

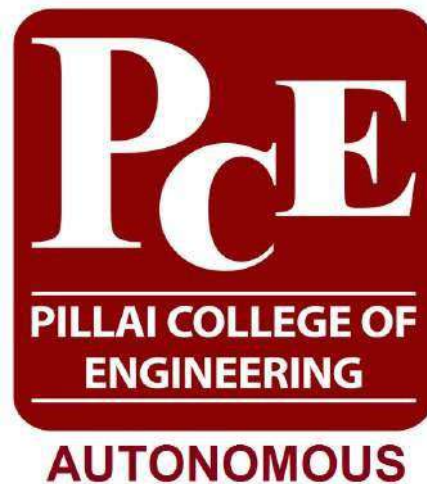
Mahatma Education Society's

# **Pillai College of Engineering**

*(Autonomous)*

**Affiliated to University of Mumbai**

Dr. K. M. Vasudevan Pillai's Campus, Sector 16, New Panvel – 410 206.



**Department of Electronics and Telecommunication Engineering**

**Syllabus**

*of*

**B.Tech. in Electronics and Telecommunication Engineering**

*for*

**The Admission Batch of AY 2022-23**

**First Year - Effective from Academic Year 2022-23**

**Second Year - Effective from Academic Year 2023-24**

**Third Year - Effective from Academic Year 2024-25**

**Fourth Year - Effective from Academic Year 2025-26**

*as per*

**Choice Based Credit and Grading System**

Mahatma Education Society's

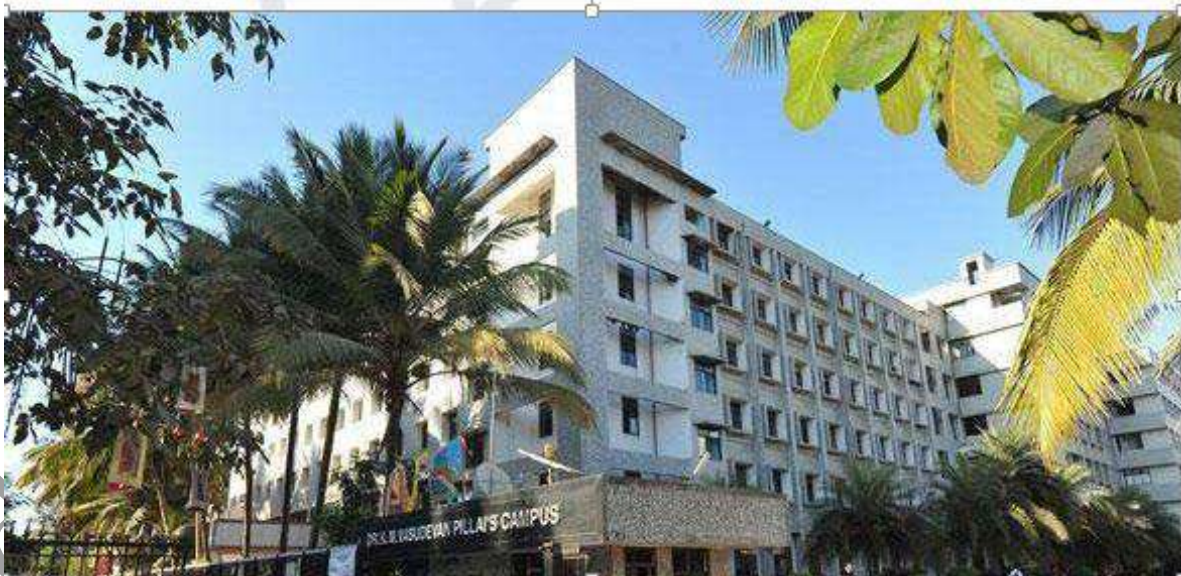
## **Pillai College of Engineering**

### **Vision**

Pillai College of Engineering (PCE) will admit, educate and train a diverse population of students who are academically prepared to benefit from the Institute's infrastructure and faculty experience, to become responsible professionals or entrepreneurs in a technical arena. It will further attract, develop and retain, dedicated, excellent teachers, scholars and professionals from diverse backgrounds whose work gives them knowledge beyond the classroom and who are committed to making a significant difference in the lives of their students and the community.

### **Mission**

To develop professional engineers with respect for the environment and make them responsible citizens in technological development both from an Indian and global perspective. This objective is fulfilled through quality education, practical training and interaction with industries and social organizations.



Dr. K. M. Vasudevan Pillai's Campus, Sector - 16, New Panvel – 410 206

# Department of Electronics and Telecommunication Engineering

## Vision

Strive towards producing world class engineers who will continuously innovate, upgrade telecommunication technology and provide advanced, hazard-free solutions to the mankind. Inspire, educate and empower students to ensure green and sustainable society.

## Mission

Benchmarking against technologically sound global telecommunication institutions with a view towards continuous improvement. Continually exposing students to scenarios that demand structuring of complex problems and proposing solutions. Educate students and promote values that can prevent further degradation of our planet. Becoming responsible citizens genuinely concerned with and capable of contributing to a just and peaceful world.

## Program Educational Objectives (PEOs):

- I. Provide graduates with a strong foundation in mathematics, science and engineering fundamentals to enable them to analyze and solve challenging problems in Electronics and Telecommunication Engineering
- II. Impart analytic and thinking skills to develop innovative ideas in the field of Telecommunication Engineering
- III. To keep students up to date with the latest advancements in the field of Electronics and Telecommunication
- IV. Inculcate qualities of leadership skills, multidisciplinary teamwork and an ability to adapt to evolving professional environment in the field of Engineering and Technology
- V. To create awareness among the students towards ethical, social and environmental issues in the professional career

## Program Outcomes:

Engineering Graduates will be able to:

1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. Conduct investigations 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.
5. 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.
6. 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.
7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. 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.
11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. 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.

### **Program Specific Outcomes (PSOs):**

1. Able to understand the concept of Basic Electronics, Network and Circuit Analysis, Analog and Digital circuits, Signals and System, Electromagnetics and apply them in various areas like Microwave Engineering, Wireless Communication, Digital image processing, Advance Communication systems etc.
2. Able to use techniques, skills, software, equipments and modern engineering tools necessary for Electronics and Telecommunication Engineers to identify, formulate and solve problems in industries and research work.
3. Able to work in multidisciplinary environment to provide socially acceptable technical solutions for complex communication engineering problems.

The Autonomous status of the institute has given an opportunity to design and frame the curriculum in such a way that it incorporates all the needs and requirements of recent developments in all fields within the scope of the Technical education. This curriculum will help graduates to attain excellence in their respective field. The curriculum has a blend of basic and advanced courses along with provision of imparting practical knowledge to students through minor and major projects. The syllabus has been approved and passed by the Board of Studies.

Outcome based education is implemented in the academics and every necessary step is undertaken to attain the requirements. Every course has its objectives and outcomes defined in the syllabus which are met through continuous assessment and end semester examinations. Evaluation is done on the basis of Choice Based Credit and Grading System (CBCGS). Optional courses are offered at department and institute level. Selection of electives from the same specialization makes the student eligible to attain a B. Tech. degree with respective specialization.

Every learner/student will be assessed for each course through (i) an Internal/Continuous assessment during the semester in the form of either Practical Performance, Presentation, Demonstration or written examination and (ii) End Semester Examination (ESE), in the form of either theory or viva voce or practical, as prescribed by the respective Board Studies and mentioned in the assessment scheme of the course content/syllabus. This system involves the Continuous Evaluation of students' progress Semester wise. The number of credits assigned with a course is based on the number of contact hours of instruction per week for the course. The credit allocation is available in the syllabus scheme of each semester.

The performance of a learner in a semester is indicated by a number called Semester Grade Performance Index (SGPI). The SGPI is the weighted average of the grade points obtained in all the courses by the learner during the semester. For example, if a learner passes five courses (Theory/labs./Projects/Seminar etc.) in a semester with credits  $C_1, C_2, C_3, C_4$  and  $C_5$  and learners grade points in these courses are  $G_1, G_2, G_3, G_4$  and  $G_5$  respectively, then learners SGPI is equal to:

$$SGPI = \frac{C_1G_1 + C_2G_2 + C_3G_3 + C_4G_4 + C_5G_5}{C_1 + C_2 + C_3 + C_4 + C_5}$$

The learner's up to date assessment of the overall performance from the time s/he entered for the programme is obtained by calculating a number called the Cumulative Grade Performance Index (CGPI), in a manner similar to the calculation of SGPI. The CGPI therefore considers all the courses mentioned in the scheme of instructions and examinations, towards the minimum requirement of the degree learners have enrolled for. The CGPI at the end of this semester is calculated as,

$$CGPI = \frac{C_1G_1 + C_2G_2 + C_3G_3 + \dots + C_i * G_i + \dots + C_nG_n}{C_1 + C_2 + C_3 + \dots + C_i + \dots + C_n}$$

The Department of Electronics and Telecommunication Engineering offers a B. Tech. programme in Electronics and Telecommunication Engineering. This is an eight semester course. The complete course is a 164 credit course which comprises core courses and elective courses. The elective courses are distributed over 6 specializations. The specializations are:

- Group 1: Smart Robotics and IoT driven Application Development
- Group 2: Product Design
- Group 3: VLSI Chip Design Technology
- Group 4: Advanced Communication System
- Group 5: Cloud Computing
- Group 6: Data Science

The students also have a choice of opting for Institute level specializations. These are

1. Entrepreneurship Development and Management
2. Business Management
3. IP Management
4. Bio Engineering
5. Bio Instrumentation
6. Engineering Design
7. Sustainable Technologies
8. Contemporary Studies
9. Art and Journalism
10. Applied Science
11. Green Technologies
12. Maintenance Engineering
13. Life Skills
14. Environment & Safety

**As minimum requirements for the credits to be earned during the B.Tech in Electronics and Telecommunication Engineering program, a student will have to complete a minimum of three specializations of which two are to be chosen from the department list and one has to be from the Institute level specialization list. In order to complete each specialization, a minimum of three courses from department list and two courses from institute list under the specialization has to be completed.** The credit requirement for the B.Tech. in Electronics and Telecommunication Engineering course is tabulated in Table 1.

Table 1. Credit Requirement for B.Tech in Electronics and Telecommunication Engineering

Category	Credits
<b>Basic Sciences</b>	<b>26</b>
<b>Basic Engineering</b>	<b>18</b>
<b>Humanities and Social Sciences</b>	<b>9</b>
<b>Program Core</b>	<b>52</b>
<b>Program Electives</b>	<b>24</b>
<b>Open Electives</b>	<b>6</b>
<b>Project(s)</b>	<b>16</b>
<b>Internships/Seminars</b>	<b>8</b>
<b>Multidisciplinary</b>	<b>5</b>
<b>Total</b>	<b>164</b>

**Program Structure for**  
**Bachelor of Technology in Electronics and Telecommunication Engineering**  
**Semester I**

Course Code	Course Name	Course Component	Teaching Scheme (Contact Hours)		Credits Assigned		
			Theory	Practical /Tutorial	Theory	Practical /Tutorial	Total
FY 101	Engineering Mathematics I	TL	3	2	3	1	4
FY 103	Engineering Physics I	TL	2	1	2	0.5	2.5
FY 105	Engineering Chemistry I	TL	2	1	2	0.5	2.5
FY 107	Basic Electrical Engineering	TL	3	2	3	1	4
FY 111	C Programming	TLP	3	2	3	1	4
FY117	Basic Workshop Practice-I	L	-	2	-	1	1
<b>Total</b>			<b>13</b>	<b>10</b>	<b>13</b>	<b>5</b>	<b>18</b>

Course Code	Course Name	Theory					Term Work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)			
		1	2	Avg					
FY 101	Engineering Mathematics I	40	40	40	60	2	25	-	125
FY 103	Engineering Physics I	30	30	30	45	2	25	-	100
FY 105	Engineering Chemistry I	30	30	30	45	2	25	-	100
FY 107	Basic Electrical Engineering	40	40	40	60	2	25	25	150
FY 111	C Programming	40	40	40	60	2	25	25	150
FY117	Basic Workshop Practice-I	-	-	-	-	-	50	-	50
Total									675

**T- Theory , L- Lab , P-Programming, C- Communication**

## Bachelor of Technology in Electronics and Telecommunication Engineering

### Semester II

Course Code	Course Name	Course Component	Teaching Scheme (Contact Hours)		Credits Assigned		
			Theory	Practical /Tutorial	Theory	Practical /Tutorial	Total
FY 102	Engineering Mathematics II	TL	3	2	3	1	4
FY 104	Engineering Physics II	TL	2	1	2	0.5	2.5
FY 106	Engineering Chemistry II	TL	2	1	2	0.5	2.5
FY 108	Engineering Mechanics and Graphics	TL	2	4	2	2	4
FY 112	Python Programming	TLP	3	2	3	1	4
FY 114	Professional Communication and Ethics I	TLC	2	2	2	1	3
FY118	Basic Workshop Practice-II	L		2		1	1
<b>Total</b>			<b>14</b>	<b>14</b>	<b>14</b>	<b>7</b>	<b>21</b>

Course Code	Course Name	Theory					Term Work	Pract/ Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)			
		1	2	Avg					
FY 102	Engineering Mathematics II	40	40	40	60	2	25	-	125
FY 104	Engineering Physics II	30	30	30	45	2	25	-	100
FY 106	Engineering Chemistry II	30	30	30	45	2	25	-	100
FY 108	Engineering Mechanics and Graphics	40	40	40	60	2	25	50	175
FY 112	Python Programming	40	40	40	60	2	25	25	150
FY 114	Professional Communication and Ethics I	20	20	20	30	1	-	25	75
FY118	Basic Workshop Practice-II	-	-			-	50		50
Total									775

**T- Theory , L- Lab , P-Programming, C- Communication**

**Bachelor of Technology in Electronics and Telecommunication Engineering**  
**Semester III**

Course Code	Course Name	Course Component	Teaching Scheme (Contact Hours)		Credits Assigned		
			Theory	Practical /Tutorial	Theory	Practical /Tutorial	Total
ET 201	Engineering Mathematics III	T	3	1	3	1	4
ET 202	Electronics Devices	TL	3	2	3	1	4
ET 203	Network Theory	T	3	-	3	-	3
ET 204	Digital System Design	TL	3	2	3	1	4
ET 205	Signals and Systems	T	3	-	3	-	3
ET 206	Python Programming II	LP	-	2	-	1	1
ET 291	Mini Project I	LC	-	2	-	2	2
<b>Total</b>			<b>15</b>	<b>09</b>	<b>15</b>	<b>6</b>	<b>21</b>

**Examination Scheme Semester III**

Course Code	Course Name	Theory					Term Work	Pract /Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)			
		1	2	Avg					
ET 201	Engineering Mathematics III	40	40	40	60	2	25	-	125
ET 202	Electronics Devices	40	40	40	60	2	25	25	150
ET 203	Network Theory	40	40	40	60	2	-	-	100
ET 204	Digital System Design	40	40	40	60	2	25	25	150
ET 205	Signal and Systems	40	40	40	60	2	-	-	100
ET 206	Python Programming II	-	-			-	25	25	50
ET 291	Mini Project I	-	-			-	25	25	50
Total									725

**T- Theory, L- Lab. P-Programming, C- Communication**

## Bachelor of Technology in Electronics and Telecommunication Engineering

### Semester IV

Course Code	Course Name	Course Component	Teaching Scheme (Contact Hours)		Credits Assigned		
			Theory	Practical /Tutorial	Theory	Practical /Tutorial	Total
ET 207	Engineering Mathematics IV	T	3	2	3	1	4
ET 208	Electronic Communication Systems	TL	3	2	3	1	4
ET 209	Linear Integrated Circuits	TL	3	2	3	1	4
ET 210	Digital Signal Processing	T	3	2	3	1	4
ET 211	Microprocessor & Microcontroller	TL	3	2	3	1	4
ET 212	Personal Finance Management	T	2	-	2	-	2
ET 292	Mini Project II	LC	-	2	-	2	2
	Internship*	-	-	-	-	-	-
<b>Total</b>			<b>17</b>	<b>12</b>	<b>17</b>	<b>7</b>	<b>24</b>

### Examination Scheme Semester IV

Course Code	Course Name	Theory					Term Work	Pract / Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)			
		1	2	Avg					
ET 207	Engineering Mathematics IV	40	40	40	60	2	25		125
ET 208	Electronic Communication Systems	40	40	40	60	2	25	25	150
ET 209	Linear Integrated Circuits	40	40	40	60	2	25	25	150
ET 210	Digital Signal Processing	40	40	40	60	2	25	25	150
ET 211	Microprocessor & Microcontroller	40	40	40	60	2	25	25	150
ET 212	Personal Finance Management	20	20	20	40	2	-	-	60
ET 292	Mini Project II	-	-			-	25	25	50
Total									835

**T- Theory, L- Lab, P-Programming, C- Communication**

\* Internship is desirable but not mandatory

## Bachelor of Technology in Electronics and Telecommunication Engineering

### Semester V

Course Code	Course Name	Course Component	Teaching Scheme (Contact Hours)		Credits Assigned		
			Theory	Practical /Tutorial	Theory	Practical /Tutorial	Total
ET 301	Digital Communication	TL	3	2	3	1	4
ET 302	Image Processing and Machine Vision	T	3	-	3	-	3
ET 303	Embedded Systems	TL	3	2	3	1	4
ET 304	Programming (Java and Scripting)	LP	-	2	-	1	1
ET 305	Professional Communication and Ethics II	TLC	2	2	-	2	2
ET 3xx	Elective I A	TL	3	2	3	1	4
ET 3xx	Elective II A	TL	3	2	3	1	4
ET 391	Mini Project III	LC	-	2	-	2	2
<b>Total</b>			<b>17</b>	<b>14</b>	<b>15</b>	<b>9</b>	<b>24</b>

### Examination Scheme Semester V

Course Code	Course Name	Theory					Term Work	Pract/ Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)			
		1	2	Avg					
ET 301	Digital Communication	40	40	40	60	2	25	25	150
ET 302	Image Processing and Machine Vision	40	40	40	60	2	-	-	100
ET 303	Embedded Systems	40	40	40	60	2	25	25	150
ET 304	Programming (Java and Scripting)	-	-	-	-	-	25	25	50
ET 305	Professional Communication and Ethics II	-	-	-	-	-	50	-	50
ET 3xx	Elective I A	40	40	40	60	2	25	25	150
ET 3xx	Elective II A	40	40	40	60	2	25	25	150
ET 391	Mini Project III	-	-			-	25	25	50
Total									850

**T- Theory, L- Lab, P-Programming, C- Communication**

Elective I A is to be chosen from Group I and Elective II A is to be chosen from Group II

Specialization	Group I			Specialization	Group II		
Semester V Electives	Smart Robotics and IoT driven Application Development	Product Design	VLSI Chip Design Technology	Semester V Electives	Advanced communication System	Cloud Computing	Data Science
Course Code Course Name Elective I A	ET 306	ET 307	ET 308	Course Code Course Name Elective II A	ET 309	ET311	ET312
					Data Processing and Coding		
	IOT Basics and Smart sensors	PCB Design and Electronics Equipment Trouble shooting	Basics of VLSI Design		ET 310	Computer Communication and Network	Database Management System
					TV and Video Engineering		

## Bachelor of Technology in Electronics and Telecommunication Engineering

### Semester VI

Course Code	Course Name	Course Component	Teaching Scheme (Contact Hours)		Credits Assigned		
			Theory	Practical /Tutorial	Theory	Practical /Tutorial	Total
ET313	Wireless and Mobile Communication	T	3	-	3	-	3
ET314	Electromagnetic Waves and Radiating Systems	T	3	-	3	-	3
ET315	WMC and EWRS Lab	L	-	2	-	1	1
ET316	Data Structures	TL	2	2	2	1	3
ET3xx	Elective I B	TL	3	2	3	1	4
ET3xx	Elective II B	TL	3	2	3	1	4
IL3xx	Institute Level Optional Course I	T	3	-	3	-	3
ET 392	Project A	LC	-	4	-	2	2
	Internship*	-	-	-	-	-	-
<b>Total</b>			<b>17</b>	<b>12</b>	<b>17</b>	<b>6</b>	<b>23</b>

### Examination Scheme Semester VI

Course Code	Course Name	Theory					Term Work	Pract /Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)			
		1	2	Avg					
ET313	Wireless and Mobile Communication	40	40	40	60	2	-	-	100
ET314	Electromagnetic Wave and Radiating Systems	40	40	40	60	2	-	-	100
ET315	WMC and EWRS Lab	-	-	-	-	-	25	25	50
ET316	Data Structures	20	20	20	40	2	25	25	110
ET3xx	Elective I B	40	40	40	60	2	25	25	150
ET3xx	Elective II B	40	40	40	60	2	25	25	150
IL3xx	Institute Level Optional Course I	40	40	40	60	2			100
ET392	Project A	-	-	-	-	-	50	25	75
	Internship*	-	-	-	-	-	-	-	-
Total									835

**T- Theory , L- Lab , P-Programming, C- Communication**

\* Internship is desirable but not mandatory

**In continuation with chosen department specialization, one department Elective (Elective I B) is to be chosen from group I.**

**Second department Elective (Elective II B) is to be chosen from group II**

Specialization	Group I			Specialization	Group II			
Semester VI Electives	Smart Robotics and IoT driven Application Development	Product Design	VLSI Chip Design Technology	Semester VI Electives	Advanced Communication System	Cloud Computing	Data Science	
Course Code Course Name Elective I B	ET 317	ET 318	ET 319	Course Code Course Name Elective II B	ET 320	ET323	ET324	
					Speech and Audio Processing			
	Robotics and Automation	Electronic Product Design	Integrated Circuit Technology		ET 321	Advanced Networking Technologies	Big Data Analytics	
					Radar Engineering			
					ET 322			
					Optical Communication			

**Institute elective is to be chosen from any one of the Institute level specialization**

SN	Specialization	Course Code	Course Name
1	Entrepreneurship Development and Management	IL 360	Entrepreneurship
2	Business Management	IL 361	E- Commerce and E-Business
3	IP Management	IL 362	Research Methodology
4	Bio Engineering	IL 363	Introduction to Bioengineering
5	Bio Instrumentation	IL 364	Biomedical Instrumentation
6	Engineering Design	IL 365	Design of Experiments
7	Sustainable Technologies	IL 366	Design for Sustainability
8	Contemporary Studies	IL 367	Political Science
9	Art and Journalism	IL 368	Visual Art
10	Applied Science	IL 369	Modern Day Sensor Physics
11	Green Technologies	IL 370	Energy Audit and Management
12	Maintenance Engineering	IL 371	Maintenance of Electronics Equipment
13	Life Skills	IL 372	Cooking and Nutrition
14	Environment & Safety	IL 373	Environmental Management

## Bachelor of Technology in Electronics and Telecommunication Engineering

### Semester VII

Course Code	Course Name	Course Component	Teaching Scheme (Contact Hours)		Credits Assigned		
			Theory	Practical /Tutorial	Theory	Practical /Tutorial	Total
ET401	Microwave and RF Design	TL	3	2	3	1	4
ET402	Human Values and Social Ethics	T	2	-	2	-	2
ET4xx	Elective I C	TL	3	2	3	1	4
ET4xx	Elective II C	TL	3	2	3	1	4
IL4xx	Institute Level Optional Course II	T	3	-	3	-	3
ET491	Project B	LC	-	8	-	4	4
<b>Total</b>			<b>14</b>	<b>14</b>	<b>14</b>	<b>7</b>	<b>21</b>

### Examination Scheme Semester VII

Course Code	Course Name	Theory					Term Work	Pract /Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)			
		1	2	Avg					
ET401	Microwave and RF Design	40	40	40	60	2	25	25	150
ET402	Human Values and Social Ethics	-	-	-	-	-	50	-	50
ET4xx	Elective I C	40	40	40	60	2	25	25	150
ET4xx	Elective II C	40	40	40	60	2	25	25	150
IL4xx	Institute Level Optional Course II	40	40	40	60	2	-	-	100
ET491	Project B	-	-	-	-	-	100	50	150
Total									750

**T- Theory, L- Lab, P-Programming, C- Communication**

**In continuation with chosen department specialization, one department Elective (Elective I C) is to be chosen from group I.**

**In continuation with chosen department specialization, second department Elective (Elective II C) is to be chosen from group II**

Specialization	Group I			Specialization	Group II		
Semester VII Elective	Smart Robotics and IoT driven Application Development	Product Design	VLSI Chip Design Technology	Semester VII Elective	Advanced Communication System	Cloud Computing	Data Science
Course Code Course Name  Elective I C	ET403	ET404	ET405	Course Code Course Name  Elective II C	ET 406	ET409	ET410
	IoT driven App Development	Communication System Design and Integration	Advanced VLSI		Blockchain for Communication	Cloud Computing	Data Science
					ET 407		
					AIML in Communication Systems		
					ET 408		
					MIMO System for 5G		

**In continuation with chosen department specialization, Institute elective is to be chosen from any of the Institute level groups**

SN	Specialization	Course Code	Course Name
1	Entrepreneurship Development and Management	IL 470	Digital Business Management and Digital Marketing
2	Business Management	IL 471	Business Analytics
3	IP Management	IL 472	IPR and Patenting
4	Bio Engineering	IL 473	Medical Image Processing
5	Bio Instrumentation	IL 474	Biomechanics
6	Engineering Design	IL 475	Product Design
7	Sustainable Technologies	IL 476	Technologies for Rural Development
8	Contemporary Studies	IL 477	Economics
9	Art and Journalism	IL 478	Journalism, Media and Communication studies
10	Applied Science	IL 479	Operation Research for Management
11	Green Technologies	IL 480	Weather and Climate Informatics
12	Maintenance Engineering	IL 481	Maintenance of Mechanical Equipment
13	Life Skills	IL 482	Physical Education
14	Environment & Safety	IL 483	Vehicle Safety

## Bachelor of Technology in Electronics and Telecommunication

### Semester VIII

Course Code	Course Name	Course Component	Teaching Scheme (Contact Hours)		Credits Assigned		
			Theory	Practical /Tutorial	Theory	Practical /Tutorial	Total
ET492	Project C	LC	-	8	-	4	4
ET493	Internship	-	-	32	-	8	8
<b>Total</b>			-	<b>40</b>	-	<b>12</b>	<b>12</b>

### Examination Scheme Semester VIII

Course Code	Course Name	Theory					Term Work	Pract/ Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)			
		1	2	Avg					
ET492	Project C	-	-	-	-	-	100	50	150
ET493	Internship	-	-	-	-	-	100	100	200
Total									350

**T- Theory , L- Lab , P-Programming, C- Communication**

Course Code	Course Name	Credits
ET201	Engineering Mathematics III	04

**Prerequisite:**

Engineering Mathematics-I and Engineering Mathematics-2

**Course Objectives:**

1. To Learn the Laplace Transform, Inverse Laplace Transform of various functions, its applications.
2. To understand the concept of Fourier Series, its complex form and enhance the problem-skills.
3. To Understand Matrix algebra for engineering problems
4. To understand the concept of complex variables, C-R equations with applications.
5. To understand the concepts of Quadratic forms and Singular value decomposition.
6. To Learn Fourier Integral, Fourier Transform and Inverse fourier transform.

**Course Outcomes:**

The learner will be able to

1. Understand the concept of Laplace transform and its application to solve the real integrals, understand the concept of inverse Laplace transform of various functions and its applications in engineering problems.
2. Expand the periodic function by using the Fourier series for real-life problems and complex engineering problems.
3. Apply the concepts of eigenvalues and eigenvectors in engineering problems.
4. Understand complex variable theory, application of harmonic conjugate to get orthogonal trajectories and analytic functions.
5. Use the concept of Quadratic forms and Singular value decomposition which are very useful tools in various Engineering applications
6. Apply the concept of fourier transform and its inverse in engineering problems.

