heinemann.
3. Electronic Access Control , Thomas L. Norman
4. Electronic Access Control , Butterworth-Heinemann

Semester - 3

Course Name: **Surveillance Systems (Installation Repair & Maintenance of IPBPX and CCTV System) (2024)**, Course Code: **SRS322S,** Course Type: **SEC**

Hours			Total Credits	Maximum Marks				Time Allowed for Theory Examination
					End Term		**Total**	
Lecture	Tutorial	Practical		Internal	Theory	Lab		
2	0	4	4	20	40	40	**100**	1 ¼ Hrs

Course Objectives:

To provide the proper understanding and functioning of automation equipment for industrial and commercial applications.

Expected Learning Outcomes:

After going through this course, the student shall be able to:

1. *Recognize & comply with safe working practices, environment regulation and housekeeping.*
2. *Understand and explain the concept of CCTV and IPBPX systems.*

Detailed Syllabus

THEORY (2 Credits):

UNIT-I: CC-Camera Competencies (15 HOURS)

Introduction to Trade and duties of "CCTV Camera Equipment Installation, Service & Maintenance", Occupational health hazards, Personal Protective Equipment (PPE) usage, Introduction, Handling, Storing and Maintenance of Tools, Elements of a basic CCTV system: - Camera, monitor and digital recorder. Camera types and uses: - Fixed dome & PTZ and Bullet, indoor and outdoor, monochrome, day and night, IP cc-cameras. Sensitivity, signal to noise ratio and resolution. Back Focus Adjustment .WDR Lens types: - Fixed and variable focal length, manual and motorized zoom, use a lens calculator to choose correct lens for a particular lens.

Unit-II: Introduction to IPBPX Systems (15 HOURS)

Essential components and features of IPPBX systems, Basics of Complete PBX 5, Linux administration, Extensions, Hot desking, Ring groups, Pickup groups, Paging and intercom, Queues, Conferences, and Time groups. Advantages of Internet Protocol PBX vs a Traditional PBX, Basic IP PBX Setup, Difference between a VoIP gateway and IP PBX, On-Premise IP PBX,

PRACTICAL (2 CREDITS: 60 HOURS)

Laboratory Component

Installation, Configuration of cc-cameras, tools for installation and maintenance of cc-cameras. Recording in cc-cameras, Backup of data. PTZ cameras installation and service maintenance. Installation of EPABX systems, setting up of local network using EPBAX systems. Troubleshooting and maintenance of EPBAX systems.

On the Job Training

The students are required to undergo on the job training at the center of excellence, to get additional exposure in the new and emerging areas in the field of CCTV and EPBAX systems. At the end of the training programme, the performance of the students shall be evaluated by the institute in collaboration with the Training Incharge.

Recommended Books

1. Building Telephony Systems with OpenSER, Goncalves Flavio E.
2. Prabhu, CCTV Camera installation, Chip Systems.
3. Herman Kruegle, CCTV Surveillance: Video Practices and Technology, Butterworth-Heinemann.

Semester - 1

Course Name: **Repair and Maintenance of Electronic Appliances (Electrical Circuits and Networking Skills) (2024)**, Course Code: **RME122S,** Course Type: **SEC**

Hours			**Total Credits**	**Maximum Marks**				Time Allowed for Theory Examination
					End Term		**Total**	
Lecture	Tutorial	Practical		Internal	Theory	Lab		
2	0	4	4	20	40	40	**100**	1 ¼ Hrs

Course Objectives:

To provide an understanding of the basics of Electrical and Electronics design with an introduction to the principles of laws governing electric and electronic science.

Expected Learning Outcomes:

After going through this course, the student shall be able to:

1. *Measure various parameters such as resistance, current, voltage and power using basic test and measuring equipment.*
2. *Understand electric drawing and symbols, various generators and transformers, and basic electronic circuits.*

Detailed Syllabus

THEORY (2 Credits):

UNIT-I: Basic Electricity Principles (15 HOURS)

Voltage, Current, Resistance, and Power. Ohm's law. Series, parallel, and series-parallel resistance combinations. AC and DC Electricity. Familiarization with multimeter, voltmeter and ammeter. Electrical Circuits: Basic electric circuit elements and their combination. Rules to analyze DC sourced electrical circuits. Current and voltage drop across the DC circuit elements. Single-phase and three phase alternating current sources. Rules to analyze AC sourced electrical circuits. Real, imaginary and complex power components of AC source. Power factor. Saving energy and money.

Unit-II: Electrical Drawing and Electric Motors (15 HOURS)

Drawing symbols. Blueprints. Reading Schematics. Ladder diagrams. Electrical Schematics. Power circuits. Control circuits. Reading of circuit schematics. Tracking the connections of elements and identify current flow and voltage drop. Generators and Transformers: DC Power sources. AC/DC generators. Inductance, capacitance and impedance. Operation of transformers.

Single-phase and three-phase DC motors. Basic design. Interfacing DC or AC sources to control heaters & motors. Speed & power of ac motor. Resistors, inductors and capacitors. Diode and rectifiers. Components in Series or in shunt. Response of inductors and capacitors with DC or AC sources.

PRACTICAL (2 CREDITS: 60 HOURS)

Laboratory Component

To verify KCL and KVL, to study the V-I characteristics of an incandescent lamp, to measure single phase power by using three ammeter method. To measure the single-phase power by using three voltmeter method. To perform short circuit test on a single-phase transformer. To perform open circuit test on a single-phase transformer. To measure three phase power by using two wattmeter method. To verify Thevenin's theorem. To verify Superposition theorem.