Sr. No.	Module	Detailed Content	Hours	CO Mapping
I	Laplace Transform	Definition of Laplace transform and Laplace transform of standard functions, Properties of Laplace Transform: Linearity, First Shifting Theorem, change of scale Property, multiplication by t, Division by t, (Properties without proof). Inverse of Laplace Transform by partial fraction and convolution theorem.	7	1
II	Fourier Series	Dirichlet's conditions, Fourier series of periodic functions with period $2\pi$ and $2L$ , Fourier series for even and odd functions, Half range sine and cosine Fourier series, Orthogonal and Ortho-normal functions, Complex form of Fourier series.	7	2

III	<b>Linear Algebra Matrix Theory</b>	Eigenvalues and eigenvectors; Diagonalization of matrices; Cayley-Hamilton Theorem, Functions of square matrix, Derogatory and Non Derogatory matrices.	7	3
IV	<b>Complex Variables and Conformal mappings</b>	Function $f(z)$ of complex variable, Introduction to Analytic function: Necessary and sufficient conditions for $f(z)$ to be analytic, Cauchy-Riemann equations in Cartesian coordinates, Milne-Thomson method: Determine analytic function $f(z)$ when real part ( $u$ ) and imaginary part ( $v$ ), Conformal mapping, Linear and Bilinear mappings, cross ratios	7	4
V	<b>Quadratic Forms</b>	Quadratic forms over real field, Linear Transformation of Quadratic form, Reduction of Quadratic form to diagonal form using congruent transformation. Rank, Index and Signature of quadratic form, Sylvester's law of inertia, Value-class of a quadratic form-Definite Semidefinite and Indefinite. Reduction of Quadratic form to a canonical form using congruent transformations. Singular Value Decomposition.	7	5
VI	<b>Fourier Transform</b>	Fourier Integral Representation, Fourier Transform and Inverse Fourier transform of constant and exponential function.	4	6

### Tutorials:-

Sr. No.	Level 1. Basic 2. Design 3. Advanced 4. Project/Case Study/Seminar	Detailed Lab/Tutorial Description	Hours
1	<b>Basic</b>	Laplace Transform	2
2	<b>Advanced</b>	Inverse Laplace Transform	2
3	<b>Basic</b>	Fourier Series -1	2
4	<b>Advanced</b>	Fourier Series -2	2
5	<b>Advanced</b>	Eigenvalues and eigenvectors;	2
6	<b>Advanced</b>	Cayley-Hamilton Theorem and its applications.	2

6	<b>Basic</b>	Complex Variables	2
7	<b>Advanced</b>	Conformal Mappings	2
8	<b>Basic</b>	Quadratic Forms-1	2
9	<b>Advanced</b>	Quadratic Forms-2	2
10	<b>Basic</b>	Fourier Transform	2

### Theory Assessment:

#### **Internal Assessment: 40 marks**

Consisting of Two compulsory internal assessments 40 Marks each. The final marks will be the average score of both the tests.

#### **End Semester Examination: 60 Marks**

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

### Term work:

The distribution of term work marks -

1. Attendance - 05 marks
2. Assignments -10 marks
3. Tutorials- 10 marks

### Text Books and References:

1. Higher Engineering Mathematics B. V. Ramana, Tata Mc-Graw Hill Publication
2. Higher Engineering Mathematics, Dr. B. S. Grewal, Khanna Publication
3. Advanced engineering mathematics H.K. Das, S . Chand, Publications.
4. Advanced Engineering Mathematics Wylie and Barret, Tata Mc-Graw Hill.
5. Complex Variables and Applications, Brown and Churchill, McGraw-Hill education.
6. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Narosa publication
7. Scilab spoken tutorials videos.  
([https://spoken-tutorial.org/tutorial-search/?search\\_foss=Scilab&search\\_language=English](https://spoken-tutorial.org/tutorial-search/?search_foss=Scilab&search_language=English))

Subject Code	Subject Name	Total
ET 202	Electronics Devices	04

**Prerequisite:**

Basic Electrical Engineering

**Course Objectives:**

1. To explain functionality of different electronic devices.
2. To perform DC and AC analysis of small signal amplifier circuits.
3. To analyze frequency response of small signal amplifiers
4. To compare small signal and large signal amplifiers.
5. To explain working of differential amplifiers and its applications in Operational amplifiers

**Course Outcomes:** The learner will be able to

1. Analyze the functionality and applications of various electronic devices with the help of V-I characteristics.
2. Derive expressions for performance parameters of BJT and MOSFET based electronic circuits.
3. Evaluate frequency response to understand behavior of BJT and MOSFET based Electronics circuits.
4. Understand working of different power amplifier circuits, their design and use in electronics and communication circuits.
5. Understand working of E-MOSFET differential amplifiers and E-MOSFET current sources.
6. Select and Design electronic circuits for given specifications.

Sr. No.	Module	Detailed Content	Hours	CO Mapping
I	<b>Introduction of Electronic Devices</b>	Study of pn junction diode characteristics & diode current equation. Application of zener diode as a voltage regulator. Construction, working and characteristics of BJT, D-MOSFET, and E-MOSFET	5	CO1
II	<b>Biasing Circuits of BJTs and MOSFETs</b>	Concept of DC load line, Q point and regions of operations, Analysis and design of biasing circuits for BJT (Fixed bias & Voltage divider Bias) DC load line and region of operation for MOSFETs. Analysis and design of biasing circuits for DMOSFET (self bias and voltage divider bias), E-MOSFET (Drain to Gate bias & voltage divider bias).	6	CO2
III	<b>Small Signal Amplifiers</b>	Concept of AC load line and Amplification, Small signal analysis ( $Z_i$ , $Z_o$ , $A_v$ and $A_i$ ) of CE amplifiers using hybrid pi model ONLY. Small signal analysis ( $Z_i$ , $Z_o$ , $A_v$ ) of CS (for EMOSFET) amplifiers. Introduction to multistage amplifiers.(Concept, advantages & disadvantages)	7	CO2, CO6

IV	<b>Frequency response of Small signal Amplifiers</b>	Effects of coupling, bypass capacitors and parasitic capacitors on frequency response of single stage amplifier, Miller effect and Miller capacitance. High and low frequency analysis of BJT CE amplifiers. High and low frequency analysis of CS (E-MOSFET) amplifiers.	7	CO3,CO6
V	<b>Large Signal Amplifiers</b>	Difference between small signal & large signal amplifiers. Classification and working of Power amplifiers. Analysis of Class A power amplifier (Series fed and transformer coupled). Transformer less Amplifier: Class B power amplifier. Class AB power amplifier. Thermal considerations and heat sinks	7	CO4
VI	<b>Introduction to Differential Amplifiers</b>	E-MOSFET Differential Amplifier, DC transfer characteristics operation with common mode signal and differential mode signal Differential and common mode gain, CMRR, differential and common mode Input impedance. Two transistor (E-MOSFET) constant current source	7	CO5

**Lab Prerequisite:**

Basic Electrical and Electronics Laboratory

**Software Requirements:**

LTSpice

**Hardware Requirements:**

Breadboard, Transistors, Resistors, Diodes, Connecting wires

**Lab Objectives:**

The objective of this course is

- 1) To provide the fundamental concepts of voltage and current characteristics of Diodes.
- 2) To familiarize with the important applications of zener diodes.
- 3) To design and study the CE and CS amplifiers characteristics.
- 4) To familiarize with biasing circuits and characteristics of EMOSFETs and DMOSFETs
- 5) To simulate design and analysis of Multistage and differential amplifiers.

**Lab Outcomes :**

1. Able to analyze the characteristics of PN junction diodes.
2. Able to Analyze and understand the zener diode as a Voltage Regulator.
3. Able to analyze and study the input and output characteristics of CE BJT
4. Able to analyze and implement the different biasing circuits of BJT
5. Able to study and analyze the frequency response.
6. Able to Simulate and understand the MOSFET characteristics.
7. Able to analyze and simulate the biasing of MOSFETs.
8. Able to simulate the frequency response of a CS amplifier.
9. Able to simulate and design the characteristics of multi stage and also differential amplifier.

Sr. No.	Level 1. Basic 2. Design 3. Advanced 4. Project/Case Study/Seminar	Detailed Lab/Tutorial Description	Hours
1	<b>Basic</b>	Study of VI Characteristics of PN junction diodes.	2
2	<b>Basic</b>	To study zener diode VI Characteristics.	2
3	<b>Basic</b>	To study zener as a voltage regulator.	2
4	<b>Design</b>	To study input and output characteristics of CE BJT configuration.	2
5	<b>Design</b>	To study BJT fixed biasing and Voltage divider circuits.	2
6	<b>Advanced</b>	To study frequency response of a single stage BJT CE amplifier.	2
7	<b>Design</b>	Simulation experiment to study EMOSFET / DMOSFET biasing circuits.	2
8	<b>Design</b>	Simulation experiment to study Drain and Transfer Characteristics of MOSFET	2
9	<b>Design</b>	Simulation experiment on study frequency response of CS amplifier.	2
10	<b>Advanced</b>	Simulation experiment on study of differential amplifiers.	2
11	<b>Advanced</b>	To study frequency response of multistage amplifier	2

**Theory Assessment:****Internal Assessment: 40 marks**

Consisting of Two compulsory internal assessments 40 Marks each. The final marks will be the average score of both the tests.

**End Semester Examination: 60 Marks**

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

**Lab Assessments:**

**1. Term work Assessment:** At least 08 Experiments including 02 simulations covering the entire syllabus must be given during the —Laboratory session batch wise—. Computation/simulation-based experiments are also encouraged. The experiments should be student centric and attempts should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for a maximum batch of four students. Term work assessment must be based on the overall performance of the student with every experiment/tutorials and mini-projects (if included) are graded from time to time.

**2. Oral/Viva Assessment:** The practical and oral examination will be based on the entire syllabus.

**Text Books:**

1. D. A. Neamen, "Electronic Circuit Analysis and Design," Tata McGraw Hill, 2nd Edition.
2. A. S. Sedra, K. C. Smith, and A. N. Chandorkar, "Microelectronic Circuits Theory and Applications," International Version, OXFORD International Students, 6th Edition
3. Franco, Sergio. Design with operational amplifiers and analog integrated circuits. Vol. 1988. New York: McGraw-Hill, 2002.

**References:**

1. Boylestad and Nashelesky, "Electronic Devices and Circuits Theory," Pearson Education, 11th Edition.
2. A. K. Maini, "Electronic Devices and Circuits," Wiley.
3. T. L. Floyd, "Electronic Devices," Prentice Hall, 9th Edition, 2012.
4. S. Salivahanan, N. Suresh Kumar, "Electronic Devices and Circuits", Tata Mc-Graw Hill, 3rd Edition
5. Bell, David A. Electronic devices and circuits. Prentice-Hall of India, 1999.

Subject Code	Subject Name	Total
ET 203	Network Theory	03

**Prerequisite:**

1. Basic Electrical Engineering
2. Engineering Mathematics

**Course Objectives:**

1. To evaluate the Circuits using network theorems.
2. To analyze the Circuits in time and frequency domain.
3. To study network Topology, network Functions and two port networks.
4. To synthesize passive network by various methods.

**Course Outcomes:** The learner will be able to

1. Apply their knowledge in analyzing Circuits by using network theorems.
2. Apply the knowledge of graph theory for analyzing the circuits.
3. Find transient and steady state response of a circuit using time and frequency domain analysis methods.
4. Find the network functions,
5. Understand the concept of Two port networks and distinguish between various two port network parameters.
6. Synthesize the network using passive elements.

Sr. No.	Module	Detailed Content	Hours	CO Mapping
I	Electrical circuit analysis	Circuit Analysis: Analysis of Circuits with and without dependent sources using generalized loop and node analysis, super mesh and super node analysis technique. Circuit Theorems: Superposition, Thevenin's, Norton's and Maximum Power Transfer Theorems (Use only DC source).	08	CO1
II	Graph Theory	Objectives of graph theory, Linear Oriented Graphs, graph terminologies Matrix representation of a graph: Incidence matrix, Circuit matrix, Cut-set matrix, reduced Incident matrix, Tieset matrix, f-cutset matrix. Relationship between sub matrices A, B & Q. KVL & KCL using matrix.	05	CO2
III	Time and frequency domain analysis	Time domain analysis of R-L and R-C Circuits: Forced and natural response, initial and final values. Solution using first order and second order differential equation with step signals. Frequency domain analysis of R-L-C Circuits: Forced and natural response, effect of damping factor. Solution using second order equation for step signal.	07	CO3

IV	<b>Network functions</b>	Network functions for the one port and two port networks, driving point and transfer functions, Poles and Zeros of Network functions, necessary condition for driving point functions, necessary condition for transfer functions, testing for Hurwitz polynomial. Analysis of ladder network (Up to two nodes or loops)	06	CO4
V	<b>Two port Networks</b>	Parameters: Open Circuits, short Circuit, Transmission and Hybrid parameters, relationship among parameters, conditions for reciprocity and symmetry. Interconnections of Two-Port networks T & $\pi$ representation.	06	CO5
VI	<b>Synthesis of RLC circuits</b>	Positive Real Functions: Concept of positive real function, necessary and sufficient conditions for Positive real Functions. Synthesis of LC, RC Circuits: properties of LC, RC driving point functions, LC, RC network Synthesis in Cauer-I & Cauer-II, Foster-I & Foster-II forms (Up to Two Loops only).	07	CO6

#### **Theory Assessment:**

#### **Internal Assessment: 40 marks**

Consisting of Two compulsory internal assessments 40 Marks each. The final marks will be the average of score of both the tests.

#### **End Semester Examination: 60 Marks**

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

#### **Text Books:**

1. Franklin F Kuo, "Network Analysis and Synthesis", Wiley Toppan, 2nd ed., 1966.
2. M E Van Valkenburg, "Network Analysis", Prentice-Hall of India Pvt Ltd, New Delhi, 26th Indian Reprint, 2000.

#### **References:**

1. A. Chakrabarti, "Circuit Theory", Dhanpat Rai & Co., Delhi, 6th Edition.
2. A. Sudhakar, Shyammoan S. Palli "Circuits and Networks", Tata McGraw-Hill education
3. Smarajit Ghosh "Network Theory Analysis & Synthesis", PHI learning.
4. K.S. Suresh Kumar, "Electric Circuit Analysis" Pearson, 2013.
5. D. Roy Choudhury, "Networks and Systems", New Age International, 1998.

Subject Code	Subject Name	Total
ET 204	Digital System Design	04

**Prerequisite:** None

**Course Objectives:**

1. To understand number representation and conversion between different representations in digital electronic circuits.
2. To analyze logic processes and implement logical operations using combinational logic circuits.
3. To understand concepts of sequential circuits .
4. To analyze sequential systems in terms of state machines.
5. To understand concept of Programmable Devices, PLA, PAL, CPLD and FPGA
6. To understand the use of VHDL for simulation of combinational and sequential circuits.

**Course Outcomes:** The learner will be able to

1. Develop a digital logic and apply it to solve real life problems.
2. Analyze, design and implement combinational logic circuits.
3. Analyze, design sequential logic circuits
4. Implement sequential logic circuits.
5. Analyze digital system design using PLD.
6. Simulate and implement combinational and sequential circuits using VHDL systems.

Sr. No.	Module	Detailed Content	Hours	CO Mapping
I	<b>Principles of combinational logic</b>	Review of Number System, Binary Code, Binary Coded Decimal, Octal Code, Hexadecimal Code Gray Code and their conversions, Binary Arithmetics, Digital logic gates, Realization using NAND, NOR gates, Boolean Algebra, De Morgan's Theorem, SOP and POS representation, K Map up to four variables.	05	CO1
II	<b>Analysis and design of combinational logic</b>	Half adder, Full adder, Half Subtractor, Full Subtractor, Ripple Carry adder, Carry Look ahead adder and BCD adder. Binary Multiplier, Magnitude Comparator, Multiplexer and Demultiplexer: Multiplexer operations, cascading of Multiplexer, Boolean Function implementation using multiplexer and basic gates, demultiplexer, encoder and decoder	07	CO2
III	<b>Sequential Logic Circuits</b>	Flip flops: RS, JK, Master slave flip flops; T & D flip flops with various triggering methods, Conversion of flip flops, Registers: SISO, SIPO, PISO, PIPO, Universal shift	07	CO3

		registers. Counters: Asynchronous and Synchronous, Up/Down, MOD N, BCD		
IV	<b>Applications of Sequential Circuits</b>	Frequency division, Ring Counter, Johnson Counter. models, State transition diagram, Design of Moore and Mealy circuits-Design of vending Machine	08	CO4
V	<b>Programmable Logic Devices</b>	Introduction : Programmable Logic Devices (PLD), Programmable Logic Array (PLA), Programmable Array Logic(PAL), CPLD and FPGA	05	CO5
VI	<b>Introduction to VHDL Design</b>	Introduction to VHDL Design of Combinational circuits using VHDL: Introduction to Hardware Description Language, Core features of VHDL, data types, concurrent and sequential statements, data flow, behavioral, structural architectures, subprograms, Examples like Adder, subtractor, Multiplexers, De-multiplexers, decoder. Design of Sequential circuits using VHDL: VHDL code for flip flop, counters.	07	CO6

#### **Theory Assessment:**

#### **Internal Assessment: 40 marks**

Consisting of Two compulsory internal assessments 40 Marks each. The final marks will be the average of score of both the tests.

#### **End Semester Examination: 60 Marks**

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

#### **Text Books:**

1. John F. Warkerly, "Digital Design Principles and Practices", Pearson Education, Fourth Edition (2008).
2. R. P. Jain, "Modern Digital Electronics", Tata McGraw Hill Education, Third Edition (2003).
3. J. Bhaskar, "VHDL Primer", PHI, Third Edition (2009).
4. Volnei A. Pedroni, "Digital Electronics and Design with VHDL" Morgan Kaufmann Publisher (2008)

#### **References:**

1. Morris Mano / Michael D. Ciletti, "Digital Design", Pearson Education, Fourth Edition (2008).
2. Thomas L. Floyd, "Digital Fundamentals", Pearson Prentice Hall, Eleventh Global Edition (2015).
3. Mandal, "Digital Electronics Principles and Applications", McGraw Hill Education, First Edition (2010).
4. Stephen Brown & Zvonko Vranesic, "Fundamentals of Digital Logic Design with VHDL", Second Edition, TMH (2009).
5. Ronald J. Tocci, Neal S. Widmer, "Digital Systems Principles and Applications", Eighth Edition, PHI (2003)
6. Donald P. Leach / Albert Paul Malvino/Gautam Saha, "Digital Principles and Applications", The McGraw Hill, Seventh Edition (2011).

**Lab Prerequisite:**

Basic Electrical and Electronics Laboratory

**Software Requirements:**

VHDL

**Hardware Requirements:**

Breadboard, Different digital IC, Resistors, Diodes, Connecting wires

**Lab Objectives:**

The objective of this course is

- 1) To provide the fundamental concepts associated with digital logic and circuit design.
- 2) To introduce the basic concepts and laws involved in the designing and implementation of combinational logic circuits
- 3) To familiarize with the combinational circuits such as Multiplexers and Demultiplexers
- 4) To familiarize Sequential circuits utilized in the different digital circuits and systems.
- 5) To simulate design and analysis of the digital circuit and system using VHDL.

**Lab Outcomes :**

1. Able to develop a digital logic and apply it to solve real life problems.
2. Able to Analyze, design and implement combinational logic circuits such as adders and Subtractors.
3. Able to analyze combinational circuits such as Mux & Demux
4. Able to analyze and convert Flip-Flops
5. Able to implement sequential circuits such as counters and shift registers.
6. Able to Simulate and implement combinational and sequential circuits using VHDL systems.

Sr. No.	Level	Detailed Lab/Tutorial Description	Hours
	1. Basic 2. Design 3. Advanced 4. Project/Case Study/Seminar		
1	<b>Basic</b>	To implement basic gates using universal gates.	2
2	<b>Design</b>	To design Half adder & Full adder	2
3	<b>Basic</b>	To verify the operation of Multiplexer	2
4	<b>Basic</b>	To verify the operation of Demultiplexer	2
5	<b>Design</b>	Verification of Truth table and conversion of FlipFlop	2
6	<b>Design</b>	Universal shift register	2
7	<b>Design</b>	Design an asynchronous counter	2
8	<b>Design</b>	Design a synchronous counter	2
9	<b>Advanced</b>	Modeling different types of gates: (a) 2-input NAND (b) 2-input OR gate (c) 2-input NOR gate (d) NOT gate (e) 2-input XOR gate (f) 2-input XNOR gate	2
10	<b>Advanced</b>	Modeling (a) Half-adder (b) Full-adder	2

Subject Code	Subject Name	Total
ET 205	Signals and Systems	03

**Prerequisite:**

Engineering Mathematics III

**Course Objectives:**

1. To identify, classify and analyze various types of signals and systems
2. To analyze time Domain analysis of continuous and discrete time signals and systems.
3. To Analyze the continuous and discrete time signals and systems in frequency domain using Fourier Transform.
4. To analyze, formulate and solve problems on frequency domain analysis of continuous time systems using Laplace Transform.
5. To analyze, formulate and solve problems on frequency domain analysis of discrete time systems using Z- Transform.
6. To provide foundation of signal and system concepts to areas like communication, control and comprehend applications of signal processing in communication systems.

**Course Outcomes:**

1. Classify and analyze various types of signals and systems.
2. Determine convolution integral and convolution sum.
3. Analyze the continuous and discrete time signals and systems in frequency domain using Fourier Transform.
4. Analyze, formulate and solve problems on frequency domain analysis of continuous time systems using Laplace Transform.
5. Analyze, formulate and solve problems on frequency domain analysis of discrete time systems using Z- Transform.
6. Understand the concept of FIR and IIR system

Sr. No.	Module	Detailed Content	Hours	CO Mapping
1	<b>Introduction of Continuous and Discrete Time Signals and systems</b>	<p>Introduction to Signals: Definition of Signals , Representation of continuous time signals and discrete time signals, Sampling theorem(only statement derivation not expected), sampling of continuous time signals</p> <p>Basic Elementary signals , Arithmetic operations on the signals- Time Shifting, Time scaling, Time Reversal of signals</p> <p>Classification of Continuous time signals and Discrete time signal</p> <p>Introduction to Systems: Definition of Systems , Classification of Continuous time systems and Discrete time systems</p>	08	<b>CO 1</b>

2	<b>Time domain analysis of continuous time and discrete time systems</b>	Linear Time Invariant (LTI) systems, Convolution integral and Convolution sum for analysis of LTI systems Correlation of Signals: Auto-correlation and Cross correlation of Discrete time signal	07	<b>CO 2</b>
3	<b>Fourier Analysis of Continuous and Discrete Time Signals and Systems</b>	Fourier transform of periodic and non-periodic functions, Properties of Fourier Transform (Property Derivations are not expected), Inverse Fourier Transform, Frequency Response: computation of Magnitude and Phase Response, Limitations of Fourier Transform	05	<b>CO 3</b>
4	<b>Frequency domain analysis of continuous time system using Laplace transform</b>	Definition of Laplace Transform (LT), Region of Convergence (ROC), Properties of Laplace transform (Property Derivations are not expected), Inverse Laplace transform. Analysis of continuous time LTI systems using Laplace Transform: Causality and stability of systems in s-domain, Total Response of the system, Relation between LT and FT	06	<b>CO 4</b>
5	<b>Frequency domain analysis of discrete time system using Z- transform</b>	Definition of unilateral and bilateral Z Transform, Region of Convergence (ROC), Properties of Z-Transform, Inverse Z-Transform ( Partial fraction method only ) Analysis and characterization of the LTI system using Z transform: Transfer Function and difference equation, plotting Poles and Zeros of a transfer function, causality, stability, Total response of a system. Relation between Laplace Transform and Z-Transform, Relation between Fourier Transform and Z-Transform	09	<b>CO 5</b>
6	<b>FIR and IIR systems</b>	Concept of finite impulse response systems and infinite impulse response systems, Linear Phase FIR systems. Realization structures of LTI Discrete time system: Direct form –I and direct form II, Linear Phase FIR structures.	04	<b>CO6</b>

#### **Theory Assessment:**

#### **Internal Assessment: 40 marks**

Consisting of Two compulsory internal assessments 40 Marks each. The final marks will be the average of score of both the tests.

#### **End Semester Examination: 60 Marks**

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

**Text Books:**

1. NagoorKani, "Signals and Systems", Tata McGraw Hill, Third Edition, 2011
2. Tarun Kumar Rawat, "Signals and Systems", Oxford University Press 2016.
3. Simon Haykin and Barry Van Veen, "Signals and Systems", John Wiley and Sons, Second Edition, 2004.

**References:**

1. Hwei. P Hsu, "Signals and Systems", Tata McGraw Hill, Third edition, 2010
2. Rodger E Ziemer, William H. Tranter and D. Ronald Fannin, "Signals and Systems", Pearson Education, Fourth Edition 2009.
3. Alan V. Oppenheim, Alan S. Willsky and S. Hamid Nawab, "Signals and Systems", Prentice-Hall of India, Second Edition, 2002.

Admission Year 2022-2023

Subject Code	Subject Name	Credits
ET 206	Python Programming II	01

**Lab Prerequisite:** Python Programming I

**Lab Objectives:**

- L1. Describe the core syntax and semantics of Python programming language.
- L2. Infer the Object-oriented Programming concepts in Python
- L3. Using database operations in python like mysql.
- L4. Formulate GUI Programming and Image processing in Python
- L5. To introduce advanced python libraries like Numpy, Pandas, Matplotlib, Seaborn, Scipy.
- L6. Develop applications using a variety of libraries and functions

**Lab Outcomes:** The learner will be able to

LO1: Describe syntax and semantics in Python

LO2: Infer the Object-oriented Programming concepts in Python

LO3: Using database operations in python like mysql.

LO4: Design GUI Applications in Python

LO5: Express proficiency in handling Python libraries for data science LO6: Develop applications using Python

**Software Requirements:** Python IDE, Anaconda Environment, mysql workbench, Google Colab to run python scripts

**Hardware Requirements:** NA

Sr. No	Level 1. Basic 2. Design 3. Advanced 4. .Project/ Case Study/ Seminar	Detailed Lab/Tutorial Description	LO Mapping
1	Basic	<b>Python Fundamentals</b> 1.1 Basics of Control Statements, Functions, Classes, Objects and Exceptions  <b>OOPS and Exception handling</b> 1.2 Creating classes, Inheritance, polymorphism, Encapsulation, Abstraction difference between exceptions and error, exception handling with try and except, Custom exception handling, Best practice exception handling 1.4 File handlings	LO1

2	Design	<b>2. OOPS and Exception handling</b> 2.1 Creating classes, Inheritance, polymorphism, Encapsulation, Abstraction 2.2 difference between exceptions and error, exception handling with try and except, Custom exception handling, Best practice exception handling	LO2
3	Design	<b>3. Using Databases in Python</b> 3.1 Python MySQL Database Access Install the MySQLdb and other Packages 3.2 Create Database Connection CREATE, INSERT, READ Operation DML and DDL Operation with Databases	LO3
4	Advanced	<b>4. Graphical User Interface And Image Processing</b> 4.1 Graphical User Interface using Tkinter Library module, Creating simple GUI; Buttons, Labels, entry fields, widget attributes. 4.2 Database: SqLite database connection, Create, Append, update, delete records from database using GUI. 4.3 Basic Image Processing using OpenCV library, simple image manipulation using image module	LO4
5	Advanced	<b>5. Numpy, Pandas, Matplotlib, Seaborn, Scipy</b> 5.1 Introduction to Numpy, Creating and Printing Narray, Class and Attributes of Narray, Basic operation, Copy and view, Mathematical Functions of Numpy. 5.2 Introduction to Pandas, Understanding Dataframe, View and Select Data, Missing Values, Data Operations, File read and write operation. 5.3 Introduction to Matplotlib library, Line properties, Plots and subplots, Types of Plots, Introduction to Seaborn. 5.4 Introduction to Scipy, ScipySub packages Integration and Optimization.	LO5
6	Project	<b>6. Python Applications</b> 6.1 Build a project based on GUI applications 6.2 Applications in Networking, Data Analytical Tools, Introduction To ML, Introduction To Big Data 6.3 Django Web Framework in Python Introduction to MVC and MVT architecture in Web development Django folder structure and flow of control, Web Scraping, BeautifulSoup package	LO6

#### Lab Assessments:

1. **Term work Assessment:** At least 08 Experiments including 02 simulations covering entire syllabus must be given during the —Laboratory session batch wise—. Computation/simulation-based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students. Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time.

2. **Oral/Viva Assessment:** The practical and oral examination will be based on entire syllabus.

**Text Books:**

1. Core Python Programming, Dr. R. Nageswara Rao, Dreamtech Press
2. Zed A. Shaw, "Learn Python the Hard Way: A Very Simple Introduction to the Terrifyingly Beautiful World of Computers and Code", Addison Wesley; 3 edition (1 October 2013).
3. Yashavant Kanetkar, "Let us Python: Python is Future, Embrace it fast", BPB Publications; 1 edition (8 July 2019).
4. Dusty Phillips, "Python 3 object-oriented Programming", Second Edition PACKT Publisher August 2015.
5. John Grayson, "Python and Tkinter Programming", Manning Publications (1 March 1999).