Recommended Books

1. Electrical Circuits, K.A. Smith and R.E. Alley, 2014, Cambridge University Press
2. A text book in Electrical Technology - B L Theraja - S Chand & Co.
3. A text book of Electrical Technology - A K Theraja
4. Performance and design of AC machines - M G Say ELBS Edn.

Semester - 2

Course Name: **Repair and Maintenance of Electronic Appliances (Repair and Maintenance of Power Supplies, Inverters and UPS) (2024),** Course Code: **RME222S,** Course Type: **SEC**

Hours			**Total Credits**	**Maximum Marks**				Time Allowed for Theory Examination
Lecture	Tutorial	Practical		Internal	End Term		**Total**	
					Theory	Lab		
2	0	4	4	20	40	40	**100**	1 ¼ Hrs

Course Objectives:

To provide an understanding of working principles of stabilizers, CVTs, Inverters and UPS and their repair.

Expected Learning Outcomes:

After going through this course, the student shall be able to:

1. *Understand working principles of various stabilizers, CVTs, inverters and UPS.*
2. *Understand various types of transformers and power backup equipment.*
3. *Service and repair various types of faults in transformers and power backup equipment.*

Detailed Syllabus

THEORY (2 Credits):

UNIT-I: Stabilizer and CVT (15 HOURS)

Need of stabilizer, working principle, types of stabilizers, Auto-cut and automatic stabilizer, Servo Stabilizer, Study of Control Circuit of Stabilizer, Transformer employed in stabilizer, Mult-winding/multi-taped transformer, Introduction to Constant Voltage transformer, General Circuit diagram of CVT, working principle of CVT, EMI/RFI filter, Surge Suppressor, Repairing of CVT.

Unit-II: Inverters and UPS (15 HOURS)

Introduction to inverters, Types of inverters, Pulse width modulated Inverter, Voltage cancellation in inverters, Single Phase Voltage source inverters, Single Phase Bridge Inverters, 3 Phase inverters.

Introduction to UPS, Types of UPS, Offline UPS, Online UPS, Line Interactive UPS, Input components in UPS, Trap Filter in UPS , UPS Rectifier stage IGBT Type, DC system components in Online UPS, Digital Power Quality Envelope.

PRACTICAL (2 CREDITS: 60 HOURS)

Laboratory Component

1. To study the operation of transformers

2. To study the construction of stabilizer.
3. To study the transformer employed in stabilizer.
4. To study the characteristics and repairing of CVT To study the characteristics of Inverter.
5. To study different range and types of oscillators.
6. To study the construction of Inverter.
7. To study different types of source generators. To verify Superposition theorem. Troubleshooting of UPS.

Recommended Books

1. Power electronics: converters, applications, and design by Ned Mohan.
2. Fundamentals of Power Electronics by Robeert W Eriction.
3. Power Electronics: Circuits, Devices, and Applications by M.H. Rashid
4. Introduction to Power Electronics by Daniel W Hart.

Semester - 3

Course Name: **Repair and Maintenance of Electronic Appliances (Repair and Maintenance of Mobile Phones) (2024),** Course Code: **RME322S,** Course Type: **SEC**

Hours			**Total Credits**	**Maximum Marks**				Time Allowed for Theory Examination
Lecture	Tutorial	Practical		Internal	End Term		**Total**	
					Theory	Lab		
2	0	4	4	20	40	40	**100**	1 ¼ Hrs

Course Objectives:

To provide an understanding of the basics of communication technologies used in Mobile communication, features of handsets, tools and equipment used for their repair, various types of faults in mobile handsets and other required topics to repair mobile handsets.

Expected Learning Outcomes:

After going through this course, the student shall be able to:

1. *Understand various communication technologies used in Mobile communication and various components of mobile handsets.*
2. *Understand and use tools and equipment required for repair of mobile handsets.*
3. *Understand different kinds of faults in mobile handsets and repair them.*

Detailed Syllabus

THEORY (2 Credits):

UNIT-I: Introduction (15 HOURS)

Introduction to mobile phones, Generations of mobile phones, FHSS networks, GSM, Spread spectrum, CDMA, TDMA & Basic electronics components. Handset Specific operating systems, Handset features & applications, working principle of mobile handset & Components used in mobile handsets. Tools & equipment used for repairing & maintenance of mobile handsets, types of power supply & batteries, boosting a battery, Troubleshooting basics, Network problems, Power failure (dead).

Unit-II: Troubleshooting (15 HOURS)

Mobile phone hardware troubleshooting (water damage, hanging, charging & keypad problems), Handsets assembly & disassembly, Soldering & desoldering & SMD rework station, BGA IC's, Basics of Computer, Installation of software, Flashing, PC based diagnostic tools, mobile sets formatting, use of secret codes.

PRACTICAL (2 CREDITS: 60 HOURS)

Laboratory Component

GSM & CDMA Structure & Generation of Mobile Phone Frequency & Channels GPRS, Bluetooth, Infrared Wi-Fi, SIM, & IMEI Mobile Phone Assembly & Disassembly Electronic Components Overview, Chip Level Soldering & De-soldering GSM Mobile Phone Troubleshooting Chinese Mobile, Phone Troubleshooting CDMA Mobile phone Troubleshooting Practically handset repairing.

Recommended Books

1. Advance Mobile Repairing by Pandit Sanjib
2. Modern Mobile Phone Repairing by Manohar Lotia.