**References:**

1. Eric Matthes, "Python Crash Course A hands-on, Project Based Introduction to programming" No Starch Press; 1 edition (8 December 2015).
2. Paul Barry, "Head First Python" O'Reilly; 2 edition (16 December 2016)
3. Andreas C. Mueller, "Introduction to Machine Learning with Python", O'Reilly; 1 edition (7 October 2016)
4. David Beazley, Brian K. Jones, "Python Cookbook: Recipes for Mastering Python 3", O'Reilly Media; 3 edition (10 May 2013).
5. Bhaskar Chaudhary, "Tkinter GUI Application Development Blueprints: Master GUI programming in Tkinter as you design, implement, and deliver 10 real world application", Packt Publishing (November 30, 2015)

Subject Code	Subject Name	Credits
ET 291	Mini Project I	02

### Lab Prerequisite:

Basic Electrical and Electronics Engineering (BEEE/BEE), C programming

### Lab Objectives:

- L1. To make students familiar with the basics of electronic devices and circuits, electrical circuits and digital systems
- L2. To familiarize the students with the designing and making of GPP
- L3. To make students familiar with the basics Microcontroller, Arduino board and Arduino IDE (Integrated Development Environment)
- L4. To familiarize the students with the programming and interfacing of different devices with Arduino Board
- L5. To acquaint with the process of identifying the needs and converting it into the problem.
- L6. To familiarize the process of solving the problem in a group

### Lab Outcomes:

The learner will be able to

- LO1. Identify basic electronic components and to design basic electronic circuits.
- LO2. Learn the technique of soldering and circuit implementation on general purpose printed circuit board (GPP).
- LO3. Utilize the basic electronic tools and equipments (like DMM, CRO, DSO etc.) and also perform analysis of hardware fault (Fault detection and correction)
- LO4. Write basic codes for the Arduino board using the IDE for utilizing the onboard resources.
- LO5. Apply the knowledge of interfacing different devices to the Arduino board to accomplish a given task.
- LO6. Identify problems based on societal /research needs , design Arduino based projects for a given problem and demonstrate capabilities of self-learning in a group, which leads to lifelong learning.

### Guidelines for Mini Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do surveys and identify needs, which shall be converted into problem statements for mini projects in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students shall submit an implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini projects.
- A log book to be prepared by each group, wherein the group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.
- Students in a group shall understand the problem effectively, propose multiple solutions and select the best possible solution in consultation with the guide/ supervisor. Students shall convert the best solution into a working model using various components of their domain areas and demonstrate. The solution to be validated with proper justification and report to be compiled in standard format.
- With the focus on self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is

preferable that a single project of appropriate level and quality be carried out in two semesters by all the groups of the students. i.e. Mini Project in semester III and IV.

**Software Requirements:**

Eagle: <https://www.autodesk.in/products/eagle/overview>

Arduino IDE: <https://www.arduino.cc/en/main/software>

**Hardware Requirements:** Arduino Board and various interfacing devices as mentioned in syllabus

Sr. No.	Level 1. Basic 2. Design 3. Advanced 4. Project/Case Study/Seminar	Detailed Lab/Tutorial Description	LO Mapping
1	1,2	<b>Identification and Designing of Circuit</b> 1.1 Identification of a particular application with understanding of its detailed operation. Study of necessary components and devices required to implement the application. 1.2 Designing the circuit for particular application (either analog , digital, electrical , analog and digital, etc )	LO1
2	2,3	<b>Software simulation and Implementation on GPP</b> 2.1 Simulation of circuit for particular application using software's to verify the expected results 2.2 Implementation of verified circuit on general purpose printed circuit board (GPP). Now Verify the hardware results by using electronic tools and equipment like millimeter, CRO, DSO etc.	LO2,LO3
3	2,3	<b>Detection of Hardware faults, Result verification and understanding Troubleshooting</b> 3.1 Identify the hardware faults in designed circuit and subsequently rectify it 3.2 Now again verify the hardware results by using electronic tools and equipments like millimeter, CRO, DSO etc. 3.3 Understand the trouble shooting by removing some wired connections. 3.4 Understand the trouble shooting of track. Troubleshoot the faculty components or devices	LO3
4	1,2	<b>Introduction to Arduino Uno board and integrated development environment (IDE)</b> 4.1 Write the code for blinking the on board led with a specified delay	LO4

		Apparatus Requirement: Hardware: Arduino Board LED, Software: Arduino IDE Software	
5	2,3	<b>GPIO (along with Analog pin) Programming</b> 5.1 Introduction to programming GPIO, Analog and PWM PINS. 1 Interface any Digital Sensors to the Arduino board and display sensor values on the serial Monitor. 2 Interface any Analog sensor to the Arduino board and display sensor values on the serial Monitor. 3. Generate varying duty cycle PWM using Arduino. 5.2 Controlling output devices/Displaying Introduction to different sensor (Analog and Digital), Relays, Motors and display. 1 Interface an Analog Sensor to the Arduino board and display sensor values on LCD/TFT/Seven segment Display. 2 Interface a temperature sensor to an Arduino and switch on a relay to operate a fan if temperature exceeds a given threshold. Also display the temperature on any of the display device	LO4, LO5
6	2,3	<b>Interfacing Communication Devices and Cloud Networking</b> 6.1 Introduction to Bluetooth, Zigbee, RFID and WIFI, specifications and interfacing methods. 1 Interface Wi-Fi /Bluetooth/GSM/Zigbee/RF module to Arduino and program it to transfer sensor data wirelessly between two devices. Any two techniques from the above-mentioned modules needs to be interfaced. 6.2 Identify problems based on societal /research needs and design Arduino based projects for a given problem.	LO4, LO5, LO6
	Project	<b>Sample Projects</b> 1. Waste Management System 2. Smart City Solutions 3. Energy Monitoring Systems 4. Smart Classrooms and learning Solutions 5. Home security systems 6. Smart Agriculture solutions 7. Healthcare solutions. 8. Industrial Applications 9. IoT Applications 10. Robotics	LO1, LO2, LO3, LO4, LO5, LO6

**Lab Assessments:****Termwork, Practical and Oral:**

The review/ progress monitoring committee shall be constituted by the heads of departments of each institute. The progress of the mini project to be evaluated on a continuous basis, minimum two reviews in each semester. In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.

**Distribution of Term work marks for both semesters shall be as below**

- Marks awarded by guide/supervisor based on log book : 10
- Marks awarded by review committee : 10
- Quality of Project report : 05

Two reviews will be conducted for continuous assessment, First shall be for finalization of problem and proposed solution Second shall be for implementation and testing of solution.

**Assessment criteria of Mini Project.**

Mini Project shall be assessed based on following criteria;

1. Quality of survey/ need identification
2. Clarity of Problem definition based on need.
3. Innovativeness in solutions
4. Feasibility of proposed problem solutions and selection of best solution
5. Cost effectiveness
6. Societal impact
7. Innovativeness
8. Cost effectiveness and Societal impact
9. Full functioning of working model as per stated requirements
10. Effective use of skill sets
11. Effective use of standard engineering norms
12. Contribution of an individual's as member or leader
13. Clarity in written and oral communication

**Guidelines for Assessment of Mini Project Practical/Oral Examination:**

Report should be prepared as per the guidelines issued by the Guide. Mini Project shall be assessed through a presentation and demonstration of the working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organizations having experience of more than five years approved by the head of Institution. Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

**Mini Project shall be assessed based on following points;**

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Full functioning of working model as per stated requirements
5. Effective use of skill sets
6. Effective use of standard engineering norms
7. Contribution of an individual's as member or leader
8. Clarity in written and oral communication

**Textbook:**

Arduino for Dummies, by John Nussey (2013)

**References:**

1. R S Khandpur, "Printed circuit board", McGraw-Hill Education; 1st edition, 24 February, 2005.

2. Arduino Projects for Dummies, by Brock Craft (2013)
3. Programming Arduino –Getting Started with Sketches, Simon Monk (2016)
4. Programming Arduino -Next Steps, by Simon Monk (2016)

**Online Repository:**

1. GitHub
2. NPTEL Videos on Arduino Programming
3. Spoken Tutorial Project-IIT Bombay: [https://spoken-tutorial.org/tutorialsearch/?search\\_foss=Arduino&search\\_language=English](https://spoken-tutorial.org/tutorialsearch/?search_foss=Arduino&search_language=English)
4. Teachers are recommended to use a free online simulation platform “Tinkercad” for the simulation of Arduino based circuits before the students implement it in the hardware: <https://www.tinkercad.com/>

Admission Year 2022-2023

Course Code	Course Name	Credits
ET 207	Engineering Mathematics IV	04

**Prerequisite:**

Engineering Mathematics-I , Engineering Mathematics-II and Engineering Mathematics -III

**Course Objectives:**

1. To understand the basic techniques of statistics like correlation, regression, and curve fitting for data analysis, Machine learning, and AI.
2. To Acquaint with the concepts of probability, random variables with their distributions and expectations.
3. To Understand the concepts of vector spaces used in the field of machine learning and engineering problems
4. To understand the concepts of Calculus of Variations.
5. To understand the concepts of complex integration
6. To Use concepts of vector calculus to analyze and model engineering problems.

**Course Outcomes:** The learner will be able to

1. Apply the concept of Correlation and Regression to the engineering problems in data science, machine learning, and AI.
2. Illustrate understanding of the concepts of probability and expectation for getting the spread of the data and distribution of probabilities.
3. Apply the concept of vector spaces and orthogonalization process in Engineering Problems.
4. Find the extremals of the functional using the concept of Calculus of variation.
5. Use the concepts of Complex Integration for evaluating integrals, computing residues & evaluate various contour integrals
6. Apply the concepts of vector calculus in real life problems.

Sr. No.	Module	Detailed Content	Hrs.	CO Mapping
I	<b>Correlation, Regression and Curve Fitting,</b>	Karl Pearson's Coefficient of correlation (r), Spearman's Rank correlation coefficient (R), Lines of regression, Fitting of first and second degree curves.	6	1
II	<b>Probability, Probability Distributions,</b>	Conditional probability, Total Probability and Baye's Theorem, Discrete and Continuous random variables, Probability mass and density function, Probability distribution for random variables, Expectation, Variance, Binomial distribution, Poisson distribution, Normal distribution	7	2
III	<b>Linear Algebra: Vector Spaces</b>	Vectors in n-dimensional vector space, norm, dot product, The Cauchy Schwarz inequality, Unit vector ; Linear combinations, linear Dependence and Independence, QR decomposition ; Orthogonal projection, Orthonormal basis, Gram-Schmidt process for vectors ; Vector spaces over real field, subspaces.	7	3

IV	<b>Calculus of Variations</b>	Euler- Lagrange equation (Without Proof), When F does not contain y, When F does not contain x, When F contains x, y, y'. Isoperimetric problems- Lagrange Method. Functions involving higher order derivatives: Rayleigh-Ritz Method.	6	4
V	<b>Complex Integration</b>	Line Integral, Cauchy's Integral theorem for simple connected and multiply connected regions (without proof), Cauchy's Integral formula (without proof). Taylor's and Laurent's series (without proof). Definition of Singularity, Zeroes, poles of f(z), Residues, Cauchy's Residue Theorem (without proof)	7	5
VI	<b>Vector Integration</b>	Vector integral: Line Integral, Green's theorem in a plane (Without Proof), Stokes' theorem (Without Proof) only evaluation. Gauss' divergence	6	6

List of tutorials

Sr. No.	Level 1. Basic 2. Design 3. Advanced 4. Project/Case Study/Seminar	Detailed Lab/Tutorial Description	Hours
1	<b>Basic</b>	Correlation and Regression	2
2	<b>Advanced</b>	Regression and Curve fitting	2
3	<b>Basic</b>	Probability	2
4	<b>Advanced</b>	Probability Distribution	2
5	<b>Advanced</b>	Calculus of variation	2
6	<b>Basic</b>	Linear algebra : Vector space -11	2
6	<b>Advanced</b>	Linear algebra : Vector space -2	2
7	<b>Basic</b>	Complex Integration -2	2
8	<b>Advanced</b>	Complex Integration -2	2
9	<b>Basic</b>	Vector Integration-1	2

10	Advanced	Vector Integration-2	2
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**Theory Assessment:**

**Internal Assessment: 40 marks**

Consisting of Two compulsory internal assessments 40 Marks each. The final marks will be average of score of both the tests.

**End Semester Examination: 60 Marks**

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

**Term work:**

The distribution of term work marks -

Attendance - 05 marks

Assignments -10 marks

Tutorials- 10 marks

**Text Books and References:**

1. Higher Engineering Mathematics B. V. Ramana, Tata Mc-Graw Hill Publication
2. Higher Engineering Mathematics, Dr. B. S. Grewal, Khanna Publication
3. Advanced engineering mathematics H.K. Das, S . Chand, Publications.
4. Advanced Engineering Mathematics Wylie and Barret, Tata Mc-Graw Hill.
5. Complex Variables and Applications, Brown and Churchill, McGraw-Hill education.
6. Probability, Statistics and Random Processes, T. Veerarajan, McGraw-Hill education.
7. Beginning Linear Algebra Seymour LipschutzSchaum's outline series, Mc-Graw Hill Publication.

Course Code	Course Name	Credits
ET 208	Electronic Communication Systems	04

**Prerequisite:**

Electronic Devices and Circuits

**Course Objectives:**

The course is introduced to

1. Illustrate the Elements in Analog Communication Systems
2. Understand the concepts of Amplitude Modulation Demodulation
3. Learn Frequency Modulation Demodulation
4. Evaluate the performance of Radio Receivers
5. Identify pulse analog modulation techniques
6. Introduce digital communication systems and multiplexing techniques

**Course Outcomes:**

The learner will be able to

1. Understand the basic components and types of noises in communication system
2. Describe amplitude modulation; compare the types and uses of AM system
3. Explain the Frequency modulator demodulator circuits and analyse noise in FM system
4. Distinguish AM and FM receivers in circuit requirements and their performance
5. Sketch the output waveforms for pulse modulation techniques.
6. Demonstrate the principles of multiplexing and demultiplexing techniques.

Sr. No.	Module	Detailed Content	Hrs.	CO Mapping
I	<b>Introduction to Communication Systems</b>	Elements of Analog and Digital Communication Systems, electromagnetic spectrum, signal bandwidth and power, types of communication channels, Introduction to time and frequency domain. Basic concepts of wave propagation. Noise in communication systems ,parameters of noise, Noise Analysis- Friss Formula	05	CO1
II	<b>Amplitude Modulation and Demodulation</b>	Basic concepts, need for modulation, waveforms (time domain and frequency domain), modulation index, bandwidth, voltage distribution and power calculations. DSBFC: Principles, low-level and high-level transmitters, DSB suppressed carrier, Balanced modulators with diode (Ring modulator and FET) and SSB systems. Amplitude demodulation: Diode detector, practical diode detector, Comparison of different AM techniques, Applications of AM and use of VSB in broadcast television.	10	CO2

III	<b>Frequency Modulation and Demodulation</b>	Frequency and Phase modulation (FM and PM): Basic concepts, mathematical analysis, FM wave (time and frequency domain), sensitivity, phase and frequency deviation, modulation index, deviation ratio, bandwidth requirement of angle modulated waves, narrow band FM and wideband FM. Varactor diode modulator, FET reactance modulator, Direct FM transmitter, indirect FM Transmitter, noise triangle, pre-emphasis and de-emphasis FM demodulation: Balanced slope detector, Foster-Seely discriminator, Ratio detector, FM demodulator using Phase lock loop, Compare FM and PM.	8	CO3
IV	<b>AM and FM Receivers</b>	Characteristics of radio receivers, AM Radio Receiver: TRF, Super-heterodyne receiver block diagram, tracking and choice of IF, AGC and its types and Double Conversion Radio Receiver, FM receiver block diagram,	4	CO4
V	<b>Pulse Modulation Techniques</b>	Sampling theorem for low pass signal, proof with spectrum, Nyquist criteria, Sampling techniques, aliasing error and aperture effect. Analog Pulse Techniques : PAM, PWM, PPM generation, detection and applications. Digital Techniques : Basics of PCM system, Delta modulation (DM) and Adaptive Delta Modulation (ADM). Comparison of Digital techniques	6	CO5
VI	<b>Multiplexing and Demultiplexing Techniques</b>	Frequency Division Multiplexing transmitter & receiver block diagram and applications. Time Division Multiplexing transmitter & receiver block diagram and applications. T1 System, PAM TDM system	5	CO6

### Electronics and Communication Laboratory :

#### Lab Prerequisite:

Electronic Devices and Circuits

**Software Requirements:** Matlab

**Hardware Requirements:** Kits for AM, DSB-SC, DSB-FC, SSB, FM, PAM, PWM, PPM, Superheterodyne receiver, TDM, FDM

Sr. No.	Level 1. Basic 2. Design 3. Advanced 4. Project/Case Study/Seminar	Detailed Lab/Tutorial Description	Hrs.
1	1, 2	Generation and detection of AM (DSB-FC, DSB-SC,SSB) signals.	2
2	1, 2	Generation and detection of FM signals.	2
3	3	Study of AM broadcast receiver (Super heterodyne).	2
4	1	Generation of PAM signal and verify the sampling theorem.	2

5	1	Generation of PPM, PWM signal.	2
6	3	Study of TDM and FDM multiplexing techniques.	2
7	2, 3	Implement Pre-emphasis and De-emphasis using Spice /Matlab Simulation	2
8	2, 3	Generate AM & FM using Matlab Simulation	2

### **Theory Assessment:**

#### **Internal Assessment: 40 marks**

Consisting of Two compulsory internal assessments 40 Marks each. The final marks will be the average score of both the tests.

#### **End Semester Examination: 60 Marks**

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

### **Lab Assessments:**

**Term work Assessment:** At least 08 Experiments including 02 simulations covering the entire syllabus must be given during the —Laboratory session batch wise—. Computation/simulation-based experiments are also encouraged. The experiments should be student centric and attempts should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for a maximum batch of four students. Term work assessment must be based on the overall performance of the student with every experiment/tutorials and mini-projects (if included) are graded from time to time.

**Oral/Viva Assessment:** The practical and oral examination will be based on the entire syllabus.

### **Text Books:**

1. Kennedy and Davis, "Electronics Communication System", Tata McGraw Hill, Fourth edition.
2. B.P. Lathi, Zhi Ding "Modern Digital and Analog Communication system", Oxford University Press, Fourth edition.
3. Wayne Tomasi, "Electronics Communication Systems", Pearson education, Fifth edition.

### **References:**

1. Taub, Schilling and Saha, "Taub's Principles of Communication systems", Tata McGraw Hill, Third edition.
2. P. Sing and S.D. Sapre, "Communication Systems: Analog and Digital", Tata McGraw Hill, Third edition.
3. Simon Haykin, Michel Moher, "Introduction to Analog and Digital Communication", Wiley, Second edition.
4. Dennis Roddy and John Coolen, Electronic Communication, Pearson, 4/e, 2011.

Course Code	Course Name	Credits
ET 209	Linear Integrated Circuits	04

**Prerequisite:**

1. Basic Electrical & Electronics Engineering
2. Electronic Devices and Circuits

**Course Objectives:**

1. To understand basic concepts of operational amplifiers.
2. To understand various linear and non-linear applications of operational amplifier.
3. To understand specifications of A/D and D/A converter and their types.
4. To understand the fundamentals of IC555 and its applications.
5. To understand PLL IC 565 and VCO IC 566 and its applications.
6. To understand various voltage regulator integrated circuits.

**Course Outcomes:**

Having successfully completed this course, the student will be able to

1. Understand the basic building blocks and fundamentals of operational amplifiers.
2. Develop skills to design linear and nonlinear applications of op-amp.
3. Analyze various ADC and DAC techniques.
4. Explain and compare the working of multivibrators using timer IC 555 and its applications.
5. Gain knowledge about PLL IC 565 and VCO IC 566 and its applications.
6. Illustrate the functions of various voltage regulator integrated circuits.

Sr. No.	Module	Detailed Content	Hrs.	CO Mapping
I	<b>Basics of Operational Amplifier</b>	Block diagram of Op-Amp, Ideal and practical characteristics of op-amp, Configurations of Op-Amp: Operational amplifier open loop and closed loop configurations.	4	CO1
II	<b>Linear Applications of OP-AMP</b>	Inverting and non-inverting amplifier, voltage follower, summing and difference amplifier, current amplifier, voltage to current converter and current to voltage converter, Integrator & differentiator (ideal & practical), Instrumentation amplifier and applications, Active Filters: First and Second order active low pass, high pass, band pass, band reject and Notch filters. Positive feedback, Barkhausen's criteria, Sine Wave Oscillators: RC phase shift oscillator, Wien bridge oscillator.	9	CO2
III	<b>Non-linear Applications of OP-AMP</b>	Comparators: Inverting comparator and non-inverting comparator, zero crossing detectors, window detector, Schmitt Triggers: Inverting Schmitt trigger, non-inverting Schmitt trigger, Waveform Generators: square wave	7	CO2

		generator and triangular wave generator, Basics of Precision Rectifiers: Half wave and full wave precision rectifiers, peak detector, sample and hold circuit.		
IV	<b>Analog to Digital and Digital to Analog Convertors</b>	Specifications of D/A converter, DAC techniques: weighted resistor DAC and R-2R ladder DAC, Specifications of A/D converter, ADC techniques: flash ADC, dual slope ADC, successive approximation ADC.	5	CO3
V	<b>Special Purpose Integrated Circuits</b>	Functional block diagram and working of IC 555, Design of Astable and Monostable multivibrator using IC 555, Applications of Astable and Monostable multivibrator as Pulse width modulator and Pulse Position Modulator, Functional block diagram and working of VCO IC 566 and application as frequency modulator, Functional block diagram and working of PLL IC 565 and application as FSK Demodulator.	8	CO4, CO5
VI	<b>Voltage Regulators</b>	Functional block diagram, working and design of three terminal fixed (78XX, 79XX series) and three terminal adjustable (LM317, LM337) voltage regulators, Functional block diagram, working and design of general purpose IC 723 (HVLC and HVHC). Introduction and block diagram of switching regulator.	6	CO6

#### Lab Prerequisite:

Basic Electrical & Electronics Engineering

Electronic Devices & Circuits

**Software Requirements:** Tina, LTspice and Proteus

**Hardware Requirements:** Function Generator, CRO, multimeter along with basic components required for designing the circuit.

Sr. No.	Level 1. Basic 2. Design 3. Advanced 4. Project/Case Study/Seminar	Detailed Lab Description	Hrs.
1	1,2	Design inverting and non-inverting amplifier using IC 741.	2
2	1,2	Design summing amplifier using op-amp IC 741	2
3	1,2	Design difference amplifier using op-amp IC 741	2
4	2,3	Design and analyze Integrator using op-amp IC 741	2
5	2,3	Design and analyze Differentiator using op-amp IC 741	2
6	1,2	Design Wein bridge and RC phase shift Oscillator using op-amp IC 741	2
7	2,3	Design and analyze second order High pass and Low pass filter using op-amp IC 741	2
8	2,3	Design Instrumentation amplifier using 3 Op-Amp.	2

9	1,2	Design Precision rectifier using op-amp IC 741	2
10	2,3	Design Square & Triangular wave generator using op-amp IC 741	2
11	1,2	Design Schmitt trigger using op-amp IC 741	2
12	2,3	Design and implement 2bit R-2R ladder DAC.	2
13	2,3	Design and implement flash ADC	2
14	2,3	Design Astablemultivibrator using IC 555 for fixed frequency and variable duty cycle.	2
15	2,3	Design Monostable Multivibrator using IC 555.	2
16	2,3	Design Low Voltage Low Current voltage regulator using IC 723.	2
17	2,3	Design High Voltage High Current voltage regulator using IC 723.	2
18	2,3	Design Frequency Modulator using IC 566	2

### **Theory Assessment:**

#### **Internal Assessment: 40 marks**

Consisting of Two compulsory internal assessments 40 Marks each. The final marks will be average of score of both the tests.

#### **End Semester Examination: 60 Marks**

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

### **Lab Assessments:**

**Term work Assessment:** At least 08 Experiments including 02 simulations covering entire syllabus must be given during the —Laboratory session batch wise—. Computation/simulation-based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students. Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time.

**Oral/Viva Assessment:** The practical and oral examination will be based on entire syllabus.

### **Text Books:**

1. Ramakant A. Gaikwad, “Op Amps and Linear Integrated Circuits”, Pearson Education
2. Saliyahanan and Kanchanabhaskaran, “Linear Integrated Circuits”, TMH
3. D. Roy Choudhury and S. B. Jain, “Linear Integrated Circuits”, New Age International Publishers, 4th Edition.

Course Code	Course Name	Credits
ET 210	Digital Signal Processing	04

**Prerequisite:**

Signals and systems

**Course Objectives:**

1. To introduce students with Discrete fourier transform and Fast fourier transforms for analysis of Discrete time signals and systems.
2. To use and design techniques for implementation of IIR digital filters.
3. To use and design techniques for implementation of FIR digital filters.
4. To introduce Finite Word Length effects in Digital Filters.
5. To introduce the students to digital signal processors and its applications.
6. To use and understand multirate digital signal processing.

**Course Outcomes:** The learner will be able to

1. Analyze the discrete time signals and system using different transform domain techniques
2. Apply the knowledge of design of IIR digital filters to meet arbitrary specifications.
3. Apply the knowledge of design of FIR digital filters to meet arbitrary specifications
4. Understand the effect of hardware limitations on performance of digital filters.
5. Develop different signal processing applications using DSP processors
6. Analyze discrete-time filter banks and multi-rate signal processing

Module	Detailed Content	Hrs	CO Mapping
I	Discrete Fourier Transform and Fast Fourier Transform: Definition and Properties of DFT, IDFT, Circular convolution, Computation of linear convolution using circular convolution, Filtering of long data sequences: Overlap-Save and Overlap-Add Method FFT: Fast Fourier Transforms (FFT), Radix-2 decimation in time and decimation in frequency FFT algorithms, inverse FFT	8	CO1
II	IIR Digital Filters: Analog filter design -Butterworth filters, Chebyshev Type I filters, Mapping of S-plane to Z-plane, IIR filter design by impulse invariance method and Bilinear transformation method, Design of IIR digital Butterworth filters and Chebyshev Type I filters. Analog and Digital frequency transformations	8	CO2
III	FIR Digital Filters- Introduction of FIR digital filters, Minimum Phase, Maximum Phase, Mixed Phase and linear phase FIR filters, location of the zeros of linear phase FIR filters, Gibbs phenomenon, Design of FIR filters using Window techniques (Rectangular, Hamming, Hanning, Blackmann), Design of FIR filters using Frequency Sampling technique, Comparison of FIR & IIR	7	CO3
IV	Finite Word Length effects in Digital Filters- Quantization, truncation and rounding, Input quantization error,	6	CO4

	Product quantization error, Coefficient quantization error, Zero-input limit cycle oscillations, Overflow limit cycle oscillations, Scaling. Quantization in Floating Point realization of IIR digital filters, Finite word length effects in FIR digital filters		
V	DSP Processors- Introduction to General Purpose and Special Purpose DSP processors, fixed point and floating point DSP processor, digital signal processor architecture, Pipelining, multiplier and accumulator (MAC), Very long instruction word Architecture (VLIW) Architecture of TMS320C6X fixed and floating DSP processors. Applications of digital signal processing-Speech processing, Radar Signal Processing, Biomedical Applications in DSP	6	CO5
VI	Multirate DSP and Filter Bank: Introduction and concept of Multirate Processing, Decimator and Interpolator, Decimation and Interpolation by Integer numbers Sample rate conversion using Polyphase filter structure, Filter Banks	4	CO6

#### List of Practicals

Sr. No.	Level 1. Basic 2. Design 3. Advanced 4. Project/Case Study/Seminar	Detailed Lab/Tutorial Description	Hours
1	<b>Basic</b>	To perform DFT and IDFT of the discrete time sequence and sketch the magnitude and phase spectrum.	2
2	<b>Basic</b>	To perform circular convolution of discrete time sequences using DFT and IDFT method and compute linear convolution using circular convolution.	2
3	<b>Design</b>	To Design a analog low pass Butterworth and Chebyshev filter	2
4	<b>Design</b>	To Design an IIR butterworth low pass filter using impulse in-variance method .	2
5	<b>Design</b>	To Design an IIR butterworth low pass filter using bilinear transformation method .	2
6	<b>Design</b>	To Design an IIR Chebyshev low pass filter using bilinear transformation method .	2
7	<b>Design</b>	To Design a FIR low pass, high pass filter using various windowing methods and plot their frequency response.	2
8	<b>Design</b>	To plot magnitude and phase response of low pass ,high pass & all Pass filter	2
9	<b>Design</b>	To plot magnitude and phase response of comb filter & notch filter	2
10	<b>Advanced</b>	To perform interpolation and decimation on a given discrete signal.	2

11	<b>Advanced</b>	To perform the Circular Convolution of two given discrete sequences using TMS320C6745 Kit.	2
12	<b>Advanced</b>	To perform the Linear Convolution of two given discrete sequences using TMS320C6745 Kit.	2
13	<b>Case Study</b>	One case study	2

### **Theory Assessment:**

#### **Internal Assessment: 40 marks**

Consisting of Two compulsory internal assessments 40 Marks each. The final marks will be average of score of both the tests.

#### **End Semester Examination: 60 Marks**

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

### **Lab Assessments:**

**Term work Assessment:** At least 08 Experiments including 02 simulations covering entire syllabus must be given during the —Laboratory session batch wise—. Computation/simulation-based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one case study can be conducted for maximum batch of four students. Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time.

**Oral/Viva Assessment:** The practical and oral examination will be based on entire syllabus.

### **Text Books:**

1. Tarun Kumar Rawat, "Digital Signal Processing", Oxford University Press, 2015
2. Nagoor Kani, "Digital Signal Processing", Tata McGraw Hill Education Private Limited.
3. Emmanuel C. Ifeachor, Barrie W. Jervis, "Digital Signal Processing", A Practical Approach by, Pearson Education
4. S. Salivahanan, C. Gnanpriya, — Digital Signal processingl, McGraw Hill
5. Ramesh Babu, "Digital Signal Processing", Sciencetech Publication (India) Private Limited

### **References:**

1. Proakis J., Manolakis D., "Digital Signal Processing", 4th Edition, Pearson Education.
2. B. Venkata Ramani and M. Bhaskar, "Digital Signal Processors, Architecture, Programming and Applications", Tata McGraw Hill, 2004.
3. A.V.Oppenheim, R.W. Schafer and J.R. Buck, "Discrete Time Signal Processing", Pearson, 8th Indian Reprint, 2004.

Course Code	Course Name	Credits
ET 211	Microprocessor & Microcontroller	04

**Prerequisite:**

Digital System Design

**Course Objectives:**

1. To understand the basic concepts of microcomputer systems.
2. To understand the architecture of the 16-bit Microprocessor 8086.
3. To understand architecture and programming of 8-bit Microcontroller 8051.
4. To develop knowledge of peripheral devices and their interfacing for designing 8051 based applications in Assembly Language.
5. To understand the architecture of PIC and AVR microcontrollers.
6. To understand the basics of the ARM Architecture.

**Course Outcomes:**

The learner will be able to

1. Understand The Basic Concepts Of Micro Computer Systems.
2. Understand The architectural aspects of 8086 microprocessor.
3. Program 8051 microcontroller by understanding its architectural aspects.
4. Interface various peripheral devices to 8051 microcontrollers.
5. Design applications using microcontrollers.
6. Develop basic knowledge about the ARM architecture.

Module No.	Unit No.	Details	Hrs.	CO Mapping
1.	<b>Introduction to Microcomputer Systems.</b>		04	CO1
	1.1	Block diagram of microprocessor-based system: CPU I/O Devices, Clock, Memory, Concept of Address, Data and Control Bus and Tristate logic.		
	1.2	Concepts of Program counter register, Reset, Stack and stack pointer, Subroutine, Interrupts and Direct Memory Access		
	1.3	Concept of RISC CISC Architecture		
	1.4	Concept of Harvard Von Neumann Architecture		
2.	<b>Architectural features of 8086 Microprocessor</b>		10	CO2
	2.1	Major Features Of 8086 Microprocessor.		
	2.2	8086 CPU Architecture, instruction set and programming, pipelined operation,		
	2.3	Programmer's Model & Memory Segmentation.		
	2.4	8086 pin description in detail.		
	2.5	Minimum And Maximum mode pins of 8086.		
	2.6	Read and Write bus cycle of 8086		

3.	<b>8051 Microcontroller Architecture and assembly language programming</b>		06	CO3
	3.1	Comparison between Microprocessor and Microcontroller		
	3.2	Features,architecture and pin configurations, Memory organization, Addressing modes of 8051		
	3.3	Assembler directives of 8051. Instruction Set:Data transfer,Arithmetic, Logical,Branching.		
	3.4	Programs related to: arithmetic, logical, delay, input, output, timer, counters, port, serial communication and interrupts.		
4.	<b>Internal Hardware of 8051 Microcontroller &amp; Interfacing Applications</b>		08	CO4
	4.1	I/O Port structures, Interrupts, Timers/Counters, Serial Ports And their programming.		
	4.1	Display Interfacing:7-segment LED display, 16x2 generic alphanumeric LCD display.		
	4.2	Analog Devices Interfacing: 8-bitADC/DAC		
	4.4	Motor Interfacing:dc motor,stepper motor and servomotor.		
5.	<b>PIC and AVR Microcontrollers</b>		06	CO5
	5.1	PIC family Categories and importance (10F/12F/16F/18F), PIC18 Architecture and Features, Assembly Language Programming: Branch, Arithmetic and Logic Instructions. Peripheral Interfacing		
	5.2	AVR Microcontroller: Architecture and Features, Standard I/O interrupts		
	5.3	Comparison of PIC and AVR microcontrollers.		
6.	<b>The ARM Architecture</b>		05	CO6
	6.1	ARM Introduction, Concept of Cortex-A, Cortex-R and Cortex-M, Architectural Inheritance, Introduction and features of ARM7,		
	6.2	Programmer's Model and Pipelining, Exceptions, Interrupts and Vector Table,		
	6.3	Instruction set: Data processing and transfer, control flow. Thumb Instruction Set Support		

**Lab Prerequisite:**

Basic Electrical and Electronics Engineering, Engineering Physics I & II

**Software Requirements:** Experiments can be conducted on Assembler, Emulator

**Hardware Requirements:** Hardware kits

Sr. No.	Level 1. Basic 2. Design 3. Advanced 4. Project/Case Study/Seminar	Detailed Lab/Tutorial Description	Hrs.
1	1	To perform the basic arithmetic and logical operations using the 8086 Microprocessor	2
2	2	To write an assembly language program to search a character in a string using 8086	2
3	3	To write an assembly language program for password checking using 8086.	2
4	1	To write an assembly language program to perform Arithmetic and Logical Operations using 8051 microcontroller.	2
5	1	To write an assembly language program To transfer of data bytes between Internal and External Memory using 8051 microcontroller.	2
6	2	To write an assembly language program to perform experiments based on General Purpose Input-Output & Timers.	2
7	3	Programs for Interfacing of SSD/LCD with 8051 microcontroller.	2
8	3	Program for Serial communication of 8051 using UART.	2
9	3	Programs for Interfacing of Stepper Motor with 8051 microcontroller.	2
10	3	Programs for Interfacing of DC Motor with 8051 microcontroller.	2
11	1	Perform DC motor speed control using PWM with PIC microcontroller	2
12	2	Interface ADC with PIC microcontroller	2
13	3	Interface Different Sensors and LCD with PIC microcontroller	2
14	4	Mini project based on any application related to (8051/ PIC) microcontroller.	2

**Theory Assessment:****Internal Assessment: 40 marks**

Consisting of Two compulsory internal assessments 40 Marks each. The final marks will be average of score of both the tests.

**End Semester Examination: 60 Marks**

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

**Lab Assessments:**

**Term work Assessment:** At least 08 Experiments including 02 simulations covering entire syllabus must be given during the —Laboratory session batch wise—. Computation/simulation-based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students. Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time.

**Oral/Viva Assessment:** The practical and oral examination will be based on entire syllabus.

**Text Books:**

1. Microprocessor and Interfacing: By Douglas Hall (TMH Publication)
2. M. A. Mazidi, J. G. Mazidi and R. D. Mckinlay, “The 8051 Microcontroller & Embedded systems”, Pearson Publications, Second Edition 2006.
3. C. Kenneth J. Ayala and D. V. Gadre, “The 8051 Microcontroller & Embedded system using assembly & ‘C’ ”, Cengage Learning, Edition 2010.

**Reference Books:**

1. 8086 Microprocessor Programming and Interfacing the PC: By Kenneth Ayala (West Publication)
2. Microcomputer Systems: 8086/8088 family Architecture, Programming and Design: By Liu & Gibson (PHI Publication).
3. Satish Shah, “The 8051 Microcontrollers”, Oxford publication first edition 2010.
4. “MCS@51 Microcontroller, Family users Manual” Intel

Course Code	Course Name	Credits
ET 212	Personal Finance Management	02

**Course objectives:** The course is aimed

1. To introduce the basic concepts of finance and their practical application.
2. To demonstrate the process of drafting a financial budget.
3. To explain investment avenues and planning of personal finance.
4. To develop portfolio strategies for individual and institutional investor
5. To discuss various components of insurance and tax management.
6. To introduce financial frauds, measures to avoid frauds and resources of frauds.

**Course outcomes:** On successful completion of course learner/student will be able:

1. To know the basic concepts of finance and interpret current business positions by reading books of accounts.
2. To analyze investment avenues and plan personal finance to develop portfolio strategies for individuals.
3. To develop skills to interpret current market position.
4. To create analytical approach for financial decisions.
5. To learn and understand Tax and Insurance management.
6. To identify financial frauds and understand the level of financial aspects.

Module No	Module	Detailed Contents	Hrs.
1	Introduction to Personal Financial Planning	Financial Planning Process: Goal, Vision and mission , Components of Personal Financial Plan, Advantages and developing personal financial plan	3
2	Financial Budget	Meaning and Process of Drafting Financial Budget , Components of Financial Budget, Drafting Financial Budget	3
3	Investment Management	Meaning of Investment, Concept of Risk and Return and Time Value of Money, Investment Avenues, Portfolio Creation and Management	6
4	Insurance and Spending Management	Components of Insurance: Life Insurance, Health Insurance ,Property Insurance ,Spending Management	3
5	Tax Management	Introduction to Tax Regime and Tax Returns, Introduction to Income Tax and its impact on Incomes ,Tax on property: Revenue and Capital Incomes, Tax Management, Tax Saving, Tax Avoidance	3
6	Financial Frauds	Meaning and Types of Fraud,Investment Frauds, Online Payment Frauds, Identity Theft, Mass Marketing Fraud ,Measures to avoid frauds,Recourse from frauds,Cases of Frauds	6

**Theory Assessment:****Internal Assessment: 20 marks**

Consisting of Two compulsory internal assessments 20 Marks each. The final marks will be the average score of both the assessments.

**End Semester Examination: 40 Marks**

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

**Books and References:**

1. Financial Management: I M Pandey, Vikas Publishing House.
2. Financial Management: M.Y. Khan, P.K. Jain, Tata McGraw Hill.
3. Financial Management: Prassana Chandra, Prentice Hall.
4. Investment Analysis & Portfolio Management- Prasanna Chandra, Tata McGrawHill
5. Wealth Management- Dun & Bradstreet, Tata McGrawHill
6. Wealth Management- S.K .Bagachi, Jaico publishing house

Course Code	Course Name	Credits
ET 292	Mini Project II	02

**Lab Prerequisite:** ET 291 Project

**Lab Objectives:**

1. To improve the knowledge of electronics hardware among students
2. To familiarize the students with the programming and interfacing of different devices with Arduino and Raspberry Pi Board.
3. To increase students' critical thinking ability and provide solutions to some real time problems.
4. To acquaint with the process of identifying the needs and converting it into the problem.
5. To familiarize the process of solving the problem in a group
6. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems
7. To inculcate the process of self-learning and research.

**Lab Outcomes:** The learner will be able to

1. Write code using python language using IDE for utilizing the onboard resources.
2. Apply the knowledge of interfacing different devices to the Raspberry Pi board to accomplish a given task.
3. Identify problems based on societal /research needs.
4. Design Raspberry Pi based projects for a given problem.
5. Draw the proper inferences from available results through theoretical/experimental/simulations
6. Demonstrate capabilities of self-learning in a group, which leads to lifelong learning

**Software Requirements:**

1. Raspbian OS: <https://www.raspberrypi.org/downloads/>
2. Win32 Disk Imager: <https://sourceforge.net/projects/win32diskimager/>
3. SD Card Formatter: <https://www.sdcard.org/downloads/formatter/>

**Online Repository:**

1. GitHub
2. NPTEL Videos on Raspberry Pi and Arduino Programming
3. <https://www.electronicsforu.com/raspberry-pi-projects>
4. <https://circuitdigest.com/simple-raspberry-pi-projects-for-beginners>
5. <https://www.electronicshub.org/raspberry-pi-projects/>

**Hardware Requirements:**

Raspberry Pi Boards, Sensors and Peripherals

Sr. No.	Level 1. Basic 2. Design 3. Advanced 4. Project/Case Study/Seminar	Detailed Lab/Tutorial Description	LO Mapping
1	1, 2	<b>Introduction to Raspberry Pi:</b> 1.1 What is Raspberry Pi? Downloading and Installation of NOOBS, First PowerUp & Having a Look around, Introduction to the Shell and Staying updated. 1.2 Familiarization with Raspberry PI and perform necessary software installation. Apparatus Requirement: Hardware: Raspberry PI Board, Memory of 16GB, Power adapter, Memory Writer. Software: NOOBS, Raspbian OS, Win32 disk Imager, SD-Formatter software.	LO1, LO2
2	1, 2	<b>Interfacing with Input / Output Devices using Python</b> 2.1 Introduction to Python, Connecting to the outside World with GPIO. 1 To Interface LED/Buzzer with Raspberry PI and write a program to turn ON LED for 1 sec after every 2 sec. Apparatus Requirement: Raspberry PI with inbuilt Python Package, LED, Buzzer. 2.2 To interface Push Button / Digital Sensor (IR/LDR) with Raspberry PI and write a program to turn ON LED when Push button is pressed or at sensor detection. Apparatus Requirement: Raspberry PI with inbuilt Python Package, Push Button Switch, Digital Sensor (IR/LDR). 2.3. To interface analog sensor using MCP 3008 analog to digital converter chip. Apparatus Requirement: Raspberry PI with inbuilt Python Package, analog sensor, MCP 3008 chip.	LO2, LO4, LO5
3	1, 2	<b>Interfacing Temperature Sensor, Motors, Display Devices.</b> 3.1 Introduction to Temperature sensor (Analog and Digital), Relays, Motors (DC, Stepper) and Driver circuits. 3.2 To interface DHT11 sensor with Raspberry PI and write a program to print temperature and humidity readings. Apparatus Requirement: Raspberry PI with inbuilt Python Package, DHT11 Sensor. 3.3 To interface motor using relay with Raspberry PI and write a program to turn ON motor when push button is pressed. Apparatus Requirement: Raspberry PI with inbuilt Python Package, Relays, Motor Driver, Motors. 3.4 To interface OLED with Raspberry PI and write a program to print temperature and humidity readings on it. Apparatus Requirement: Raspberry PI with inbuilt Python Package, OLED display	LO2, LO4, LO5

4	2, 3	<b>Interfacing Communication Devices and Cloud Networking</b> 4.1 Introduction to Bluetooth, Zigbee, RFID and WIFI, specifications and interfacing methods. 4.2 To interface Bluetooth/Zigbee/RFID/WiFi with Raspberry Pi and write a program to send sensor data to smartphones using Bluetooth/Zigbee/RFID/WIFI. (Any -one can be used for performing) Apparatus Requirement: Raspberry PI with inbuilt Python Package, Bluetooth/Zigbee/RFID/WIFI. 4.3 Introduction to Cloud computing, different types cloud networks and interconnection using Raspberry Pi 4.4 Write a program on Raspberry Pi to upload temperature and humidity data from thingspeak cloud. Apparatus Requirement: Raspberry PI with inbuilt Python Package, Cloud networks such as thingspeak(open source), AWS, Azure, etc. anyone can be used for understanding purpose and building projects.	LO2, LO3, LO4, LO5
5	2, 3	<b>Understanding of Communication Protocols</b> 5.1 Introduction to MQTT, IFTTT protocols and configuration steps. 1 Write a program on Raspberry Pi to publish temperature data to MQTT broker 5.2 Write a program on Raspberry Pi to subscribe to MQTT broker for temperature data and print it. 5.3 Configuration of Web Server using Raspberry Pi.	LO2, LO3, LO4, LO5
6	4	<b>Sample Projects</b> 1. MQTT Based Raspberry Pi Home Automation: Controlling Raspberry Pi GPIO using MQTT Cloud 2. License Plate Recognition using Raspberry Pi and OpenCV 3. Real Time Face Recognition with Raspberry Pi and OpenCV 4. Smart Garage Door Opener using Raspberry Pi 5. Remote Controlled Car Using Raspberry Pi and Bluetooth 6. Fingerprint Sensor based door locking system using Raspberry Pi 7. Raspberry Pi Ball Tracking Robot using Processing 8. Web Controlled Home Automation using Raspberry Pi 9. Line Follower Robot using Raspberry Pi 10. Raspberry Pi based Smart Phone Controlled Home Automation 11. Web Controlled Raspberry Pi Surveillance Robotic Car 12. Raspberry Pi Based Weight Sensing Automatic Gate 13. Raspberry Pi Emergency Light with Darkness and AC Power Line Off Detector 14. Detecting Colors using Raspberry Pi and Color Sensor TCS3200 15. Measure Distance using Raspberry Pi and HCSR04 Ultrasonic Sensor	LO3, LO6

		16. Call and Text using Raspberry Pi and GSM Module 17. Raspberry Pi Home Security System with Email Alert 18. Raspberry Pi Based Obstacle Avoiding Robot using Ultrasonic Sensor 19. Web Controlled Notice Board using Raspberry Pi 20. RF Remote Controlled LEDs Using Raspberry Pi 21. RFID and Raspberry Pi Based Attendance System 22. Raspberry Pi Interactive Led-Mirror 23. Garage Door monitor using Raspberry Pi 24. Raspberry Pi Digital Code Lock on Breadboard 25. Electronic Voting Machine using Raspberry Pi	
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### **Guidelines for Mini Project**

Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.

Students should do surveys and identify needs, which shall be converted into problem statements for mini projects in consultation with faculty supervisor/head of department/internal committee of faculties.

Students shall submit an implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini projects.

A log book to be prepared by each group, wherein the group can record weekly work progress, guide/supervisor can verify and record notes/comments.

Faculty supervisors may give inputs to students during mini project activity; however, focus shall be on self-learning.

Students in a group shall understand the problem effectively, propose multiple solutions and select the best possible solution in consultation with the guide/ supervisor.

Students shall convert the best solution into a working model using various components of their domain areas and demonstrate.

With the focus on self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV.

However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on a case by case basis.

### **Lab Assessments:**

#### **Termwork, Practical and Oral:**

Term Work The review/ progress monitoring committee shall be constituted by the head of departments of each institute.

The progress of the mini project to be evaluated on a continuous basis, minimum two reviews in each semester.

In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.

Distribution of Term work marks for both semesters shall be as below;

- Marks awarded by guide/supervisor based on log book : 10
- Marks awarded by review committee : 10
- Quality of Project report : 05

Review/progress monitoring committee may consider the following points for assessment based on following general guidelines.

A students' group shall complete project in all aspects including,

- Identification of need/problem
- Proposed final solution
- Procurement of components/systems
- Building prototype and testing

Two reviews will be conducted for continuous assessment, First shall be for finalisation of problem and proposed solution Second shall be for implementation and testing of solution.

### **Oral/Viva Assessment:**

Assessment criteria of Mini Project. Mini Project shall be assessed based on following criteria;

1. Quality of survey/ need identification
2. Clarity of Problem definition based on need.
3. Innovativeness in solutions
4. Feasibility of proposed problem solutions and selection of best solution
5. Cost effectiveness
6. Societal impact
7. Innovativeness
8. Cost effectiveness and Societal impact
9. Full functioning of working model as per stated requirements
10. Effective use of skill sets
11. Effective use of standard engineering norms
12. Contribution of an individuals as member or leader
13. Clarity in written and oral communication

All criteria in generic may be considered for evaluation of performance of students in mini projects.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

Report should be prepared as per the guidelines issued.

### **Lab Prerequisite: ECP1 Project**

Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organisations having experience of more than five years approved by the head of Institution.

Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Mini Project shall be assessed based on following points;

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Full functioning of working model as per stated requirements
5. Effective use of skill sets
6. Effective use of standard engineering norms
7. Contribution of an individual as member or leader
8. Clarity in written and oral communication

### **Text Books:**

1. Raspberry Pi Documentation: <https://www.raspberrypi.org/documentation/>
2. The Official Raspberry Pi Beginner's Book by **raspberrypi.org/magpi**:  
[https://www.raspberrypi.org/magpi-issues/Beginners\\_Book\\_v1.pdf](https://www.raspberrypi.org/magpi-issues/Beginners_Book_v1.pdf)

3. The Official Raspberry Pi Projects Book by **raspberrypi.org/magpi**:  
[https://www.raspberrypi.org/magpi-issues/Projects\\_Book\\_v1.pdf](https://www.raspberrypi.org/magpi-issues/Projects_Book_v1.pdf)

**References:**

1. Simon Monk, “Hacking Electronic: Learning Arduino and Raspberry Pi”, McGraw-Hill Education TAB; 2 edition (September 28, 2017)
2. Simon Monk, “Raspberry PI Cookbook Software and Hardware Problems and Solutions” O’Reilly 2nd Edition
3. Simon Monk, Programming the Raspberry Pi, 2nd Edition: Getting Started with Python” The McGraw Hill
4. “DK Workbooks: Raspberry Pi Project Workbook”, DK Children; Workbook edition (March 7, 2017)
5. Donald Norris, “Raspberry Pi Electronic Projects for Evil Genius”, McGraw-Hill Education TAB; 1 edition (May 20, 2016)

Admission Year 2022-2023

Course Code	Course Name	Credits
ET 301	Digital Communication	04

**Prerequisite:**

Electronic Communication System, Signals and systems

**Course Objectives:**

1. To understand the basics of probability theory and Digital Communication
2. To Understand the basics of information theory, source coding techniques.
3. To evaluate performance of different error control coding schemes.
4. To compare the performance of line c distinguish various digital modulations techniques.
5. To understand impulse response of a matched filter for optimum detection

**Course Outcomes:**

After successful completion of the course learner will be able to

1. Understand the basics of probability theory and Digital Communication.
2. Identify various source coding schemes
3. Design and implement different error correction codes
4. Describe and determine the performance of line codes and methods to mitigate inter symbol interference
5. Describe various digital modulations techniques.
6. Illustrate the impulse response of a matched filter for optimum detection

**Theory Syllabus:**

Sr. No.	Module	Detailed Content	Hours	CO Mapping
1	Introduction to Probability Theory and Digital Communication	Information, Probability, Conditional Probability of independent events, Relation between probability and probability Density , Rayleigh Probability Density , CDF, PDF. Introduction to Digital Communication System, Advantages of the digital representation of the signal, Comparative study of analog and digital Communication System	05	01
2	Information Theory and Source Coding	Block diagram and sub-system description of a digital communication system, measure of information and properties, entropy and its properties Shannon's Source Coding Theorem, Shannon- Fano Source Coding, Huffman Source Coding Differential Entropy, joint and conditional entropy, mutual information and channel capacity, channel coding theorem, channel capacity theorem	06	02

3	Error Control Systems	Types of error control, error control codes, linear block codes, systematic linear block codes, generator matrix, parity check matrix, syndrome testing, error correction, and decoder implementation Systematic and Non-systematic Cyclic codes: encoding with shift register and error detection and correction Convolution Codes: Time domain and transform domain approach, graphical representation, code tree, trellis, state diagram, decoding methods	09	03
4	Baseband Modulation and Demodulation	4.1 Discrete PAM signals and its power spectra Inter-symbol interference, Nyquist criterion for zero ISI, sinusoidal roll-off filtering, correlative coding, equalizers, and eye pattern	05	04
5	Bandpass Modulation & Demodulation	Band-pass digital transmitter and receiver model, digital modulation schemes Generation, detection, signal space diagram, spectrum, bandwidth efficiency, and probability of error analysis of: Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK) Modulations, Binary Phase Shift Keying (BPSK) Modulation, Quaternary Phase Shift Keying (QPSK), M-ary PSK Modulations, Quadrature Amplitude Modulation (QAM), Minimum Shift Keying (MSK)	10	05
6	Optimum Reception of Digital Signal	Baseband receiver, Optimum Receiver and Filter Matched Filter and its probability of error, Coherent Reception.	04	06

### Laboratory Syllabus:

Sr. No.	Level 1. Basic 2. Design 3. Advanced 4. Project/ Case Study /Seminar	Detailed Lab/Tutorial Description	Hours
1	Basic	Study and analyze Line codes	02
2	Advance	Error detection and correction using Hamming code <a href="http://vlabs.iitb.ac.in/vlabs-dev/labs/mit_bootcamp/comp_networks_sm/labs/exp1/index.php">http://vlabs.iitb.ac.in/vlabs-dev/labs/mit_bootcamp/comp_networks_sm/labs/exp1/index.php</a>	02
3	Basic	To Study Generation & reception of ASK & its spectral analysis.	02
4	Basic	To Study Generation & reception of FSK & its spectral analysis.	02
5	Basic	To Study Generation & reception of PSK & its spectral analysis.	02
6	Advance	To observe the effect of signal Distortion using EYE-Diagram	02
7	Design	To Study and perform Linear Block codes	02
8.	Design	To Study and perform Cyclic Codes	02
9.	Design	To Study and perform Convolutional Codes	02
10.	Advance	Matched filter impulse response for a given input	02

**Theory Assessment:****Internal Assessment for 40 marks:**

Consisting of Two Compulsory Internal assessment of **40 Marks each** on 40% syllabus for each test. The final marks will be the average of the score of both the tests.

**End Semester Examination: 60 Marks**

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

**Laboratory Assessment:**

**Term work Assessment:** At least 08 Experiments including 02 simulations covering entire syllabus must be given during the —Laboratory session batch wise—. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students. Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time.

**Oral/Viva Assessment:** The practical and oral examination will be based on entire syllabus.

**Text Books:**

1. Digital Communication, Sanjay Sharma, S. K. Kataria and sons
2. H. Taub, D. Schilling, and G. Saha, —Principles of Communication Systems, Tata Mc- Graw Hill, New Delhi, Third Edition, 2012.
3. Lathi B P, and Ding Z., —Modern Digital and Analog Communication Systems, Oxford University Press, Fourth Edition, 2009.
4. Haykin Simon, —Digital Communication Systems, John Wiley and Sons, New Delhi, Fourth Edition, 2014

**References:**

1. Sklar B, and Ray P. K., —Digital Communication: Fundamentals and applications, Pearson, Dorling Kindersley (India), Delhi, Second Edition, 2009.
2. T L Singal, —Analog and Digital Communication, Tata Mc-Graw Hill, New Delhi, First Edition, 2012.
3. P Ramakrishna Rao, —Digital Communication, Tata Mc-Graw Hill, New Delhi, First Edition, 2011.
4. M F Mesiya, —Contemporary Communication systems, Mc-Graw Hill, Singapore, First Edition, 2013

Course Code	Course Name	Credits
ET 302	Image Processing & Machine Vision	03

**Prerequisite:**

Signals and Systems, Digital Signal Processing, Python Programming Skill Lab

**Course Objectives:**

1. To cover the fundamentals and mathematical models in digital image processing and Machine Vision
2. To teach quality enhancement of image through filtering operations.
3. To teach the students image morphology and restoration techniques.
4. To expose the students to segmentation techniques in image processing and Machine Vision.
5. To teach the techniques of extracting image attributes like regions and shapes.
6. To learn classification and recognition algorithms for machine vision

**Course Outcomes:**

After successful completion of the course student will be able to

1. Understand fundamentals of image processing and machine vision.
2. Enhance the quality of image using spatial and frequency domain techniques for image enhancement.
3. Learn image morphology and restoration techniques.
4. Learn image segmentation techniques based on the principle of discontinuity and similarity using various algorithms.
5. Represent boundaries and shapes using standard techniques.
6. Classify the object using different classification methods.

Sr. No.	Module	Detailed Content	Hours	CO Mapping
I	Digital Image Fundamentals and Point processing techniques	1.1 Introduction –Steps in Digital Image Processing, concept of spatial and intensity resolution, Relationships between pixels. 1.2 Point Processing : Image Negative, Log Transform, Power Law transform, Bit plane slicing, Contrast stretching , Histogram equalization and Histogram Specification	4	CO1
II	Image Enhancement	1 Spatial Domain filtering : The Mechanics of Spatial Filtering, Smoothing Spatial Filters-Linear Filters-Averaging filter, Order-Statistic Filters- Median filter, Application of Median filtering for Noise removal Sharpening Spatial Filters- The Laplacian, Unsharp Masking and Highboost Filtering, Using First-Order Derivatives —The Gradient- Sobel, Prewitt and Roberts 2 Frequency Domain Filtering: Introduction to 2-D DFT and its application in frequency domain filtering, Wavelet transform, Haar transform 3 Frequency Domain Filtering Fundamentals, Fourier Spectrum and Phase angle ,Steps for Filtering in the Frequency Domain, Correspondence Between Filtering in the Spatial	8	CO2

		and Frequency Domains, Frequency domain Image Smoothing and sharpening filter - Ideal, Butterworth , Gaussian		
III	Image morphology and restoration	.1Morphology: Erosion and Dilation, Opening and Closing, The Hit-or-Miss Transformation, Boundary extraction , Hole filling, Thinning and thickening .2Restoration : A Model of the Image Degradation/Restoration Process, Noise models, Removal periodic noise, Principle of Inverse filtering	6	CO3
IV	Image Segmentation	Point, Line, and Edge Detection: Detection of Isolated Points, Line detection, edge models, Canny's edge detection algorithm , Edge linking : Local processing and boundary detection using regional processing (polygonal fitting) Thresholding : Foundation, Role of illumination and reflectance, Basic global thresholding Region Based segmentation: Region Growing, Region Splitting and merging	8	CO3,CO4
V	Introduction to machine vision and descriptors	Principle of machine vision , real world applications, chain code, simple geometric border representation, Fourier Transform of boundaries, Boundary description using segment sequences Introduction to Texture, co-occurrence matrix	6	CO3,CO5
VI	Machine Vision Algorithms	Knowledge representation, Classification Principles, Classifier setting, Classifier Learning, Confusion Matrix K-means clustering algorithm, Introduction, bays decision theory continuous case, two category classification, Bayesian classifier ,Support vector machine setting, Classifier Learning, Support vector machine, cluster analysis	6	CO5,CO6

### Theory Assessment:

#### Internal Assessment for 40 marks:

Consisting of Two Compulsory Internal assessment of **40 Marks each** on 40% syllabus for each test. The final marks will be the average of the score of both the tests.

#### End Semester Examination: 60 Marks

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

#### Text Books:

1. Milan Sonka, Vaclav Hlavac, Roger Boyle, "Image Processing, Analysis, and Machine Vision" Cengage Engineering, 3rd Edition, 2013
2. Gonzalez and Woods, "Digital Image Processing", Pearson Education, India, Third Edition.
3. R. O. Duda and P. E. hart, Pattern classification and scene analysis, Wiley Interscience publication
4. Christopher M. Bishop; Pattern Recognition and Machine Learning, Springer, 2006

**References:**

1. Anil K.Jain, “Fundamentals of Image Processing”, Prentice Hall of India, First Edition, W Pratt, “Digital Image Processing”, Wiley Publication, 3rd Edition, 2002

Admission Year 2022-2023

Course Code	Course Name	Credits
ET 303	Embedded Systems	04

**Prerequisite:**

Microcontroller and microprocessors, C programming

**Course Objectives:**

1. Understand the basics of an embedded system.
2. To study concepts involved in Embedded Hardware.
3. To study concepts involved in Embedded Software for System realization.
4. To learn Real-time programming to design time-constrained embedded systems
5. To learn the development of Embedded system
6. To study various Embedded System applications

**Course Outcomes:**

1. Students will be able to define and explain embedded systems and the different embedded system design technologies explain the various metrics or challenges in designing an embedded system.
2. Student will be able to cultivate ability to understand the internal architecture and interfacing of different peripheral devices and Devices and Communication Buses
3. Students will be able to use Embedded C programming language to Implement embedded systems.
4. Student will be able to know Program Modeling Concepts with Real Time Operating Systems
5. Students will able to design embedded system based on Cortex series
6. Students will be able to foster the ability to understand the role of embedded systems application as well as select the relevant microcontrollers for various industrial applications.

**Theory Syllabus:**

Sr. No.	Module	Detailed Content	Hours	CO Mapping
1	Introduction	Definition, Characteristics, Classification, Applications Design metrics of Embedded system and Challenges in optimization of metrics.	03	CO1
2	Embedded Hardware	<b>2.1</b> Features of Embedded cores- Microcontroller, ASIC, ASSP, SoC, FPGA, RISC and CISC cores. <b>2.2</b> Types of memories: SRAM, DRAM, PROM,EEPROM,FLASH, NVRAM. <b>2.3</b> ARM Cortex-M3 Features, Architecture, Programmer's model, Special Registers, Operating Modes and States, MPU, Memory map and NVIC. <b>2.4</b> Low power - Need and techniques. Case study of Low Power modes in Cortex-M3. <b>2.5</b> Communication Interfaces: Comparative	13	CO2

		study of Serial communication Interfaces -RS-232, RS-485, SPI, I2C, CAN, USB (v2.0), Bluetooth, Zig-Bee. (Frame formats of above protocols are not expected) <b>2.6 Selection Criteria of Sensors and Actuators</b>		
<b>3</b>	<b>Embedded Software</b>	Program Modeling concepts: DFG, CDFG, FSM. Embedded firmware design approaches: super loop based approach, operating system based approach; embedded firmware development languages-assembly language based development, high level language based development.	03	CO3
<b>4</b>	<b>Real-time Operating system</b>	<b>4.1</b> Real-time Operating system: Need of RTOS in Embedded system software and comparison with GPOS. <b>4.2</b> Task Management: Task, Task states, Multi-tasking, Task scheduling, and algorithms-Preemptive SJF, Round-Robin, Priority, Rate Monotonic Scheduling, Earliest Deadline First <b>4.3</b> Inter-process communication: Message queues, Mailbox, Event timers. <b>4.4</b> Task synchronization: Need, Issues- Deadlock, Race condition, live Lock, Solutions using Mutex, Semaphores. <b>4.5</b> Shared Data problem, Priority inversion.	10	CO4
<b>5</b>	<b>Testing and Debugging Methodology</b>	Testing & Debugging: Hardware testing tools, Boundary-scan/JTAG interface concepts, Emulator. Software Testing tools, Simulator, Debugger. White-Box and Black-Box testing.	03	CO5
<b>6</b>	<b>System Integration (Case Studies)</b>	<b>6.1</b> Embedded Product Design Life-Cycle (EDLC)- Waterfall Model <b>6.2</b> Hardware-Software Co-design Case studies for Automatic Chocolate Vending Machine, Washing Machine, Smart Card, highlighting i) Specification requirements (choice of components) ii) Hardware architecture iii) Software architecture	07	CO6

#### Laboratory Syllabus:

<b>Sr. No.</b>	<b>Level</b> 1. Basic 2. Design 3. Advance 4. Project/ Case Study /Seminar	<b>Detailed Lab/Tutorial Description</b>	<b>Hours</b>
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1	Basic	Interfacing of LEDs /switches with any embedded core.(ARM/STM32,MSP430 etc)	02
2	Basic	Interfacing of a relay with any embedded core. (ARM/STM32,MSP430 etc)	02
3	Basic	Interfacing of LCD/ Seven segment display with any embedded core.(ARM/STM32,MSP430 etc)	02
4	Basic	Interfacing of Ultrasonic/Humidity sensor with any embedded core. (ARM/STM32,MSP430 etc)	02
5	Basic	Interfacing of Temperature sensor with any embedded core. (ARM/STM32,MSP430 etc)	02
6	Design	Interfacing of a DC motor (speed and direction control) with any embedded core. (ARM/STM32,MSP430 etc)	02
7	Design	Interfacing of a stepper motor (to move by a particular angle) with any embedded core.(ARM/STM32,MSP430 etc)	02
8	Design	Implement the I2C communication (ARM/STM32, MSP430 etc)	02
9	Advance	Write a Program to Create Multiple Tasks and understand the Multitasking capabilities of RTOS (FreeRTOS).	02
10	Advance	Write a Program to illustrate the Queue Management Features of FreeRTOS.	02
11	Advance	Write a Program to illustrate the Event Management Features of FreeRTOS.	02
12	Design	Write a Program to illustrate the use of Binary and Counting Semaphore for Task Synchronization using FreeRTOS	02

**Software Requirements:** Respective IDE platform

**Hardware Requirements:** Development board of 8051/ARM/STM32, etc

**Theory Assessment:**

**Internal Assessment for 40 marks:**

Consisting of Two Compulsory Internal assessment of 40 Marks each on 40% syllabus for each test. The final marks will be the average of the score of both the tests.

**End Semester Examination: 60 Marks**

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

**Lab Assessments:**

1. **Termwork Assessment:** Term work should consist of 8 experiments [Four Experiments should be considered from Experiment 1 to Experiment 8 and four should be from remaining from the proposed list given in above table] and one case study based on hardware/Simulation. Journal must include at

least 3 assignments on theory and practicals of “Embedded C Programming”. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks).

2. **Oral/Viva Assessment:** Viva exam to be conducted by Internal & External examiners.

**Text Books:**

1. Shibu K V, “Introduction to Embedded Systems”, Tata McGraw Hill Education Private Limited, New Delhi, 2009.
2. Rajkamal, “Embedded Systems: Architecture, Programming and Design”, McGraw Hill Education (India) Private Limited, New Delhi, 2015, Edition 3rd.
3. Sriramlyer, Pankaj Gupta, “Embedded Real Time Systems Programming”, Tata McGraw Hill Publishing Company Ltd., 2003.
4. Joseph Yiu, “The Definitive guide to ARM CORTEX-M3 & CORTEX-M4 Processors”, Elsevier, 2014, 3rd Edition.
5. Dr. K.V. K. K. Prasad, “Embedded Real Time System: Concepts, Design and Programming”, Dreamtech, New Delhi, Edition 2014.

**Reference Books/sites:**

1. David Simon, “An Embedded Software Primer”, Pearson, 2009.
2. Jonathan W. Valvano, “Embedded Microcomputer Systems - Real Time Interfacing”, Publisher - Cengage Learning, 2012 Edition 3rd.
3. Andrew Sloss, Domnic Symes, Chris Wright, “ARM System Developers Guide Designing and Optimising System Software”, Elsevier, 2004
4. Frank Vahid, Tony Givargis, “Embedded System Design - A Unified Hardware/Software Introduction”, John Wiley & Sons Inc., 2002. [www.freertos.org](http://www.freertos.org)

Course Code	Course Name	Credits
ET 304	Programming (Java and scripting)	01

### Lab Objectives: Three to Four

- L1.** To understand the functions and expression used in java coding
- L2.** To learn how to implement object - oriented design with Java
- L3.** To understand how to use Java API's for program development
- L4.** To understand how to design applications with threads in Java
- L5.** To learn how to design Graphical User Interface (GUI) with Java Swing
- L6.** To learn how to handle and manage files in Java.

### Lab Outcomes: Six Course Outcomes

- LO1:** Learn to write, compile, run and test simple Java programs
- LO2.** Learn to implement object - oriented programming concepts using Java Programming.
- LO3.** Learn to use and access packages and Applet's .
- LO4.** Understanding multithreading in Java and designing simple applications.
- LO5.** Learn to design GUI applications using Java Swing.
- LO6.** Managing Files and I/O Handling in Java.

### Hardware Requirements: PC with windows OS, 64bit

### Laboratory Syllabus:

Sr. No.	Level 1. Basic 2. Design 3. Advanced 4. Project/ CaseStudy/ Seminar	Detailed Lab/Tutorial Description	LO Mapping
1	1	Java Program to find GCD of two number	LO1
2	1	Java program to convert binary number to Decimal and vise-versa	LO1
3	1	Java program to multiply two matrix using multi-dimensional array	LO1
4	2	Write a program to implement default and parameterized constructors.	LO2
5	2	Java program of painting in Applet	LO3
6	3	Write a program to implement multithreaded	LO4
7	3	To develop a program to display a table using swings.	LO5
8	3	Write a program to demonstrate Exception handling	LO6
9	1	Create a text file using Java file writer.	LO6
10	4	Mini Project using concept of Principles of Programming	LO6

**Lab Assessments:**

- 1. Termwork Assessment:** Term work should consist of 10 experiments. Journal must include at least 2 assignments on content of theory and practical of “Java Programming”. The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks).
- 2. Oral/Viva Assessment:** Practical & oral exam to be conducted by Internal & External examiners. Practical execution (10 marks) & Oral (15 marks).

**Text Books:**

1. E Balagurusamy ,”Programming with Java – A Primer” , Forth Edition, Tata – Mcgraw-Hill Publication, 2010, ISBN: 978-0-07-014169
2. Khalid A. Mughal, Rolf W. Rasmussen, A Programmer’s Guide to Java™ SCJP Certification Third Edition , Addison -Wesley
3. Joyce Farrell. Programming Logic and Design, Comprehensive, 6th edition

**References:**

1. H.M. Deitel, P.J. Deitel , “Java - How to Program” ,Fifth Edition, PHI Publication , 2003, ISBN:81-203-2371-8
  2. Bruce Eckel “ Thinking in Java”, PHI Publication
  3. Patric Naughton ,Michael Morrisson , “The Java Handbook “ McGraw Hill Publication
- Steven Holzner etal . Java 2 Programming, Black Book , Dreamtech Press, 2009

Course Code	Course Name	Credits
ET 305	Professional Communication & Ethics II	02

#### Course Objectives:

1. To enable learners to formulate professional documents in a structured manner that meets the corporate requirements.
2. To provide an appropriate environment, opportunity and scope to the learners to acquire skills such as collaboration, leadership qualities, assertiveness etc. necessary for group discussion and team building.
3. To promote the importance of having an impressive personality that will enhance self-esteem, build self-confidence and sensitize the learners in appropriate behavior.
4. To prepare the learners for campus placement, employability and competitive examination required for lifelong learning.
5. To inculcate the ethical code of conduct and corporate etiquettes.
6. To develop effective presentation, research and organizational and creative skills necessary for global and industrial set up.

#### Course Outcomes:

1. Learners will be able to acquire the writing skills necessary for professional documents to meet the corporate requirement.
2. Learners will be able to demonstrate the skills required for self-improvement and effective communication.
3. Develop self-confidence and behave professionally.
4. Learners will be able to perform successfully in competitive exams like GRE, CET and TOEFL
5. Able to determine the importance of ethics and etiquettes in social and professional situations.
6. Able to illustrate effective presentation, research organizational and creative skills necessary for lifelong learning.

**Prerequisite:** Basic language skills

#### DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
I	Structure, Style and Language of Report Writing	1.1 Introducing the purpose , aim, objective and format of report 1.2 Literature review-ability to gather and analyse information from different sources and summarize. Specific emphasis on plagiarism, use of quotation marks appropriately. 1.3 Research Methodology 1.4 Presenting data-figures, diagrams and labelling 1.5 How and why to write discussion 1.6 Citing and referencing- IEEE format 1.7 Writing an abstract	6	CO1

II	Writing Technical Proposals	1.1 Format 1.2 Executive summary 1.3 Defining the problem and presenting the solution 1.4 Summarizing a technical proposal	4	CO1
III	Oral Skills For Employability	1.1 Group Discussion- with special reference to leadership qualities, assertiveness, analyzing the topic, developing different perspectives, introducing and concluding the discussion. 1.2 Interview-with special reference to introducing oneself and answering questions with confidence. 1.3 Presentation Skills-with special reference to preparing slides, dress code, non-verbal communication including paralinguistic features, introduction and conclusion.	4	CO2, CO4, CO6
IV	Personality Development and Social Etiquettes	3.1. Personality Development <ul style="list-style-type: none"> <li>Improving self-awareness-analyzing our own experiences, looking at ourselves through the eyes of others</li> <li>Knowing and Building your own identity</li> <li>Discovering and Developing your talents</li> <li>Teamwork/collaboration</li> </ul> 3.2. Social Etiquettes <ul style="list-style-type: none"> <li>Formal Dining Etiquettes</li> <li>Cubicle Etiquettes</li> <li>Responsibility in Using Social Media</li> <li>Showing Empathy and Respect</li> <li>Learning Accountability and Accepting Criticism</li> <li>Demonstrating Flexibility and Cooperation</li> <li>Selecting Effective Communication Channels</li> </ul>	5	CO3, CO5
V	Ethics and Ethical codes of conduct	5.1 Writing Resume and statement of purpose 5.2 Business and corporate activities(special emphasis on business meetings) 5.3 Personal ethics, conflicting values, choosing a moral response, the process of making ethical decisions.	3	CO4, CO5
VI	Content writing	6.1 Research Skills 6.2 Organizational skills 6.3 Creative Writing- Blog posts, Web pages etc.	4	CO6

Sr. No.	Details of Assignments	Details of Activities	Hours	CO Mapping
I	Written assignment on Literature Review 20 page report on technical topic (to be included as part of term work)	Sample IEEE papers to be shared with students and train them to identify contributions of each author. These contributions can then be written in the format required in journals.	5	CO1, CO5
II	Written assignment on summarising a technical proposal 4 page technical proposal (to be included as part of term work)	Example of summarising techniques to be demonstrated.	4	CO1, CO5
III	Oral Skills for Employability- to be included in term work.	Role play and mock interviews Mock group discussion Mock presentation	2 4 4	CO2, CO3, CO4
IV	Written Assignment on Documentation of Business Meeting	Mock meetings	2	CO1, CO4
V	Written Assignment on Resume writing/ Statement of Purpose.	NA	2	CO3
VI	Written Assignment on Blog Posts	NA	2	CO6

#### Assessment:

Term work will consist of-

1. Assignments - 10 marks
2. Group Discussion - 10 marks
3. Interviews - 5 marks
4. Report - 5 marks
5. Technical Proposal - 5 marks
6. Attendance - 5 marks
7. Presentation - 10 marks

#### References:

1. Raman Meenakshi & Sharma Sangeeta, *Communication Skills*, Oxford University Press
2. Kumar Sanjay & Lata Pushp, *Communication Skills*, Oxford University Press
3. Virendra Singh Nirban, Krishna Mohan, RC Sharma, *Business Correspondence and Report Writing*

Course Code	Course Name	Credits
ET 306	IoT Basics & Smart Sensors	04

**Prerequisite:**

Microprocessor & Microcontroller

**Course Objectives:** Introduce evolution of internet technology and need for IoT.

1. Discuss on IoT reference layers and various protocols and software.
2. To provide in depth knowledge in physical principles applied in sensing, measurement and a comprehensive understanding on how measurement systems are designed, calibrated, characterized, and analyzed.
3. To introduce the students to sources and detectors of various Optical sensing mechanisms and provide in-depth understanding of the principle of the basic laws and phenomena on which operation of sensor transformation of energy is based, measurement and theory of instruments and sensors.
4. Train the students to build IoT systems using sensors, single board computers and open source IoT platforms.
5. Make the students apply IoT data for business solutions in various domains in a secure manner.

**Course Outcomes:**

1. Identify the IoT networking components with respect to the OSI layer.
2. Build schematic for IoT solutions .
3. Design and develop IoT based sensor systems.
4. Select IoT protocols and software.
5. Evaluate the wireless technologies for IoT.
6. Appreciate the need for IoT Trust and variants of IoT and compete in the design, construction, and execution of systems for measuring physical quantities

**Theory Syllabus:**

Sr. No.	Module	Detailed Content	Hours	CO Mapping
I	Introduction to Internet of Things	Defining IoT, Characteristics of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Communication models & APIs, Trends in the Adoption of IoT, Societal Benefits of IoT, Risks, Privacy, and Security. Exemplary Device Boards, Arduino, Linux on Raspberry, Interface and Programming & IOT Device. Hardware Platforms and Energy Consumption, Operating Systems, Time Synchronization, Positioning and Localization, Medium Access Control, Topology and Coverage Control, Routing: Transport Protocols, Network Security, Middleware, Databases	5	1

II	Sensing and Actuation	Sensor fundamentals and characteristics, Optical Sources and Detectors, Intensity Polarization and Interferometric Sensors, Strain, Force, Torque and Pressure sensors, Position, Direction, Displacement and Level sensors, Velocity and Acceleration sensors, Flow, Temperature and Acoustic sensors, Actuators and its types: Hydraulic, Pneumatic, Electrical, Thermal, Magnetic	7	2
III	Networking and the Internet of Things	IoT and Machine to Machine Communications, IoT protocols, Network configurations, Network Operator Requirements, SNMP, NETCONF, YANG, Interoperability in IoT. SDN	6	3
IV	Sensor Networks and IoT	Characteristic and challenges, WSN vs Adhoc Networks, Sensor node architecture, Physical layer and transceiver design considerations in WSNs, Energy usage profile, Choice of modulation scheme, Dynamic modulation scaling, Antenna considerations. Sensor Network Architecture: Data Dissemination, Flooding and Gossiping-Data gathering Sensor Network Scenarios, Optimization Goals and Figures of Merit, Design Principles for WSNs- Gateway Concepts, Need for gateway, WSN and Internet Communication, WSN Tunneling, Amplifiers and Sensor Noise, Importance and Adoption of Smart Sensors, Architecture of Smart Sensors	9	4
V	Cloud Computing	Interfacing and data logging with cloud, Evolution of Cloud Computation, Commercial clouds and their features, open source IoT platforms, cloud dashboards, Fog Computing, Introduction to big data analytics and Hadoop.	7	5
VI	Developing Internet of Things Data Analytics and Tools for IoT	IoT security, Need for encryption, standard encryption protocol, lightweight cryptography, Quadruple Trust Model for IoT-A – Threat Analysis and model for IoT-A, Cloud security	5	6

## Lab Syllabus

Sr. No	Level 1. Basic 2. Design 3. Advanced 4. Project/ Case Study/ Seminar	Detailed Lab/Tutorial Description	Hours
1	Basic	IoT systems Working with Raspberry pi using Python. Arduino platform Working with open source clouds	02
2	Design	Python Programming for IoT Systems: Basic operations, String manipulation, Dictionary, Signal plotting, processing and graphics on cloud	02

3	Basic	Develop a displacement measurement system with the following sensors: i. Inductive transducer (LVDT) ii. Hall effect sensor	02
4	Design	After studying the characteristics of temperature sensors listed below, develop a temperature measurement system for a particular application using the suitable sensor. i. Thermocouple principles ii. Thermistor and linearization of NTC Thermistor iii. Resistance Temperature Detector iv. Semiconductor Temperature sensor OA79 v. Current output absolute temperature sensor Based on sensing experiments carried out suggest a noncontact method and try to complete its proof of concept.	02
5	Basic	Embedded Programming and IoT: C programming, Declarations and Expressions, Arrays, Pointers, Constructs, Data structures and Linked list, Embedded C (Keil).	02
6	Design	Working with ARM (Keil and energia) Sub Task 1: Peripheral programming of ARM7 board Sub Task 2: PWM generation Sub Task 3:Configuring CC3200, wifi configuration ,HTTP and MQTT Protocol	02
7	Basic	Working with MSP430 (CCStudio) Sub Task 1: Port programming of MSP430 microcontrollers Sub Task 2: Analog to Digital Conversion using MSP430 microcontroller Sub Task 3: LCD display of characters and numbers. Sub Task 4: Timer	02
8	Design	Low power wireless transmission using Zigbee Sub Task 1 : Interfacing Zigbee controller with MSP 430 microcontroller using SPI/UART. Sub Task 2: Programming sleep and wake up mode of MSP 430.	02
9	Advanced	Design a method to analyze liquid flow velocity using a non-contact measurement technique(Laser/Ultrasonic sensor). Record the dynamic flow velocity using LabVIEW	02
10	Advanced	Consider a real time data available in college campus and develop a data analytic system to determine the average, trend and prediction	02
11	Project	Mini Project	04

#### Software Requirements:

Arduino IDE, Noobs, Keil and energia, CCStudio

#### Hardware Requirements:

Arduino, Raspberry Pi, ARM7 Board, MSP430, Inductive transducer, Hall Effect sensor, Thermocouple, Thermistor, Temperature sensor, LCD Display, Zigbee Chip, Motors, LabVIEW and Peripherals, Miscellaneous

#### Theory Assessment:

##### Internal Assessment for 40 marks:

Consisting of Two Compulsory Internal assessment of **40 Marks each** on 40% syllabus for each test.

The final marks will be the average of the score of both the tests.

##### End Semester Examination: 60 Marks

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

**Laboratory Assessment:****Term work for 25 marks:**

At least 10 Experiments from the above mentioned list must be performed during the “Laboratory session batch wise”. A mini project based on the entire syllabus must be performed by every student individually (can be hardware or Computation/simulation based project must be encouraged). Term work assessment must be based on the overall performance of the student with experiments and assignments graded from time to time.

**End Semester Practical/Oral Examination: 25 Marks**

Pair of Internal and External Examiner should conduct practical/viva based on contents. Distribution of marks for practical/viva examination shall be as follows:

Practical Examination: 15 Marks Oral Examination: 10 Mark

**Text Books:**

1. Alessandro Bassi, Martin Bauer, Martin Fiedler, Thorsten Kramp, Rob van Kranenburg, Sebastian Lange, Stefan Meissner, “Enabling things to talk”
2. Designing IoT solutions with the IoT Architecture Reference Model”, Springer Open, 2016
3. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stamatis Karnouskos, Stefan Avesand, David Boyle, “From Machine to Machine to Internet of Things”, Elsevier Publications, 2014.
4. Jacob Fraden, “HandBook of Modern Sensors: physics, Designs and Applications”, 2015, 3rd edition, Springer, New York.
5. Jon. S. Wilson, “Sensor Technology Hand Book”, 2011, 1st edition, Elsevier, Netherland.

**References:**

1. Vijay Madiseti , Arshdeep Bahga, Adrian McEwen (Author), Hakim Cassimally “Internet of Things A Hands-on-Approach” Arshdeep Bahga & Vijay Madiseti, 2014
2. LuYan, Yan Zhang, Laurence T. Yang, Huansheng Ning, The Internet of Things: From RFID to the Next-Generation Pervasive Network, Aurbach publications, March,2008.
3. RonaldL. Krutz, Russell Dean Vines,Cloud Security: A Comprehensive Guide to Secure Cloud Computing,Wiley-India, 2010.
4. John G Webster, “Measurement, Instrumentation and sensor Handbook”, 2017, 2nd edition, CRC Press, Florida.
5. Bahaa E. A. Saleh and Malvin Carl Teich, “Fundamentals of photonics”, 2012, 1st edition, John Wiley, New York.

**Text Books:(For Laboratory)**

1. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stamatis Karnouskos, Stefan Avesand, David Boyle, “From Machine to Machine to Internet of Things”, Elsevier Publications, 2014.
2. Jacob Fraden, “HandBook of Modern Sensors: physics, Designs and Applications”, 2015, 3rd edition, Springer, New York.
3. John H. Davies, “MSP430 Microcontroller Basics”, 2011, 2nd edNewnes publishing, New York.
4. Holger Karl, Andreas Willig, “Protocols and Architectures for Wireless Sensor Networks” 2011, 1st ed., John Wiley & Sons, New Jersey

**References:(For Laboratory)**

1. Vijay Madiseti , Arshdeep Bahga, Adrian McEwen (Author), Hakim Cassimally “Internet of Things: A Hands-on-Approach” Arshdeep Bahga & Vijay Madiseti, 2014.
2. Bahaa E. A. Saleh and Malvin Carl Teich, “Fundamentals of photonics”, 2012, 1st edition,

John Wiley, New York.

3. Sergey Y. Yurish, "Digital Sensors and Sensor Systems: Practical Design", 2011, 1st ed., IFSA publishing, New York.
4. Zach Shelby, Carsten Bormann, "6LoWPAN: The Wireless Embedded Internet", 2009, 1 st ed., John Wiley & Sons, New Jersey.

Admission Year 2022-2023

Course Code	Course Name	Credits
ET 307	PCB Design and Electronics Equipment Troubleshooting	04

**Prerequisite:**

Basic Circuit theory, Electromagnetics

**Course Objectives:**

1. Understanding of PCB design fundamentals
2. Ability to select the circuit, components and prepare layout
3. Ability to design PCB and perform drilling, component mounting, soldering, tinning, masking and testing.
4. Ability to design a PCB with SMD Components
5. Inculcate PCB design rules at high frequencies and to be aware of SMD components and packages.
6. To develop a skill set to work on real life projects and design

**Course Outcomes:**

1. Explain types of PCBs and basic procedure to design a PCB
2. Identify various tools and to become familiar with electronic components and their packages/footprints
3. Illustrate the use of PCB CAD tools and their features for practical designs and schematic preparation.
4. Fabricate PCB and become familiar with drilling, tinning, masking and soldering of components.
5. To compare PCB design at high frequency with low frequency
6. Fabricate PCBs for simple and advanced circuits and perform hardware testing to validate the design.

**Theory Syllabus:**

Sr. No.	Module	Detailed Content	Hours	CO Mapping
I	Fundamentals of PCB Design	Types of PCBs: General purpose, Single sided, Double Sided, Multi-layered PCBs. PCB materials, Introduction to layout Design, Rules for track (track length, width, size, joint and angle etc) PCB Design rules at radio frequency, Photolithography, Introduction to softwares like Eagle, Express-PCB, OrCAD, Ki-CAD, Altium, Proteus. Files and their extensions, Schematic/Layout editor, library editor, Text editor, preparation of Gerber/dxf/dwg/step/iges files, Short-cut keys and special commands, Forward and backward annotation, Electrical components and packages, Component libraries, footprint,	6	CO1, CO2

		symbol, Plug ins, Routing, Assembling, Multi-layered PCB Design, Making of Schematic Symbol, Export, import and modify library components, Making of component footprints, Portability/compatibility of project files		
II	PCB fabrication processes	<b>Pre-PCB fabrication processes:</b> Selection of circuit and components, Selection of PCB type, track printing, legend printing, Schematic preparation, Electronic rule checking (ERC) <b>Post-PCB fabrication processes:</b> <b>Implementation of PCB:</b> Etching, tinning, Masking (Green, Red, White, Black, Blue and Pink), Drilling, pads, vias, Component mounting, soldering, EMI-EMC issues, Hardware testing, Packaging / Enclosure Design	8	CO3, CO4
III	Advanced PCB Design	High frequency PCB design technology, Selection of SMD (Surface mounted devices) components packages / libraries and its mounting, Design Rules, Plated through hole technology	7	CO3, CO4
IV	Introduction to Troubleshooting	Troubleshooting Basics, Safety measures and Precaution during Troubleshooting, Common Troubleshooting Techniques, Test and Measuring instruments for troubleshooting, Measurement of A.C. voltage and D.C. voltage using multimeter for the given circuit, Continuity test of PCB track, wiring, switch etc., Inspection of solder joints, defects of soldered joints in given circuits.	5	CO5
V	Device Troubleshooting	Testing of Active and passive components separately or Mounted on PCB like: Resistor, Capacitors, Inductors, Switches, Relays, Transformers, Fuses, Connectors, Single/three phase MCBs, single phase ELCBs, RJ45 connector, Diodes, Transistors, FETs, MOSFET, SCR, DIAC, TRIAC, Displays (LCD or LED), Opto electronics components, Crystal oscillator, Fault diagnosis in op-amp circuits. Testing Various parameters of electronic active/passive components using a data book.	7	CO6
VI	Troubleshooting Digital Circuits	Logic IC families, Packages in Digital ICs, IC identification, IC pin-outs, Handling ICs, Digital troubleshooting methods – typical faults, testing digital ICs with pulse generators, Special consideration for fault diagnosis in digital circuits, Handling	6	CO6

		precautions for ICs sensitive to static electricity, Testing flip-flops, counters, registers, multiplexers and demultiplexers, encoders and decoders; Tri-state logic. Testing Various parameters of digital IC using data book.		
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### Laboratory Syllabus:

Sr. No.	Level	Detailed Lab/Tutorial Description	Hours
	1. Basic 2. Design 3. Advanced Project/ Case Study/ Seminar		
1	Design	Design of a General Purpose PCB for Basic Circuit	02
2	Design	Implementation of Single sided Glass epoxy PCB for an Electronic Circuit.	02
3	Design	Implementation of both sided Glass epoxy PCB for an Electronic Circuit.	02
4	Design	Implementation of multi-layered PCBs for an Electronic Circuit.	02
5	Advanced	Implementation of PCB with SMD Components	02
6	Advanced	Implementation of Both sided PCB Using PTH (Design of SIW)	02
7	Basic Design	Mini-Project -1	02
8	Advanced Design	Mini-Project -2	02

**Software Requirements:** EAGL/Ki-CAD/ ORCAD/Express-PCB/Altium/Proetis/ Hardware Requirements: PCB Board, PCB Lab setup, SMD and PTH Setup.

### Theory Assessment:

#### Internal Assessment for 40 marks:

Consisting of Two Compulsory Internal assessment of **40 Marks each** on 40% syllabus for each test. The final marks will be the average of the score of both the tests.

#### End Semester Examination: 60 Marks

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

### Laboratory Assessment:

**Termwork Assessment:** Term work should consist of 10 experiments. Journal must include at least 2 assignments on content of theory and practical of “Java Programming”. The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks)

**Oral/Viva Assessment:** Practical & oral exam to be conducted by Internal & External examiners. Practical execution (10 marks) & Oral (15 marks).

**Text Books:**

1. Simon Monk, Make your own PCBs with EAGLE: From Schematic Designs to Finished Boards, 1<sup>st</sup> Edition, McGraw Hill Education.
2. P. Horowitz and W. Hill, The Art of Electronics, 3<sup>rd</sup> Edition, Cambridge University Press.
3. Henry W. Ott, "Electromagnetic Compatibility Engineering", A John Wiley and Sons, Inc. Publication.
4. Matthew Scarpino, Designing Circuit Boards with EAGLE: Make High Quality PCBs at Low Cost, 1<sup>st</sup> Edition, Prentice Hall. Archambeault and Drewniak James, PCB Design for Real World EMI Control, Springer Publication

Admission Year 2022-2023

Course Code	Course Name	Credits
ET 308	Basics of VLSI Design	04

#### Course Objectives:

1. To teach fundamental principles of VLSI circuit design and layout techniques.
2. To highlight the circuit design issues in the context of VLSI technology
3. To explain different scaling effects.
4. To study CMOS gates and effect of W/L ratio.
5. To study dynamic gates and circuit realization using pass transistors.
6. To design semiconductor memories and its importance.

#### Course Outcomes: Upon successful completion of the course students will be able to

1. Apply the knowledge to demonstrate a clear understanding of choice of technology and technology scaling.
2. Explain the design of MOSFET Inverters.
3. Analyze and design MOS based circuits design styles.
4. Understand CMOS gates and effect of W/L ratio.
5. Understand dynamic gates and circuit realization using pass transistors.
6. Understand the design of Semiconductor Memories.

**Prerequisite:** Analog Electronics Circuits, Digital Circuits and System Design (DCSD)

#### DETAILED THEORY SYLLABUS:

Sr. No.	Module	Detailed Content	Hrs
1	<b>Technology Comparison MOSFET Scaling</b>	Comparison of BJT, NMOS and CMOS technology Types of scaling, MOSFET Models, MOSFET capacitances	5
2	<b>MOSFET Inverters</b>	<b>Circuit Analysis:</b> Static and dynamic analysis (Noise, propagation delay and power dissipation) of resistive load, E mode MOSFET load, D mode MOSFET load inverter and CMOS inverter, comparison of all types of MOS inverters, design of CMOS inverters	7
3	<b>Universal gates, Complex circuits using MOSFETs</b>	<b>Logic Circuit Design:</b> Analysis and design of 2-I/P NAND and NOR using equivalent CMOS inverter, W/L ratio, Complex circuits	7
4	<b>MOS Circuit Design Styles</b>	<b>Design Styles:</b> Static CMOS, pass transistor logic, transmissiongate, Pseudo NMOS, Domino, NORA, Zipper, C2MOS, sizing using logical effort	8
5	<b>Circuit Realization using MOSFETs</b>	<b>Circuit Realization:</b> SR Latch, JK FF, D FF, 1 Bit Shift Register, MUX, decoder using above design styles	6

6	<b>Semiconductor Memories</b>	<b>SRAM:</b> ROM Array, SRAM (operation, design strategy, leakage currents, read/write circuits), DRAM (Operation, leakage currents, refresh operation), Flash memory- NOR Flash, NAND flash.	6
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#### DETAILED LAB SYLLABUS:

**Software Requirements:** TINA, NGSpice, Microwind

Sr. No.	Detailed Lab Description
1	Effect of parasitic capacitance and threshold voltage on output of NMOS inverter with resistive load.
2	Circuit characteristics and performance estimation of NMOS inverter with resistive load. 1) Verification of $V_{OH}$ level for different values of load resistance. 2) Find rise time for different values of load resistance.
3	Circuit characteristics and performance estimation of NMOS inverter with Enhancement mode MOSFET load.
4	Circuit characteristics and performance estimation of NMOS inverter with Depletion mode N channel MOSFET as a load.
5	Circuit characteristics and performance estimation of CMOS inverter. 1) Verification of $V_{OH}$ and $V_{OL}$ levels. 2) Comparison of rise and fall times for different values of W/L ratio of pull up and pulldown devices.
6	Circuit characteristics and performance estimation of CMOS Dynamic 2 Input NAND Gate. 1) Verification of $V_{OH}$ and $V_{OL}$ levels for various input possibilities. 2) Verification of precharge and evaluate condition for different inputs. 3) Verification of charge leakage problem.
7	Design of 4:1 MUX using pass transistor logic and transmission gates.
8	Design of 6T SRAM using Microwind dsch3.1.

#### Theory Assessments:

**1. Internal Assessment:** Two Internal assessments will be conducted for 40 marks each with average marks of both assessments as final score.

#### 2. End Sem Theory Examination:

- Question paper will consist of 4 questions, each carrying 20 marks.
- Total 3 questions need to be solved.
- Q.1 will be compulsory, based on the entire syllabus.
- Remaining questions will be randomly selected from all the modules.
- Weightage of marks should be proportional to number of hours assigned to each module.

#### Lab Assessments:

- Term work should consist of 8 experiments.
- Journal must include at least 3 assignments.

**1. Term work Assessment:**

Total 25 Marks (Experiments: 10-marks, Assignments: 10-marks, Attendance Theory & Practical: 05-marks)

**2. Oral/Viva Assessment:**

Based on the above contents and entire syllabus.

**Text Books:**

1. Sung-Mo Kang and Yusuf Leblebici, "CMOS Digital Integrated Circuits Analysis and Design", Tata McGraw Hill, 3rd Edition.
2. Jan M. Rabaey, Anantha Chandrakasan and Borivoje Nikolic, "Digital Integrated Circuits: A Design Perspective", Pearson Education, 2nd Edition.

**References:**

1. Etienne Sicard and Sonia Delmas Bendhia, "Basics of CMOS Cell Design", Tata McGraw Hill, First Edition.
2. Neil H. E. Weste, David Harris and Ayan Banerjee, "CMOS VLSI Design: A Circuits and Systems Perspective", Pearson Education, 3rd Edition.
2. Debaprasad Das, "VLSI Design", Oxford, 1st Edition.
6. Kaushik Roy and Sharat C. Prasad, "Low-Power CMOS VLSI Circuit Design", Wiley, Student Edition

Course Code	Course Name	Credits
ET 309	Data Processing and Coding	04

**Prerequisite:**

Electronics Communication System Digital Communication

**Course Objectives:**

**To teach the students**

1. Lossy & Lossless compression techniques for Text.
2. Compression techniques for Audio signals.
3. Lossy & Lossless compression techniques for Image & Video.
4. Goals and design principles for cryptography and common structures of secret key primitives such as block and stream ciphers and message authentication codes.
5. Basic key management techniques in both secret key and public key cryptography.
6. Network and Web Security.

**Course Outcomes:**

After successful completion of the course student will be able to

1. Define compression; understand compression as an example of representation
2. Implement text, audio and video compression techniques.
3. Translate the most common file formats for image, sound and video.
4. Understand basic principles of cryptography and general cryptanalysis & be acquainted with the concepts of symmetric encryption and authentication.
5. Compare & Contrast Symmetric and Asymmetric Key Cryptography schemes.
6. Compose, build and analyze simple cryptographic solutions

**Theory Syllabus**

Sr. No.	Module	Detailed Content	Hours	CO Mapping
I	Text Compression	<ol style="list-style-type: none"> <li>1. Introduction to Information theory: Entropy, Information Value, Data Redundancy.</li> <li>2. Statistical Methods: Shannon-Fano Algorithm, Huffman Algorithm, Adaptive Huffman Coding.</li> <li>3. Statistical Methods: Arithmetic Coding (Encoding, Decoding, Adaptive Coding).</li> <li>4. Dictionary Methods: LZ77, LZ78, LZW Algorithms.</li> </ol>	8	CO1,CO2
II	Audio Compression	Sound, Digital Audio, $\mu$ -Law and A-Law Companding, MPEG – 1/2 Audio Layer (MP3 Audio Format)	5	CO2,CO3
III	Image & Video Compression	<ol style="list-style-type: none"> <li>1. Image Compression: Discrete Cosine Transform, JPEG. Differential Lossless Compression, DPCM</li> <li>2. Wavelet Methods: Discrete Wavelet Transform, JPEG 2000.</li> </ol>	5	CO2,CO3

		4. Video Compression: Analog Video, Digital Video, Motion Compensation, Temporal and Spatial Prediction. MPEG and H.264.		
IV	Data Security	1. Security Goals, Cryptographic Attacks, Techniques 2. Symmetric Key: Substitution Cipher, Transposition Cipher, Stream and Block Cipher 3. DES, AES	8	CO4
V	Number Theory and Asymmetric Key Cryptography	1. Primes, factorization, Fermat's little theorem, Euler's theorem, and extended Euclidean algorithm 2. RSA, attacks on RSA, Diffie Hellman key exchange, key management, and basics of elliptical curve cryptography 3. Message integrity, message authentication, MAC, hash function, H MAC, and digital signature algorithm.	8	CO5
VI	System Security	Malware, Intruders, Intrusion detection system, firewall design, antivirus techniques, digital Immune systems, biometric authentication, and ethical hacking.	5	CO6

### Lab Syllabus

**Lab Prerequisite:** Knowledge of MATLAB/SCILAB

Sr. No.	Level 1. Basic 2. Design 3. Advanced 4. Project/ Case Study/ Seminar	Detailed Lab/Tutorial Description	Hours
1	2	To implement Huffman Coding	02
2	2	To implement Arithmetic coding	02
3	2	To implement LZ77/78 Coding	02
4	2	To implement LZW Coding	02
5	3	To implement one dimension & two-dimensional DCT	02
6	2	To implement Chinese Remainder Theorem	02
7	2	To implement Caesar Cipher Algorithm	02
8	2	To implement Transposition cipher	02
9	3	To implement Diffie Hellman key exchange Algorithm	02
10	3	To implement RSA algorithm	02

**Software Requirements:** MATLAB/SCILAB

**Hardware Requirements:** NIL

**Theory Assessment:****Internal Assessment for 40 marks:**

Consisting of Two Compulsory Internal assessment of **40 Marks each** on 40% syllabus for each test. The final marks will be the average of the score of both the tests.

**End Semester Examination: 60 Marks**

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

**Laboratory Assessment:**

Term Work: **25 Marks**

**End Semester Practical/Oral Examination 25 marks:****Text Books:**

1. Mark Nelson, Jean-Loup Gailly, The Data Compression Book, 2nd edition, BPB Publications
2. Khalid Sayood, Introduction to Data Compression, 2nd Edition Morgan Kaufmann.
3. William Stallings, —Cryptography and Network Security Principles and Practices 5th Edition, Pearson Education.
5. Behrouz A. Forouzan, —Cryptography and Network Security, Tata McGraw-Hill.

**References:**

1. David Salomon, —Data Compression: The Complete Reference, Springer.
2. Matt Bishop, —Computer Security Art and Science, Addison-Wesley.

Course Code	Course Name	Credits
ET 310	TV & Video Engineering	04

**Prerequisite:**

Electronic Communication System

**Course Objectives:**

1. To understand basic concepts of TV system
2. To learn the importance of the digitization in Television Engineering
3. To become well conversant with new development in video engineering.
4. To understand compression techniques
5. To introduce to advanced systems and dvb standards
6. Describe the modern display devices like.

**Course Outcomes:**

1. Understand overview of TV system.
2. Able to understand NTSC and PAL Television system and concept of Colour theory in Colour TV.
3. Able to recollect digitization in television and compression technique.
4. Understand details of Know about different dvb standards.
5. Understand advanced digital systems
6. Understand various display device

**Theory Syllabus:**

Sr. No.	Module	Detailed Content	Hours	CO Mapping
I	Fundamentals of TV system	1.1 Elements of TV system, Transmitter and receiver- block diagram approach, interlaced scanning, composite video signal, VSB transmission and reception 1.2 Camera Tubes: Vidicon, Image Orthicon	8	CO1
II	Colour TV Standards	2.1 Colour fundamentals, mixing of colors, color perception, chromaticity diagram, Color TV systems 2.2 NTSC, PAL systems, colour TV transmitter, colour TV receivers.	8	CO2
III	Fundamental Concept of Digital Video	3.1 Introduction to Digital TV, Principle of Digital TV, Digital TV signals and parameters (Digitization, pixel array, scanning notation, viewing distance and angle, aspect ratio, frame rate and refresh rate.) 3.2 Chroma subsampling: 4:4:4, 4:2:2, 4:2:0, 4:1:1 digital video formats	10	CO3

		3.3 Video compression standards: MPEG2:DCT coding, codec structure. Introduction to H.264/MPEG-4 AVC, Introduction to H.265 Direct-to-home TV(DTH)		
IV	Digital Video Broadcasting	4.1 Introduction to DVB-T,DVB-T2,DVB-H,DVB-S,DVB- C	6	CO4
V	Advanced Digital TV Systems	5.1 MAC signal, D2-MAC/packet signal, MAC decoding and interfacing, advantages of MAC signal, HDTV, MUSE, Smart TV and its functions IP Audio and Video, IPTV systems, Mobile TV, Video transmission in 3G mobile System, Digital	10	CO5
VI	Displays Device	6.1 LCD,LED 6.2 Chromecast	4	CO6

#### Laboratory Syllabus:

Sr. No.	Level 1. Basic 2. Design 3. Advanced 4. Project/ Case Study/ Seminar	Detailed Lab/Tutorial Description	Hours
1	Basic	To acquire the knowledge of the RF section and IF section of the TV trainer kit and test faults in both sections.	02
2	Basic	To test various faults in the Horizontal & Vertical Oscillator section of the TV trainer kit.	02
3	Basic	To understand and test faults in the Video and Chroma section of TV trainer kits.	02
4	Basic	Study block diagram and functioning of different sections of wi-fi/ Smart LED Television	02
5	Design	Develop an algorithm to compress the image/video using modern compression methods.	02
6	Advanced	To Study the function of front panel control keys and remote control keys of smart LED TV.	02
7	Advanced	Study and measure voltage of the power supply section.	02
8	Advanced	To understand the LED interface section.	02
9	Advanced	To acquire the knowledge of direct to home television system	02
10	Advanced	To study various waveform and important voltages level in DTH system	02

**Theory Assessment:****Internal Assessment for 40 marks:**

Consisting of Two Compulsory Internal assessment of **40 Marks each** on 40% syllabus for each test. The final marks will be the average of the score of both the tests.

**End Semester Examination: 60 Marks**

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

**Lab Assessments::**

1. **Termwork Assessment:** At least 08 Experiments including 02 simulations covering the entire syllabus must be given during the **Laboratory session batch wise**". Computation/simulation based experiments are also encouraged. The experiments should be student centric and attempt to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for a maximum batch of four students. Term work assessment must be based on the overall performance of the student with every experiment/tutorial and mini-projects (if included) are graded from time to time.
2. **Oral/Viva Assessment:** The practical and oral examination will be based on the entire syllabus.

**Text Books:**

1. Television and video Engineering, A. M. Dhake, Tata McGraw Hill Publication
2. Monochrome and colour Television by R.R.Gulati
3. R.G.Gupta , "Television and Video Engineering", Tata Mc Graw Hill publication.
4. Dhake A.M, "Television and Video Engineering", Tata McGraw Hill publication.
5. Keith Jack, "Video Demystified", 4e, Elsevier

**References:**

1. Charles Poynton, "San Francisco, Digital video and HDTV, Algorithms And Interfaces," Morgan Kaufmann publishers, 2003.
2. Digital Television ( Practical guide for Engineers) by Fischer

Course Code	Course Name	Credits
ET 311	Computer Communication & Network	04

### Course Objectives:

1. To develop an understanding of computer networking basics.
2. Describe how computer networks are organized with the concept of layered approach.
3. Analyze the contents in a given data link layer packet, based on the layer concept.
4. Describe what a classless addressing scheme is? Design logical sub-address blocks with a given address block.
5. Describe how routing protocols, transport layer and application layer protocols work.

### Course Outcomes: Six (Based on Bloom's Taxonomy)

1. Demonstrate the concepts of data communication at the physical layer and compare ISO - OSI model with TCP/IP model.
2. Demonstrate the knowledge of networking protocols at the data link layer.
3. Design the network using IP addressing and subnetting / supernetting schemes.
4. Analyze various routing algorithms and protocols at the network layer.
5. Analyze transport layer protocols and application layer protocols.
6. Develop knowledge and skills necessary to gain employment as computer network engineer and network administrator.

### Prerequisite: Basic knowledge of Computer Theory

### Syllabus:

Sr. No.	Module	Detailed Content	Hours	CO Mapping
I	Introduction to Computer Network and Physical Layer Specifications	Overview of OSI Model, of TCP/IP Protocol Suite, Applications of Computer Networks, Software Primitives, Transmission Media, Network devices, Switching, Physical Layer Coding	6	CO1
II	Framing and Channel Allocation, Error Control	Bits stuffing, Byte Stuffing, Character Coding, HDLC, PPP, CRC, Checksum, Hamming Code, Overview ARQ, Dynamic Channel Allocation(CSMA/CD, CSMA/CA)	7	CO2
III	IP addressing (IP v4, IPv6)	Classful, classless addressing, Subnetting, IPV4, IPV6, Migration from IPv4 to IPV6	6	CO3,CO6
IV	Routing(interdomain, Intradomain),	Types of Routing, Routing Algorithm: Distances Vector Routing, Link state Routing Path vector Routing,	5	CO4,C06
V	TCP and UDP services, Socket Programming	TCP header, 3-way connection Establishment, TCP services: Error Control, Flow control, Congestion Control, TCP state transition diagram, TCP timers, UDP header, Socket Programming, Client Server programming	8	CO5,CO6

VI	HTTP, FTP, Mailing Protocols, DNS, DHCP,	Application Layer Services, HTTP, FTP, TFTP, SNMP, POP3, IMAP4, DNS, DHCP	7	CO5, CO6
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### Laboratory Syllabus:

Sr. No.	Level 1. Basic 2. Design 3. Advanced 4. Project/ Case Study/ Seminar	Detailed Lab/Tutorial Description	Hours
1	Basic	To perform crimping and set up a LAN connection.	02
2	Design	To configure a network using Distance Vector Routing Protocol-RIP using Cisco Packet Tracer.	02
3	Design	Configure a network using Path Vector Routing Protocol- BGP using Cisco Packet Tracer	02
4	Advanced	To perform subnetting using Cisco Packet Tracer	02
5	Advanced	To configure the DHCP server.	02
6	Basic	To study about the NS2 simulator in detail.	02
7	Advanced	To Simulate and to study stop and Wait protocol using NS 2.1	02
8	Advanced	To Simulate Sliding Window protocol using NS 2.1	02
9	Project	Mini Project	02

**Software Requirements:** Cisco Packet Tracer, NS2

**Hardware Requirements:** Network Devices: Routers, Switches, Crimping Tool

### Theory Assessment:

#### Internal Assessment for 40 marks:

Consisting of Two Compulsory Internal assessment of **40 Marks each** on 40% syllabus for each test. The final marks will be the average of the score of both the tests.

#### End Semester Examination: 60 Marks

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

### Lab Assessments:

1. Termwork Assessment: At least 08 Experiments including 02 simulations covering the entire syllabus must be given during the —Laboratory session batch wise—. The experiments should be student centric and attempts should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for a maximum batch of four students. Term work assessment must be based on the overall performance of the student with every experiment/tutorials and mini-projects (if included) are graded from time to time. Based on the above scheme grading and term work assessment should be done.
2. Oral/Viva Assessment: The practical and oral examination will be based on the entire syllabus.

**Textbooks:**

1. Computer Networks, Fifth Edition, Andrew S. Tanenbaum.
2. TCP/IP Protocol Suite, Tata McGraw Hill, Behrouz A. Forouzan

**References:**

1. DATA AND COMPUTER COMMUNICATIONS Eighth Edition William Stallings
2. Computer Networking: A Top-Down Approach, 6th Edition. James Kurose. Keith W. Ross

Admission Year 2022-2023

Course Code	Course Name	Credits
ET 312	Database Management System	04

**Prerequisite:** C Programming, Python Programming

**Course Objectives:**

1. Understand the requirement of Database Management System
2. Develop entity relationship data model and its mapping to relational model
3. Learn relational algebra and Formulate basic SQL queries
4. Formulate Advance complex SQL queries
5. Apply normalization techniques to normalize the database
6. Understand the concept of transaction, concurrency control and recovery techniques.

**Course Outcomes:**

1. Recognize the need of database management system and understanding Data Models
2. Design ER and EER diagrams for real life applications and Construct relational models for the same.
3. Formulate SQL queries and design Database.
4. Analyze Database using complex SQL queries
5. Apply the concept of normalization to relational database design.
6. Describe the concept of transaction, concurrency and recovery.

**Theory Syllabus:**

Sr. No.	Module	Detailed Content	Hours	CO Mapping
I	Introduction to DBMS	Characteristics of database, Database users, Advantages of DBMS , Data Models , Schemas and Instances, DBMS system Architecture, Three schema Architecture and Data Independence, Data abstraction	4	CO1
II	Entity-Relationship Data Model and Relational Model	The Entity-Relationship (ER) Model: Entity types: Weak and strong entity sets, Entity sets, Types of Attributes, Relationship constraints: Cardinality and Participation, Design of an E-R database schema; Extended E- R features; Introduction to the Relational Model, relational schema and concept of keys. Reduction of an E-R schema to EER schema; Reduction of an E-R schema to tables.	6	CO2
III	Structured Query Language (SQL)	Overview of SQL, Data Definition Commands, Basic SELECT Queries, SELECT Statement Options, FROM Clause Options, Integrity constraints: key constraints, Domain Constraints, Referential integrity , check constraints, Data Manipulation commands, Data Control commands	7	CO3

IV	Advanced SQL	Nested and Complex Query, SQL with SET operations: Union, Intersect, Except, etc, Aggregate Functions, Group By, Having, SQL with Logical operations, Join Queries, Virtual Tables: Creating a View, Sequences, Procedural SQL, Embedded SQL Database Design: The Information System, The Systems Development Life Cycle, The Database Life Cycle, Conceptual Design, DBMS Software Selection, Logical Design, Physical Design, Database Design Strategies, Centralized versus Decentralized Design.	10	CO4
V	Relational-Database Design	Pitfalls in relational-database design, Concept of normalization, Function Dependencies, First Normal Form, 2NF, 3NF, BCNF, 4NF	6	CO5
VI	Transactions Management and Concurrency and Recovery	Transaction concept, Transaction states, ACID properties, Transaction Control Commands, Concurrent Executions, Serializability-Conflict and View, Concurrency Control: Lock-based, Timestamp-based protocols, Recovery System: Log based recovery, Deadlock handling	6	CO6

### Laboratory Syllabus:

Lab Prerequisite: C Programming, Python Programming

Sr. No.	Level 1.Basic 2.Design 3.Advance 4.Project/ Case Study/ Seminar	Detailed Lab/Tutorial Description	Hours
1	1	Identify the case study and detailed statement of the problem.	02
2	2	Design an Entity-Relationship(ER)/ Extended Entity-Relationship (EER) Model.	02
3	2	Mapping of ER Diagram to Relational Schema Model	02
4	3	Create a database using Data Definition Language (DDL) and apply integrity constraints for the specified System.	02
5	3	Apply DML commands for the specified system.	02
6	3	Perform Merge Operation	02
7	3	Perform Aggregation Function and Clauses in SQL	02
8	3	Perform Join Operation	02
9	3	Perform Trigger Function and view in Postgresql	02

10	4	Analysis of any Database / case study	02
11	4	Application of the knowledge on mini project	02

**Software Requirements:** SQL server (Oracle/MySQL/PostgreSQL)

**Hardware Requirements:** 2GB RAM

**Theory Assessment:**

**Internal Assessment for 40 marks:**

1. Consisting of One Compulsory Internal assessment of 40 Marks
2. Continuous evaluation : Test/Assignments /Quiz/Case studies/project/Seminar presentation of 40 Marks

**End Semester Examination:** 60 Marks

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

**Lab Assessments:**

**1. Teamwork Assessment:** Term work should consist of 10 experiments. Journal must include at least 2 assignments on content theory and practical of "Database Management System". The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments:05-marks).

**2. Oral/Viva Assessment:** Practical & oral exam to be conducted by Internal & External examiners. Practical execution (10 marks) & Oral (15 marks).

**Text Books:**

1. Elmasri & Navathe, "Fundamentals of Database System", 7 th Edition, Addison Wesley Publication.(2015).
2. Abraham Silberschatz, Henry Korth, Sudarshan , "Database System Concepts", 6th Edition, (2010)
3. Raghuram Ramakrishnan, Johannes Gehrke, Database Management Systems, 3rd Edition, McGraw-Hill, (2002)

**References:**

1. Michael Mannino, "Database design, Application Development and Administration", 4th Edn(2008)
- Peter Rob and Coronel, "Database systems, Design, Implementation and Management", 5th Edition, Thomson Learning,2001
3. C. J. Date, "Introduction To Database Systems", Seventh Edition, Addison Wesley

**Text Books (For Laboratory)**

1. Korth, Silberchatz, Sudarshan, Database System Concepts, 6thEdition, McGraw Hill.
2. Elmasri and Navathe, Fundamentals of Database Systems, 5thEdition, Pearson Education.
3. Dr. P.S. Deshpande, SQL and PL/SQL for Oracle 10g, Black Book, Dreamtech Press.

**References (For Laboratory)**

1. Microsoft SQL Server Black Book By Patrick Dalton
2. <https://www.w3schools.com/sql/>  
<https://www.postgresqltutorial.com>

Admission Year 2022-2023

Course Code	Course Name	Credits
ET 391	Mini Project III	02

#### Course Objectives:

1. To develop background knowledge Embedded Systems.
2. To understand the design of embedded systems.
3. To choose proper microcontroller for Embedded systems
4. To understand use of wireless sensors/communications with Embedded systems
5. To understand communication techniques.
6. To write programs for embedded systems and real time operating systems /IoT

#### Course Outcomes: After successful completion of the course, the student will be able to

1. Understand the embedded systems with design metrics.
2. Understand microcontrollers and programming in Embedded C.
3. Implementation of Embedded systems with different sensors.
4. Implementation of Embedded systems with different communication protocols.
5. Analyze concepts of Real time operating systems.
6. Design embedded system applications using sensors, peripherals and RTOS

#### Course Contents :

Guidelines for mini project

Mini Project should be completely microcontroller based.

- a) Take specifications, using these specifications design projects.
- b) Select proper microcontroller board considering features and requirements of the project.
- c) Program it using Embedded C and perform verification of each module
- d) Test Functional Simulation and verify it using a simulation tool.
- e) Make hardware connection of peripherals with microcontroller board and execute the program.
- f) Troubleshoot if not get expected result

#### A: Execution of Project:

Project group shall consist of not more than 4 students per group. Project Work should be carried out in the Design / Projects Laboratory.

Project designs ideas can be necessarily adapted from recent issues of electronic design Use of Hardware devices/components is mandatory.

Layout versus schematic verification is mandatory Assembly of components and enclosure design is mandatory.

Students shall be motivated to publish a paper based on the work in Conferences / students competitions.

#### B: Selection of Project :

The Project may be beyond the scope of curriculum of courses taken or may be based on the courses but thrust should be on Learning additional skills.

**C: Weekly Interaction of project team and project guide :**

Week 1 & 2: Formation of groups, Finalization of Mini project & Distribution of work. Week 3 & 4: PCB artwork design using an appropriate EDA tool, Simulation.

Week 5 to 8: PCB manufacturing through vendor/at lab, Hardware assembly, programming (if required) Testing, Enclosure Design, Fabrication etc

Week 9 & 10: Testing of final product, Preparation, Checking & Correcting of the Draft Copy of Report Week 11 & 12: Demonstration and Group presentations.

Log book for all these activities shall be maintained and shall be produced at the time of examination.

**D. Report writing : A project report with following contents shall be prepared:**

Title Specifications Block diagram Circuit diagram

Selection of components Calculations

Simulation results

PCB artwork Layout versus schematic verification report Testing procedures

Enclosure design Test results Conclusion

Module No	Module	Detailed Content	CO Mapping
I	Introduction	Definition of Embedded System, Embedded Systems Vs General Computing Systems, Classification, Major Application Areas. Characteristics and Design Metric of an embedded system. Identification of Project Title	CO1
II	Controller boards and Programming – Embedded C	ARM LPC 21XX (2148)/8051, STM32 boards and Texas MSP 430 lunchbox/ Tiva C board and PIC/PSoc* Comparison of C and embedded C, Data Types, Variable, Storage Classes, Bit operation , Arrays, Strings, Structure and unions, Classifier	CO2
III	Interfacing Sensors and Peripherals	Sensors and Signal Conditioning Circuits amplifiers /attenuators /filters /comparators/ADC and DAC) , Interfacing with GLCD/TFT display , Relays and Drivers for interfacing Motors (DC and stepper ) Interfacing with BLDC motors and drivers, USB/HDMI camera interfacing	CO3
IV	Communication in Embedded C	Serial communication, CAN bus, I2C, MOD bus, SPI Interfacing with Wi-Fi, Bluetooth ,ZigBee, LoRa, RFID and putting data on IoT Interfacing with GSM module , GPS module, SD card	CO4
V	Real Time Operating Systems	Operating system basics , Types of OS , Tasks, process, Threads Multiprocessing and ,Multitasking , Task scheduling ,	CO5
VI	Cloud/Web server	Implementation on web server , Thingspeak, AWS cloud platform for IoT based programming and modeling	CO6

**Guidelines for Assessment of Mini Project:**

**Term Work (25 Marks) :-** On demonstration in front of an internal and external examiner. In the examination each individual student should be assessed for his/her contribution, understanding and knowledge gained about the task completed. The review/ progress monitoring committee shall be constituted by the head of departments of each.

Admission Year 2022-2023

Course Code	Course Name	Credits
ET 313	Wireless & Mobile communication	03

**Prerequisite:**

Computer Communication and Network

**Course Objectives:**

1. To get familiar with the basics of wireless systems.
2. To understand various aspects of Mobile radio propagation.
3. To study various emerging technologies like Bluetooth, Zigbee, Wi- fi, WiMax etc.
4. To explore details of UWB.
5. To study advanced technologies used in Wireless communication.
6. To discuss the introduction of 5G technology.

**Course Outcomes:**

Students will be able to:

1. Get familiar with the basics of wireless systems.
2. Understand various aspects of Mobile radio propagation.
3. Study various emerging technologies like Bluetooth, Zigbee, Wi- fi, WiMax etc..
4. Explore details of UWB.
5. Study advanced technologies used in Wireless communication.
6. Discuss introduction of 5G technology

**Theory Syllabus:**

Sr. No.	Module	Detailed Content	Hours	CO Mapping
I	Introduction to Wireless Networks	Infrastructure of Wireless Networks , Wireless communication systems, Applications of wireless communication systems, Types of wireless communication systems, trends in mobile communication systems.	06	CO1
II	Mobile Radio Propagation	Large scale fading: Free space propagation model, the three basic propagation mechanisms, reflection, ground reflection (two-ray) model, diffraction, scattering, practical Link budget design using path loss models Small scale fading: Small scale multipath propagation, parameters of mobile multipath channels, types of small-scale fading, Rayleigh and Rician distributions.	08	CO2
III	Emerging wireless technologies	Bluetooth, ZigBee, WiMax, Wi-fi, Ad-hoc wireless networks, Wireless sensor networks, UWB	08	CO3

IV	Wireless Local Area Networks	Introduction, WLAN equipment, topologies and technologies, WLAN applications and existing basic service set, WLAN security and power management, WLAN main features of IEEE 802.11a,b,I and n.	06	CO4
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V	Advanced technologies in Wireless Communication	Mobile Machine to Machine communication, Mobile traffic management, cooperative communication	06	CO5
VI	Introduction to 5G	Salient features of 5G , 5G technology, 5G Architecture, Advantages and disadvantages, Applications, 5G Advancements, 5G Challenges, 5G future scope	06	CO6

### **Theory Assessment:**

#### **Internal Assessment for 40 marks:**

Consisting of Two Compulsory Internal assessment of **40 Marks each** on 40% syllabus for each test. The final marks will be the average of the score of both the tests.

#### **End Semester Examination: 60 Marks**

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

#### **Textbooks:**

1. Vijay K. Garg, “Wireless Communication and Networking”, Morgan – Kaufmann Series in Networking—Elsevier
2. KE- LIN DU & M. N. S. Swamy, —Wireless Communication Systems, Cambridge University Press India Pvt. Ltd
3. Dr. Sunilkumar S. Manvi, Mahabaleshwar S. Kakkasageri, —Wireless & Mobile Networks: Concepts and Protocols Wiley India
4. Theodore S. Rappaport “wireless communications - principles and practice”, PEARSON Second edition.

#### **References:**

1. T L Singal “wireless communications”, Mc Graw Hill Education
2. Fundamentals of 5G Mobile Networks: Jonathan Rodriguez (Ist Edition), Wiley Publication
3. Carlos de Morais Cordeiro, Dharma Prakash Agrawal, —AD HOC & Sensor Networks – Theory & Applications , Cambridge University Press India Pvt. Ltd

Course Code	Course Name	Credits
ET 314	Electromagnetic wave and Radiating Systems	03

**Pre-requisites:**

1. Vector Calculus
2. Fundamental concepts of electricity and magnetism

**Course Objective:**

1. To learn electromagnetics and the laws governing it.
2. To apply Maxwell's equation to solve various electromagnetic phenomenon such as electromagnetic wave propagation in different medium, power in EM wave.
3. Understanding of antenna fundamentals.
4. Ability to design, and analyze the performance of wire antennas.
5. Ability to design, and analyze the performance of antenna arrays.
6. Ability to design, and analyze aperture antennas and patch antennas.

**Course Outcomes:**

Students will be able to

1. Understand the laws governing Electromagnetics
2. Apply Maxwell's equation to solve various electromagnetic phenomenon such as electromagnetic wave propagation in different medium, power in EM wave.
3. Describe various antenna parameters.
4. Design and analyze wire antennas
5. Design and analyze array antennas
6. Design and analyze aperture and patch antennas.

Sr. No.	Module	Detailed Content	Hours	CO Mapping
I	Introduction to Static fields	1.1 Charge, Coulomb's law, Charge configurations, Electric field intensity, Electric flux density, Gauss's law and applications, Current density, and Continuity equation 1.2 Scalar Electric Potential, Potential gradient, Laplace's and Poisson's equations 1.3 Biot Savart Law, Ampere Circuit law, Gauss's law for magnetic field, Vector magnetic potential	6	CO1
2	Electromagnetic Field and Maxwell's Equations	2.1 Faraday's Law, Displacement current density, Maxwell's equation for time varying field 2.2 EM wave propagation through lossy, perfect dielectric and conducting medium. 2.3 Power in EM Wave: Poynting theorem and	7	CO2

		Poynting vector		
3.	Antenna Fundamentals	3.1 Introduction, Radiation Mechanism, basic antenna parameters, Radiation pattern, radiation power density, radiation intensity, Beamwidth, directivity, Antenna efficiency, Gain, beam efficiency, bandwidth, polarization, input impedance, antenna vector effective length and equivalent areas, Antenna radiation efficiency, 3.2 Friis transmission equation 3.3 Near field and Far field	6	CO3
4	Wire Antennas	4.1 Infinitesimal dipole, radiation fields, radiation resistance, radiation pattern, near field, far field, directivity, small dipole, finite length dipole, half wavelength dipole, Monopole antenna, Folded dipole. Design of dipole and monopole antenna. 4.2 Loop Antenna: Small circular loop, comparison of small loop with short dipole, Ferrite loop, radiation pattern. patterns and their application. 4.3 Helical Antennas: Axial mode and normal mode helical antenna.	6	CO4
5	Antenna Arrays	5.1 Linear arrays, Array of two isotropic point sources, linear arrays of N elements, principle of pattern multiplication applicable to non-isotropic sources, broadside and End-fire Array, Increased Directivity end fire array, Calculations of Directivity, Beam width, Maxima and null directions for N-element Array. 5.2 Introduction to planar and circular arrays . 5.3 Design of Yagi antenna and Log Periodic antenna.	8	CO5
6.	Aperture Antennas and patch Antennas	6.1 Horn Antennas :E-Plane Sectoral Horn, H-Plane Sectoral Horn, Pyramidal Horn, Conical Horn 6.2 Reflector Antennas: Introduction, Plane Reflector, Corner Reflector, Parabolic Reflector, Design considerations 6.3 Microstrip antenna (MSA): Introduction, Feeding Techniques, Design of regular Shape MSAs (Rectangular,Circular)	6	CO6

#### Theory Assessment:

##### Internal Assessment for 40 marks:

Consisting of Two Compulsory Internal assessment of **40 Marks each** on 40% syllabus for each test. The final marks will be the average of the score of both the tests.

#### End Semester Examination: 60 Marks

Weightage of each module in the end semester examination will be proportional to the

number of respective lecture hours mentioned in the curriculum.

**Textbooks:**

1. Electromagnetic Waves and Radiating Systems- Jordan and Balmain, PHI, 2nd edition
2. Principles of Electromagnetics Engineering- Matthew N. O.Sadiku , S.V.Kulkarni, Oxford university press , 6th edition
3. Antenna Theory: Analysis and Design, Costantine A. Balanis, John Wiley Publication, 4th edition
4. Antenna and wave Propagation, John D Kraus, A S Khan, McGraw Hill, 4th edition
5. Antenna Theory and Design. Stutzman, Theile, John Wiley and Sons, 3rd edition

**Reference Books:**

1. Engineering Electromagnetics, William H Hayt and John A Buck, Tata McGraw-Hill Publishing Company Limited, 7th edition
2. Antennas and Radio Wave Propagation, R. E. Collin, M
3. G. Kumar, K. P. Ray, Broadband Microstrip Antenna, Artech House, 2002.

Admission Year 2022-2023

Course Code	Course Name	Credits
ET 315	WMC and EWRS Lab	01

**Lab Prerequisite:**

1. Electromagnetics and wave theory.
2. Transmission line

**Lab Objectives: Six Course Objectives**

- L1. Ability to design and analyze the performance of wire antennas and its applications.  
L2. Ability to design and analyze the performance of microstrip antennas and its applications.  
L3. Ability to measure the performance parameters of reflector/ array/ Yagi-Uda/ Log-periodic antenna  
L4. Ability to design and analyze the performance of various wireless systems like GSM CDMA and WCDMA in Matlab or Scilab  
L5. Ability to study and analyze various Systems like Zigbee and WSN in NS2  
L6. Ability to study Path loss models

**Lab Outcomes: At the end of the course the student should be able to:**

1. Estimate the impact of various parameters of wire antennas like wire diameter and its length on the radiation characteristics of the antenna.
2. Design microstrip antenna using simulation tools and estimate the effect of change in antenna dimensions on the radiation characteristics of the antenna.
3. Determine beamwidth, directivity and radiation pattern of a reflector/array Yagi-Uda/ Log-periodic antenna
4. Design and analyze the performance of various wireless systems like GSM CDMA and WCDMA in Matlab or Scilab.
5. Analyze various Systems like Zigbee and WSN in NS2
6. Determine various losses from Path loss models.

**Laboratory Syllabus: (Minimum 8 experiment)**

Sr. No.	Level 1. Basic 2. Design 3. Advanced 4. Project/ Case Study/ Seminar	Detailed Lab/Tutorial Description	LO Mapping
1	Basic	To determine radiation pattern, beamwidth and F/B ratio of Dipole antenna	LO1
2	Basic	To determine radiation pattern, beamwidth, and F/B ratio of monopole antenna	LO1
3	Basic	To determine radiation pattern, beamwidth, and F/B ratio of array of two dipole antenna	LO1
4	Basic	To determine radiation pattern, beamwidth, and F/B ratio of yagi-uda antenna	LO1

5	Basic	To determine radiation pattern, beamwidth, and F/B ratio of Log-periodic antenna	LO1
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6	Basic	To determine radiation pattern, beamwidth, and F/B ratio of reflector antenna	LO1
7	Design	To design a dipole antenna and study the effect of variation of wire diameter and length of wire on its performance (using software simulation tool)	LO2
8.	Design	To design a Rectangular microstrip antenna and study the effect of variation in length and width of the patch on its performance.	LO2
9.	Design	To design a 2-element microstrip MIMO antenna system and study the effect of spacing between antenna elements on the radiation characteristics of antennas.	LO2
10	Project	To design and fabricate a patch antenna and test its parameters.	LO2
11	Basic	Study, discussion and installation of different network simulation tools such as NS2/NS3, Net stumbler , Wireshark etc.	LO2
12	Design	Analysis of Zigbee Network to compute the energy efficiency of the network.	LO3
13	Design	Simulation of a simple wireless network (IEEE802.11)using NS2 or any other simulator.	LO4
14	Design	Simulation of path loss model.	LO3
15	Basic	Configuration of WLAN.	LO4
16	Basic	Analysis of WiFi network to compute average end to end delay and packet delivery ratio.	LO5
17	Design	Link budget analysis of a GSM Network using Scilab / Matlab.	LO4
18	Design	Simulation of Wireless Sensor Network (IEEE802.15.4)in NS2 or any other simulator.	LO5
19	Design	Link budget analysis of a WCDMA Network using Scilab / Matlab.	LO6

Software Requirements: CST Microwave studio(any simulation software)

Hardware Requirements:Antenna trainer kit, SCILAB/MATLAB software, NS2

#### Lab Assessments:

- 1. Teamwork Assessment:** Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time. The grades will be converted to marks as per —Choice Based Credit and Grading System” manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.
- 2. Oral/Viva Assessment:** The practical and oral examination will be based on entire syllabus.

**Text Books:**

1. C. A. Balanis, Antenna Theory: Analysis and Design (3rd eds.), John Wiley & Sons, Hoboken, NJ, 2005.
2. J. D. Kraus, R. J. Marhefka, A.S. Khan —Antennas & Wave Propagation, McGraw Hill Publications, 4th Edition, 2011
3. G. Kumar, K. P. Ray, Broadband Microstrip Antenna, Artech House, 2002.
4. Theodore S. Rappaport “wireless communications - principles and practice”, PEARSON Second edition.

**References:**

1. Printed MIMO antenna by Mohammed Sharawi
2. Stutzman, Theile, — Antenna Theory and Design, John Wiley and Sons , 3rd Edition
3. R. E. Collin, —Antennas and Radio Wave Propagation, International Student Edition, McGraw Hill
4. T L Singal “Wireless Communications”, McGraw Hill Education
5. Fundamentals of 5G Mobile Networks: Jonathan Rodriguez (1st Edition), Wiley Publication
6. Carlos de Morais Cordeiro, Dharma Prakash Agrawal, —AD HOC & Sensor Networks – Theory & Applications , Cambridge University Press India Ltd

Course Code	Course Name	Credits
ET 316	Data Structures	03

**Prerequisite: Java Programming**

**Course Objectives:**

1. To understand the basic elements of algorithms, importance of the analysis of algorithms, their notations, and relationships.
2. to understand the difference between linked lists and arrays.
3. To introduce the underflow and overflow concept.
4. To understand nonlinear data structures and connections between objects

**Course Outcomes:**

After successful completion of the course students will be able to

1. Students will be able to implement linear and Non-Linear data structures.
2. Students will be able to discover how to maintain data in an ordered fashion
3. Students will be able to manipulate the data efficiently.
4. Students will be able to calculate routes and path lengths in networks.
5. Students will be able to understand relationships and connections between different elements.
6. Students will be able to analyze and Implement appropriate sorting and searching techniques for a given problem

Sr. No.	Level 1. Basic 2. Design 3. Advanced 4. Project/ Case Study/ Seminar	Detailed Lab/Tutorial Description	LO Mapping
1	Basic	<b>Basics:</b> Introduction, Types of Data Structures – Linear and Nonlinear, Operations on Data Structures, Concept of Abstract Data Types (ADTS), Array	3
2	Basic	<b>Stacks:</b> What is a Stack? How Stacks are used, Stack ADT, operations on stacks, Array implementation of stack, Array, Applications of Stack – Well form-ness of Parenthesis, Infix to Postfix Conversion and Postfix Evaluation <b>Queues:</b> What is a Queue? Queue ADT, operations on Queue, Array implementation of Queue, Circular Queue, Priority Queue Doubled ended Queue.	6

3	Basic/Design	<b>Linked Lists:</b> What is a Linked List?, Representation of Linked List, Linked List v/s Array Types of Linked List - Singly Linked List (SLL), Doubly Linked List, Circular Linked List, Operations on Singly Linked List: Insertion, Deletion, reversal of SLL, Print SLL. Implementation of Stack and Queue using Singly Linked List.	6
4	Design	<b>Trees:</b> Tree Terminologies, Binary Tree, Types of Binary Tree, Binary Tree Traversals, Binary Search Tree Implementation Applications of Binary Tree - Expression Tree, Huffman Encoding.	6
5	Design/ Advanced	<b>Graph:</b> Graph Terminologies, Representation of graph (Adjacency matrix and adjacency list), Graph Traversals, Depth First Search (DFS) and Breadth First Search (BFS) Topological Sort.	5
6	Project	<b>Sorting:</b> Introduction Bubble Sort, Insertion Sort, Merge Sort, Quick Sort <b>Searching:</b> Linear Search, Binary Search, Hashing concept, Hash functions, Applications:- Finding a root of a general quadratic polynomial over a finite interval	4

#### DETAILED LAB SYLLABUS:

Sr No	Name of the Lab
1	Array Implementation of Stack
2	Conversion of Infix to Postfix.
3	Evaluation of Postfix Expression.
4	Check continuity of different types of parenthesis using stack
5	Array Implementation of Queue.
6	Array Implementation of Circular Queue.
7	Array Implementation of Priority Queue.
8	Implementation of Singly Linked List.
9	Linked Implementation of Stack.

10	Linked Implementation of Queue.
11	Implementation of Circular Linked List.
12	Implementation of Doubly Linked List.
13	Implement Binary Search Tree.
14	Implementation of Bubble Sort.
15	Implementation of Insertion Sort.
16	Implementation of Merge Sort.
17	Implementation of Quick Sort.
18	Implementation of Binary Search.
19	Implementation of Hashing.
20	Implementation of Depth First Search and Breadth First Search

#### **Theory Assessment:**

**Internal Assessment for 20 marks:** Consisting of Two Compulsory Internal assessment of **20 Marks each** on 40% syllabus for each test. The final marks will be the average of the score of both the tests.

#### **End Semester Examination: 40 Marks**

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

**Termwork Assessment:** Term work should consist of 08 experiments. Journal must include at least 2 assignments on content theory and practicals. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks).

**Oral/Viva Assessment:** Practical & oral exam to be conducted by Internal & External examiners. Practical execution (10 marks) & Oral (15 marks).

#### **Text Books:**

1. G. L. Heileman (2002) Data Structures Algorithms and Object Oriented Programming, Tata Mcgraw Hill.
2. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein (2003) Introduction to Algorithms and Java, 2nd edition, McGraw-Hill.
3. Jean Paul Tremblay, P. G. Sorenson, "Introduction to Data Structure and Its Applications", McGraw-Hill Higher Education
4. Narasimha Karumanchi, (2017) "Data Structures And Algorithms Made Easy In JAVA" CareerMonk Publications.

**Reference Book:**

1. Robert Lafore, “Data Structures and Algorithms in Java”, Sams Publishing; 7th edition

**Mooc Courses:**

1. <https://www.coursera.org/learn/developer-data-structures-and-algorithms>
2. <https://www.codeintuition.io/learning-paths/data-structures>
3. <https://www.edx.org/certificates/professional-certificate/gtx-data-structures-and-algorithms>

Admission Year 2022-2023

Course Code	Course Name	Credits
ET 317	Robotics and Automation	04

**Prerequisite:**

IoT Basics & Smart Sensors, Applied Mathematics.

**Course Objectives:** Students will try:

1. To introduce the students to different types of Robots and understand the fundamentals of robotics.
2. To provide in depth knowledge of Direct Kinematics & Inverse Kinematics.
3. To impart skills for analysis of Velocity Kinematics and Dynamics.
4. To familiarize students with Trajectory planning of robots and robot vision.
5. To familiarize students with task planning of robots and industrial automation.
6. To train the students to analyze industrial automation and build automated systems.

**Course Outcomes:** Students will be able to:

1. Understand the basic concepts of robotics.
2. Perform the kinematic analysis of robots.
3. Analyze Velocity Kinematics and Dynamics.
4. Perform trajectory planning of robots & describe importance of visionary system in robotic manipulators
5. Perform task planning of robots and design industrial automation systems.
6. Analyze and build industrial automation systems

**Theory Syllabus**

Sr. No.	Module	Detailed Content	Hours	CO Mapping
I	Fundamentals of Robotics	Robot Classification, Robot Components, Robot Specification, Joints, Coordinates, Coordinate frames, Workspace, Languages, Applications.	06	CO 1
II	Kinematics of Robots	Homogeneous transformation matrices, Inverse transformation matrices, Forward and inverse kinematic equations – position and orientation Denavit-Hartenberg representation of forward kinematics, Forward and inverse kinematic solutions of three and four axis robot	08	CO2
III	Velocity Kinematics & Dynamics	Differential motions and velocities: Differential relationship, Jacobian, Differential motion of a frame and robot, Inverse Jacobian, Singularities. Dynamic Analysis of Forces : Lagrangian mechanics, Newton Euler formulation, Dynamic equations of two axis robot	08	CO3
IV	Trajectory planning &	Basics of Trajectory planning , Joint-space trajectory planning, Cartesian-space trajectories,	06	CO4

	Robot Vision	Image representation, Template matching, Polyhedral objects, Shape analysis, Segmentation, Iterative processing, Perspective transform, Camera Calibration		
V	Task Planning & Fundamental concepts of Industrial Automation	Task level programming, Uncertainty, Configuration Space, Gross motion Planning; Grasp planning, Fine-motion Planning, Simulation of Planer motion, Source and goal scenes, Task planner simulation.  Concepts in manufacturing and automation, definition of automation, reasons for automating. Types of production automation strategies, levels of automation.	06	CO5
VI	Transfer lines and automated assembly	General terminology and analysis, analysis of transfer lines without storage, partial automation. Automated flow lines with storage buffers. Automated assembly-design types of automated assembly systems, part feeding devices, analysis of multi-station assembly machines. AS/RS, RFID system, AGVs, Flow line balancing.	06	CO6

#### List of Experiment:

- Suggested List of experiments
- Forward kinematics
- Inverse kinematic
- Dynamic analysis
- Joint-space trajectory
- Cartesian-space trajectory
- Template matching
- Iterative processing Segmentation

#### Software Requirements:

MATLAB/Scilab

#### Theory Assessment:

**Internal Assessment for 40 marks:** Consisting of Two Compulsory Internal assessment of **40 Marks each** on 40% syllabus for each test. The final marks will be the average of the score of both the tests.

#### End Semester Examination: 60 Marks

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

#### Laboratory Assessment:

##### Term work for 25 marks:

1. At least eight experiments covering the whole syllabus, duly recorded and graded. The experiments should be students' centric and attempts should be made to make experiments more meaningful, interesting and innovative.

2. Two assignments to be included covering at least 60% of the syllabus.
3. The final certification and acceptance of term work ensures satisfactory performance of Laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus.

Term work assessment must be based on the overall performance of the student with every experiment graded from time to time. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme.

### **End Semester Practical/Oral Examination:**

Pair of Internal and External Examiner should conduct practical/viva based on contents. Distribution of marks for practical/viva examination shall be as follows:

Practical Examination: 15 Marks

Oral Examination: 10 Marks

### **Text Books:**

1. Robert Shilling, "Fundamentals of Robotics - Analysis and control", Prentice Hall of India, 2009
2. Saeed Benjamin Niku, "Introduction to Robotics—Analysis, Control, Applications", Wiley India Pvt. Ltd., Second Edition, 2011

### **References:**

1. John J. Craig, "Introduction to Robotics – Mechanics & Control", Third Edition, Pearson Education, India, 2009
2. Mark W. Spong, Seth Hutchinson, M. Vidyasagar, "Robot Modeling & Control", Wiley India Pvt. Ltd., 2006
3. Mikell P. Groover et.al, "Industrial Robots-Technology, Programming & applications", McGraw Hill, New York, 2008

Course Code	Course Name	Credits
ET 318	Electronic Product Design	04

**Prerequisite:**

Electromagnetics Engineering, Antenna, Microwave Engineering, Transmission lines, Electronic Devices and Systems, Knowledge of basic electronic components

**Course Objectives: Six**

1. Understand the fundamentals of Product Design
2. Understand market needs and generate innovative ideas for product development
3. Understand the sources of EMI that may affect the performance of the product
4. Understand various techniques of making the product compatible to the electromagnetic environment
5. Understand basic rules of PCB design and system integration for prototyping
6. Understand the debugging techniques and testing of the prototype

**Course Outcomes:**

1. Describe the fundamentals of Product design
2. Identify the innovative ideas for product development
3. Identify various sources of EMI affecting system performance
4. Identify and describe the techniques of electromagnetic compatibility
5. Describe design considerations of printed circuit board
6. Describe the procedure of debugging and testing of the prototype

Sr. No.	Module	Detailed Content	Hours	CO Mapping
I	Introduction to Product Design	Introduction, Product Requirements and Specifications, Product Architecture, packaging, case studies of products in markets, Disassembling existing Product(s) and understanding relationship of components with each other, Case studies of product failures	09	CO1
II	Ideation	Generation of ideas, Funnelling of ideas, Short-listing of ideas for product(s) as an individual or a group of individuals, Sketching of products, Market research for need, competitions, scale and cost, Initial specifications of products, Selection of circuit and components, Identification of suitable simulation software, Prototype Design in simulation software	10	CO2

III	Electromagnetic Interference (EMI)	Introduction. Natural and Nuclear Sources of EMI, Intrinsic sources of noise, EMI from Apparatus and Circuits. Quantification Of Communication System EMI, Electrostatic Discharge (ESD), Elements of Interference, Including Antennas, Transmitters, Receivers and Propagation. Electronic Equipment And System EMI Concepts. Examples Of EMI Coupling Modes. Equipment Emissions And Susceptibilities- Types of coupling: Common-Mode Coupling, Differential-Mode Coupling, and Coupling Reduction Techniques. Other Coupling mechanisms: Power Supplies And Victim Amplifiers	10	CO3
IV	Electromagnetic Compatibility	Grounding, Shielding, Filtering, Bonding, EMC Specifications, EMC Regulations / Standards and Measurements	08	CO4
V	PCB Layout Considerations and Prototyping	Introduction to PCB layout making software's, General PCB Layout Considerations: Partitioning, Keep Out Zones, Critical Signals, System Clocks, PCB-to-Chassis Ground Connection, Return Path Discontinuities PCB Layer Stackup: One- and Two-Layer Boards, Multilayer Boards, General PCB Design Procedure, component mounting and System integration	09	CO5
VI	Prototype Debugging, Testing and Report writing	Steps of debugging, troubleshooting techniques, Inspection and testing of components, EMI-EMC testing, Enclosure design consideration, Product safety and liability issues, Product Documentation and report writing	08	CO6

### Laboratory Syllabus

Sr. No.	Level 1. Basic 2. Design 3. Advance 4. Project/ Case Study Seminar	Detailed Lab/Tutorial Description	Hours
1	Study	Case study of product failures	02
2	Design	Ideation and prototype design in simulation software	02
3	Advanced	Measurement of conducted and radiated Electromagnetic Interference	02
4	Design	To study electromagnetic compatibility techniques.	02
5	Advanced	Implementation of PCB prototype considering EMI-EMC issues.	02
6	Advanced	Enclosure design for the prototype	02
7	Advanced	Troubleshooting of the prototype.	02
8	Basic	Preparation of product manual and launching of product.	02

### **Theory Assessment:**

#### **Internal Assessment for 40 marks:**

Consisting of Two Compulsory Internal assessment of **40 Marks each** on 40% syllabus for each test. The final marks will be the average of the score of both the tests.

#### **End Semester Examination: 60 Marks**

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

### **Laboratory Assessment:**

#### **Term work Assessment:**

At least 08 experiments covering the entire syllabus should be set to have well predefined inference and conclusion. The experiments should be students' centric and an attempt should be made, to frame experiments more meaningful, interesting and innovative. Term work assessment must be based on the overall performance of the student with every experiment graded from time to time. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work

#### **Oral/Viva Assessment:**

Practical and Oral exams will be based on the entire syllabus.

#### **Hardware Requirements:**

1. CRO (Analog/ DSO),
2. Spectrum Analyzer (SA)
3. Vector network analyzer (VNA)
4. Basic electronic and electrical components and tools
5. SMD and PTH Setup.
6. PCB Lab setup

#### **Software Requirements:**

- EAGLE
- Ki-CAD
- ORCAD
- Express-PCB
- Altium
- Proetis
- CST Microwave studio
- Other open source

**Text Books**

1. Henry W. Ott, "Electromagnetic Compatibility Engineering", John Wiley and Sons, 2005
2. W. Prasad Kodali, "Engineering Electromagnetic Compatibility: Principles, Measurements, Technologies, and Computer Models", 2nd Edition, ISBN: 978- 0-7803-4743-4, January 2001, Wiley-IEEE Press
3. David. A. Weston, "Electromagnetic Compatibility-principles and applications", Second Edition, Publisher: Marcel Dekker, Inc. 2001, ISBN 0-8247-8889-3
4. J. A. S. Angus, "Electronic Product Design", Chapman and Hall, 1996.
5. Eppinger, S., & Ulrich, K. "Product design and development", McGraw - Hill Higher Education

**References:**

1. Clayton R. Paul, "Electromagnetic Compatibility", John Wiley & Sons, 2nd Edition.
2. Roozenburg, N. F. and Eekels, J. "Product design: fundamentals and methods" Vol. 2, John Wiley & Sons Inc. 1995.

Subject Code	Subject Name	Total
ET 319	Integrated Circuit Technology	04

**Course Objectives:**

1. To provide knowledge of Wafer preparation and fabrication for VLSI Technology
2. To provide knowledge of IC fabrication processes and advanced IC technologies.
3. To provide knowledge of IC fabrication processes and design rules.
4. To disseminate knowledge about novel semiconductor measurement.
5. To provide knowledge about different VLSI Technology.
6. To disseminate knowledge about novel VLSI devices and materials.

**Course Outcomes: Upon successful completion of the course students will be able to**

1. Analyze and demonstrate a clear understanding of various MOS fabrication processes & CMOS fabrication flow.
2. Analyze and design layout of MOS based Circuits.
3. Demonstrate a clear understanding of Semiconductor Measurements & Testing.
4. Analyze SOI and GaAs technology.
5. Develop different fabrication process.
6. Understand advanced technologies, Novel Devices and materials in Modern VLSI Technology

**Prerequisite:** Electronic Devices and Circuits I, Digital Circuit Design, VLSI Design

**DETAILED THEORY SYLLABUS:**

Sr. No.	Module	Detailed Content	Hours
1	<b>Semiconductor manufacturing requirements and Crystal growth techniques</b>	<b>Semiconductor Manufacturing:</b> Semiconductor technology trend, Clean rooms, Wafer cleaning and Gettering. Semiconductor Substrate: Crystal structure, Crystal defects, Czochralski growth, Float Zone growth, Bridgman growth of GaAs, Wafer Preparation and specifications	<b>08</b>
2	<b>Semiconductor Device Fabrication Processes-1</b>	Epitaxy: Classification, Molecular Beam Epitaxy Silicon Oxidation: Thermal oxidation process, Kinetics of growth, Properties of Silicon Dioxide, Oxide Quality. Device Isolation: LOCOS, Shallow Trench Isolation (STI). Deposition: Physical Vapor Deposition-Evaporation and Sputtering, Chemical Vapor Deposition: APCVD, LPCVD, PECVD Diffusion: Nature of diffusion, Diffusion in a concentration gradient, diffusion Equation, diffusion systems, problems in diffusion. Ion Implantation: Penetration range-Nuclear & Electronic stopping and Range, implantation damage, Annealing-Rapid thermal annealing, ion implantation systems.	<b>07</b>

3	<b>Semiconductor Device Fabrication Processes-2</b>	Etching & Lithography: Etching: Basic concepts and Classification Lithography: Introduction to Lithography process, Types of Photoresist, Types of Lithography: Electron beam, Ion beam and X-ray lithography. Metallization and Contacts: Introduction to Metallization, Schottky contacts and Ohmic contacts. CMOS Process Flow: N well, P-well and Twin tub, CMOS Latch Up Design rules, Layout of MOS based circuits (gates and Combinational logic), Buried and Butting Contact.	07
4	<b>Measurement and Testing</b>	Semiconductor Measurements: Conductivity type, Resistivity, Hall Effect Measurements, Drift Mobility. Testing: Technology trends affecting testing, VLSI testing process and test equipment, test economics and product quality	06
5	<b>VLSI Technologies</b>	SOI Technology: SOI fabrication using SIMOX, Bonded SOI and Smart Cut ,PD ,SOI and FD SOI Device structure and their features. Advanced Technologies: low $\kappa$ and high $\kappa$ , BiCMOS, H $\kappa$ MG Stack, Strained Silicon. GaAs Technologies: MESFET Technology, MMIC technologies, MODFET	06
6	<b>Novel Devices and Materials</b>	Multigate Devices: Various multigate device configurations-double gate, triple gate (FinFET) and Gate All Around (Nanowire). Nanowire: Concept, VLS method of fabrication, Nanowire FET, Types: Horizontal and Vertical Nanowires, III-V compound Materials in Nanowires. 2-D Materials and FET: Graphene & CNT FET, MOS2 and Black Phosphorous	05

#### DETAILED LAB SYLLABUS:

**Software Requirements:** NANO HUB, MICROWIND

Sr. No.	Detailed Lab Description
1	To study the CZ process for Silicon Crystallization.
2	Implement NMOS inverter with resistive load using NANO HUB and study its Characteristics.
3	Various effects of Temperature on Thermal Oxidation using NANO HUB.
4	Design of CMOS Inverter using Microwind.
5	Design of CMOS NAND using Microwind.
6	Design of CMOS NOR using Microwind.
7	Design of CMOS EXOR using Microwind.
8	To implement the given function $Y=A+BC$ using Microwind.
9	Design of 6T SRAM using Microwind.
10	Case Study IEEE paper.

### **Theory Assessments:**

**1. Internal Assessment:** Two Internal assessments will be conducted for 40 marks each with average marks of both assessments as final score.

### **2. End Sem Theory Examination:**

- Question paper will consist of 4 questions, each carrying 20 marks.
- Total 3 questions need to be solved.
- Q.1 will be compulsory, based on the entire syllabus.
- Remaining questions will be randomly selected from all the modules.
- Weightage of marks should be proportional to number of hours assigned to each module.

### **Lab Assessments:**

#### **1. Term work Assessment:**

- Term work should consist of 10 experiments.
- Journal must include at least 2 assignments
- Mini Project to be performed

Total 25 Marks (Experiments: 10-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks, Mini Project: 5-marks)

#### **2. Oral/Viva Assessment:**

Based on the above contents and entire syllabus.

### **Text Books:**

1. James D. Plummer, Michael D. Deal and Peter B. Griffin, "Silicon VLSI Technology", Pearson, Indian Edition.
2. Stephen A. Campbell, "The Science and Engineering of Microelectronic Fabrication", Oxford University Press, 2nd Edition.
3. Sorab K. Gandhi, "VLSI Fabrication Principles", Wiley, Student Edition.
4. G. S. May and S. M. Sze, "Fundamentals of Semiconductor Fabrication", Wiley, First Edition.
5. Kerry Bernstein and N. J. Rohrer, "SOI Circuit Design Concepts", Kluwer Academic Publishers, 1st edition.

### **References:**

1. Jean-Pierre Colinge, "FinFETs and Other Multigate Transistors", Springer, 1<sup>st</sup> edition
2. M. S. Tyagi, "Introduction to Semiconductor Materials and Devices", John Wiley and Sons, 1st edition.
3. James E. Morris and Krzysztof Iniewski, "Nanoelectronic Device Applications Handbook", CRC Press.
4. Glenn R. Blackwell, "The electronic packaging", CRC Press.
5. Michael L. Bushnell and Vishwani D. Agrawal, "Essentials of Electronic Testing for digital, memory and mixed-signal VLSI circuits", Springer.
6. G.S. May and S. M. Sze, "Fundamentals of Semiconductor Fabrication", Wiley, First Edition

Subject Code	Subject Name	Total
ET 320	Speech and Audio Processing	04

**Prerequisite:** Signals and Systems, Digital Time Signal Processing Course

**Objectives: Six**

1. To understand basic concepts and methodologies for the analysis and modeling of speech signals.
2. To characterize the speech signal as generated by a speech production model.
3. To understand the digital representation of the speech waveform.
4. To perform the analysis of speech signals using STFT.
5. To extract the information of the speech or audio signals.
6. To provide a foundation for developing applications in this field.

**Course Outcomes: Six (Based on Bloom's Taxonomy)**

After successful completion of the course student will be able to

1. Demonstrate advanced Knowledge in Digital model representation of speech signals.
2. Design and implement algorithms for processing speech and audio signals considering the properties of acoustic signals and human hearing.
3. Analyze speech signals to extract the characteristics of vocal tract (formants) and vocal cords (pitch).
4. Formulate and design a system for speech recognition and speaker recognition.
5. Acquired knowledge about audio and speech signal estimation and detection.

### Theory Syllabus

Sr. No.	Module	Detailed Content	Hours	CO Mapping
I	Fundamentals of Human speech production system	1.1 Review of digital signal and systems, Transforms representations of signal and systems, 1.2 Speech production and acoustic tube modelling, anatomy, and physiology of the vocal tract and ear, hearing and perception.	6	1

II	Digital Models for Speech signals	2.1 Articulatory phonetics, acoustic phonetics, discrete time model for speech production	4	2
III	Time domain analysis of speech processing,	3.1 Time energy, average magnitude, and zero-crossing rate, speech vs silence discrimination 3.2 Short-time autocorrelation, pitch period estimation using short-time autocorrelation, median smoothing	8	3
III	Frequency domain representations ,	4.1 Time dependent Fourier representation for voiced and unvoiced speech signals, linear filtering interpretation, spectrographic displays 4.2 Pitch period estimation based on FFT and harmonic peak detection method, estimation of formants using log spectrum	8	4
IV	Homomorphic Speech Processing	5.1 Cepstral analysis of speech, mel frequency cepstral coefficients (MFCC), perceptual linear prediction (PLP) 5.2 Pitch period estimation in cepstral domain, evaluation of formants using cepstrum	7	5
VI	Speech and Audio Processing	6.1 Vocoder- Voice excited channel vocoder, Voice excited and error signal excited LPC vocoders. Adaptive predictive coding of speech, Auditory Modeling. Audio signal processing for Music applications. Speech recognition pattern comparison techniques.	6	6

### Lab Syllabus

**Lab Prerequisite:** Knowledge of MATLAB/SCILAB

Sr. No.	Level 1. Basic 2. Design 3. Advanced Project/Case Study/Semin ar	Detailed Lab/Tutorial Description	Hours
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1	1	To implement a program to generate basic signals	02
2	2	To implement a program to read and play Audio file	02
3	2	To implement a program to concatenate speech signals	02
4	2	To implement a program to concatenate into a stereo file	02
5	3	To implement a program to find resonating frequency of a tuning fork using Autocorrelation method	02
6	2	Program to find effect of length of window on Short Time Autocorrelation Function.	02
7	2	To implement a program, to compute short time energy of audio file using various windows.	02
8	2	To implement a program to compare spectrum of Voiced and Unvoiced Speech segments using Hamming window.	02
9	3	To implement stereo to mono conversion	02
10	3	To implement an application of Speech processing	02

**Software Requirements:** MATLAB/SCILAB

**Theory Assessment:**

**Internal Assessment for 40 marks:**

Consisting of Two Compulsory Internal assessment of **40 Marks each** on 40% syllabus for each test. The final marks will be the average of the score of both the tests.

**End Semester Examination: 60 Marks**

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

**Lab Assessments:**

- 1. Term work Assessment:** At least 08 Experiments including 02 simulations covering the entire syllabus must be given during the —Laboratory session batch wise—. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students. Term work assessment must be based on the overall

performance of the student with every experiment/tutorials and mini-projects (if included) are graded from time to time.

2. **Oral/Viva Assessment** :The practical and oral examination will be based on the entire syllabus.

**Text Books:**

1. L R Rabiner and S W Schafer, —Digital processing of speech signals, Pearson Education,2009.
2. Shaila D. Apte, —Speech and Audio Processing Wiley India, New Delhi, 2012.

**Reference Books**

1. Thomas F Quateri, — Discrete Time Speech Signal Processing —Pearson Edition,2006.
  2. Ben Gold and Nelson Morgan, —Speech & Audio Signal Processing, wiley, 2007.
- Douglas O Shaughnessy, —Speech Communications, 2nd Edition, Oxford university press, 2000

Subject Code	Subject Name	Credits
ET 321	Radar Engineering	04

### Prerequisite:

Electronic Communication Systems  
Antenna and Wave Propagation Course

### Objectives:

1. Learn the basic terminology and concept of Radar
2. Interpret Radar equation , in presence of noise
3. Understand Different types of Radar
4. Analyze Tracking Radar
5. Requirements for Radar transmitter and Receivers
6. Design Consideration of Advance Radar Systems

### Course Outcomes:

1. Define terms used in Radar and Tabulate Radar Frequencies
2. Interpret the equation of Radar Range in varying Conditions
3. Describe and compare various types of Radar
4. Analyze working of Tracking Radar
5. Evaluate the performance of Radar Transmitters and Receivers
6. Explain the advance applications of Radar

### Theory Syllabus

Sr. No.	Module	Detailed Content	Hours	CO Mapping
I	Basics of RADAR	RADAR- definition, Terms in RADAR , Frequencies used, Block Diagram, Applications of Radar	4	CO1
II	Mathematical Modelling of Radar	Detection of signal in noise, Receiver Noise and Signal-to-noise Ratio, Probability of detection and false alarm: Simple , complex	6	CO2

		Targets , Pulse Repetition Frequency, Integration of Pulses ,		
III	MTI and Pulse Doppler Radar	Introduction to Doppler and MTI radar, Doppler frequency shift , Simple CW Doppler radar, MTI radar block diagram , Delay line canceler ,Moving-target-detection Pulse Doppler radar	8	CO3
IV	Tracking Radar	Monopulse tracking , Conical scan and sequential lobbing , Limitation of tracking accuracy , Low angle tracking	6	CO4
V	Radar Transmitters and Receivers	Radar RF power sources: Klystron, Travelling wave tube, Magnetron, CFA , low power transmitter, high power transmitter, Radar Receivers : Receiver noise figure , Superheterodyne Receiver , Types of displays, Antennas used in Radar	10	CO5
VI	Advance Radar Systems	LORAN, DECCA, Instrumentation Landing System, Synthetic Aperture Radar-SAR	5	CO6

### Lab Syllabus

Sr. No.	Level 1. Basic 2. Design 3. Advanced 4. Project/ Case Study/Seminar	Detailed Lab/Tutorial Description	Hours
1	Basic	To demonstrate the elements in the RADAR system	02
2	Basic	Use Doppler RADAR to detect the maximum range.	02
3	Basic	Determine the velocity of the moving objects with the help of RADAR range.	02
4	Basic	Use RADAR system to measure the distance traveled by any object.	02
5	Design	Simulation experiment on Matlab/Scilab	02
6.	Design	Simulation experiment on Matlab/Scilab	02
7	Project/Case Study/Seminar	Design a RADAR system( PBL)	02
8	Project/Case Study/Seminar	Seminar on Recent Advancements in RADAR	02

### **Theory Assessment:**

#### **Internal Assessment for 40 marks:**

Consisting of Two Compulsory Internal assessment of **40 Marks each** on 40% syllabus for each test. The final marks will be the average of the score of both the tests.

#### **End Semester Examination: 60 Marks**

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

### **Lab Assessments:**

**1. Term workAssessment:** At least 08 Experiments including 02 simulations covering entire syllabus must be given during the —Laboratory session batch wise—. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students. Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are graded from time to time.

**2. Oral/Viva Assessment :**The practical and oral examination will be based on entire syllabus.

### **Text Books:**

- 1)MerillSkolnik,—”IntroductiontoRADARSystems”,Tata McGrawHill, Third Edition
- 2)MerillSkolnik,—Radar Handbook, Tata Mcgraw Hill, Second Edition

### **References:**

1. Mark A.Richards,JamesA.Scheer, William A.Holm, —Principles of Modern Radar Basic Principals, ScitechPublishing.
- 2.SimonKingsley,ShaunQuegon,—UnderstandingRadarSystemsI,ScientechnPublishing Inc.
3. G.S. N.Raju, —Radar Engineering and Fundamentals Of Navigational Aids, I. K International publishing House Pvt.Ltd

Subject Code	Subject Name	Credits
ET322	Optical Communication	04

### Prerequisite:

Analog and Digital Communication, Physics, Electromagnetic Engineering

### Course Objectives:

1. List, write and explain fundamentals and transmission characteristics of optical fiberCommunication.
2. List, write and explain the design of Optical Fiber(OF) Component Material, it's fabrication, connectors, splicers to vary length of OF.
3. List, write and explain fundamentals and transmission characteristics of optical fiber communication.
4. List, write and explain principles and characteristics of various sources, detectors and various fiber optic components.
5. List, write and explain principles and characteristics of various sources, detectors and various fiber optic components
6. Calculate parameters for optical link budgeting and analyze the link.

### Course Outcomes:

1. Analyze the fundamental principle of optical fiber communication.
2. Apply the fundamental principles of optics and light waves to design optical fiber communication.
3. Design optical fiber communication links using appropriate components like optical fiber, light source, detectors, connectors, splicers, etc.
4. Explore concepts of designing and operating principles of optical fiber communication.
5. Apply the knowledge developed in class to contemporary research and industrial areas.
6. Design simple and basic optical fiber communication system with various basic faults, configurations, techniques in mind.

### Theory Syllabus

Sr. No.	Module	Detailed Content	Hours	CO Mapping
I	Overview of Optical Fiber Communication	1.1-Historical development, general system, advantages, disadvantages, and applications of optical fiber communication, 1.2-Optical fiber waveguides,	08	CO1

		1.3-Ray theory, cylindrical fiber (no derivations), single mode fiber, cutoff wavelength, and mode field diameter.		
II	Fiber Optic Technology	2.1-Fiber materials, 2.2-Fiber fabrication, 2.3-Fiber optic cables, couplers, splices, connectors	06	CO2
III	Transmission Characteristics	3.1 Attenuation, absorption, linear and nonlinear scattering losses, bending losses, 3.2-Modal dispersion, waveguide dispersion, dispersion and 3.3-Pulse broadening, dispersion shifted and dispersion flattened fibers.	07	CO3
IV	Optical Sources	4.1-Working principle and characteristics of sources (LED, LASER), 4.2- Tunable lasers Quantum well lasers , 4.3-Charge capture in Quantum well lasers, Multi Quantum well Laser diodes, 4.4-Surface Emitting Lasers: Vertical cavity Surface Emitting Lasers	06	CO4
V	Optical Detectors	5.1-Working principle and characteristics of detectors (PIN, APD), 5.2-Material requirement for RCEPD, Resonant cavity enhancement (RCE) Photo Detector, 5.3-Noise analysis in detectors, 5.4-Coherent and non-coherent detection, receiver structure, bit error rate of optical receivers, and receiver performance	06	CO5
VI	Optical Fiber Systems	6.1-Introduction, 6.2-Point to point links, 6.3-System considerations, link power budget, and rise time budget. 6.4-RF over fiber, key link parameters, 6.5-Radio over fiber links, microwave photonics	06	CO6

### Lab Syllabus Lab

#### Prerequisite:

- Analog and Digital Communication, Physics, Electromagnetic Engineering

Sr. No.	Level 1. Basic 2. Design 3. Advanced	Detailed Lab/Tutorial Description	Hours
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1	1	To study optic fiber analog link.	02
2	1	To set up fiber optic analog link.	02
3	1	To study propagation loss in fiber optic.	02
4	2	To study Bending loss.	02
5	2	To measure Numerical Aperture.	02
6	3	To determine cutoff wavelength, responsivity and incident optical power by using SCILAB.	02
7	3	Comparison of acceptance angle for meridional & skew rays using SCILAB.	02
8	2	Determination of Quantum efficiency of photo diodes using SCILAB.	02
9	2	To determine the outer diameter of the Optical fiber in micrometer using SCILAB.	02
10	2	To determine the multiplication factor of the Photodiode using SCILAB.	02
11	4	Design a Optical fiber case study 1.	02
12	4	Design a Optical fiber with given parameters - case study2	02

**Software Requirements: Scilab or Matlab**

**Hardware Requirements: Optical Communication kit**

**Theory Assessment:**

**Internal Assessment for 40 marks:**

Consisting of Two Compulsory Internal assessment of **40 Marks each** on 40% syllabus for each test. The final marks will be the average of the score of both the tests.

**End Semester Examination: 60 Marks**

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

**Lab Assessments:**

**1. Termwork:** At least 08 Experiments covering the entire syllabus must be given during the "Laboratory session batch wise". Computation/simulation based experiments are also encouraged. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four student term work assessment must be based on the overall performance of the student with every experiment graded from time to time

**2. Oral/Viva :** Practical and Oral exams will be based on the entire syllabus.

**Textbooks:**

1. Optical Fiber Communication - John Senior Prentice Hall of India Publication.
2. Optical Fiber Communication - Gerd Keiser Mc- Graw Hill Publication.

**References:**

1. Fiber Optic Communication - Djafar K. Mynbarv, Lowell L. Scheiner.
2. Optical Fiber Communication - Selvarajan, Subartkar, T. Srinivas Tata Mc-Graw Hill Publication.
3. Fundamentals of Fibre Optics in Telecommunication and sensor System, PalB.P., New Age International
4. Fiber Optic Communication, Agrawal, 3rd edi, Wiley
5. Fibre optics and Optoelectronics by Khare, Oxford University Press
6. Rajappa Papannareddy, Lightwave Communication Systems: A Practical Perspective, Penram International Publishing

Subject Code	Subject Name	Credits
ET 323	Advanced Networking Technologies	04

**Prerequisite:** Computer Communication Network Concepts

**Course Objectives:**

1. To make students familiar with data communication technologies and how to use them to Design, Implement, Operate, Manage enterprise networks
2. To understand the basics of Mobile Ad-hoc and emerging protocols.
3. To learn technical principles of ATM and Frame Relay , how they function as Wide Area Network (WAN) technologies.
4. To understand protocols of network security.
5. To know different network performance monitoring tools.
6. To understand parameters of traffic engineering.

**Course Outcomes:**

On completion of the course, students should be able to:

1. Understand optical networks and its standards.
2. Analyze the concept of mobile IP and tunneling in foreign networks.
3. Understand the need and standards of ATM and Frame relay.
4. Demonstrate the various tools for network security.
5. Determine the network performance using monitor tools.
6. Computing the quality of service for desired applications

**Theory Syllabus**

Sr. No.	Module	Detailed Content	Hours	CO Mapping
1	Optical Networking	SONET/SDH standards DWDM Performance and Design Considerations	04	CO1
2	Mobile Networks	Mobile IP: Goals, assumptions and requirements, Entities and Terminology, IP packet delivery, Agent advertisement and discovery, Registration, Tunneling and Encapsulation, Optimizations, Reverse tunneling, IPv6, Dynamic Host Configuration Protocol, Mobile Ad hoc networks MANET routing, DSDV,AODV,ZRP	06	CO2
3	WAN Technologies	ATM: Faces of ATM, ATM Protocol operations. (ATM cell and Transmission) ATM Networking basics, Theory of Operations, B-ISDN reference model, PHY layer, ATM Layer (Protocol model), ATM layer and cell.  Frame relay concept, FR specifications, FR design and VoFR and Performance and	10	CO3

		design considerations.		
4	Network Security	Network layer Security:IPSec,IKE,VPN, Transport Layer Security:SSL Architecture Application layer security: Email Security,PGP,S/MIME Firewalls:Packet Filter firewall,Proxy Firewall	08	CO4
5	Network Design	2 Tier And 3 Tier Architecture in Networking Network Design Layers Three-Layer Hierarchical Model in Cisco Virtual LAN (VLAN) :VLAN Trunking Protocol,Inter VLAN Routing	05	CO5
6	Traffic Engineering and Capacity Planning:	Traffic Engineering Basics, Parameters for traffic analysis, Traffic matrix Source Models:Poisson Arrivals and Markov Processes, Voice Traffic Modelling (Erlang Analysis) Queued Data and Packet Switched Traffic Modeling LAN Traffic Modelling, Queuing System Models Notation, Markovian Queuing System Models Capacity Planning tools	06	CO6

### Lab Syllabus

### Lab Prerequisite:

Computer Communication Network, Basic Networking Knowledge. Software

Requirements: NS2,WireShark

Hardware Requirements: Routers. Cables, Switches, Servers.

Sr. No.	Level 1. Basic 2. Design 3. Advanced 4. Project / Case Study / Seminar	Detailed Lab/Tutorial Description	Hours
1	Basic	To set up WLAN using Cisco Packet Tracer	02
2	Design	To configure Access List using Cisco Packet Tracer	02
3	Design	To configure Tunnel using Cisco Packet Tracer	02
4	Design	To configure TELNET using Cisco Packet Tracer	02
5	Advanced	To configure VLAN using Cisco Packet Tracer	02

6	Advanced	To configure Frame Relay using Cisco Packet Tracer	02
7	Advanced	To configure SNMP Protocol using Cisco Packet Tracer	02
8	Basic	To capture and filter packets using Wireshark	02

### **Theory Assessment:**

#### **Internal Assessment for 40 marks:**

Consisting of Two Compulsory Internal assessment of **40 Marks each** on 40% syllabus for each test. The final marks will be the average of the score of both the tests.

#### **End Semester Examination: 60 Marks**

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

Lab Assessments:

**Term work Assessment:** Journal must contain 08 Experiments and 02 assignments/case study/mini project. Term work assessment will be based on the overall performance of the student with every experiment/tutorials and mini-projects (if included) are graded from time to time.

**Oral/Viva Assessment:** The practical and oral examination will be based on the entire syllabus.

### **Textbooks**

1. Data Network Design by Darren Spohn, 3e McGraw Hill publications
2. Communication Networks by Leon-Garcia and Indra Widjaja, 2e, Tata McGraw- Hill Publications.

### **Reference Books**

1. Behrouz A Forouzan, Data communications and Networking 4th Edition, 6. McGraw-Hill Publication.
2. William Stallings, Data Computer Communications, Pearson Education

Course Code	Course Name	Credits
ET324	Big Data Analytics	04

**Prerequisite:** DBMS

**Course Objectives:**

1. To provide an overview of an exciting growing field of Big Data analytics.
2. To discuss the challenges traditional data mining algorithms face when analyzing Big Data.
3. To introduce the tools required to manage and analyze big data like Hadoop, NoSql MapReduce.
4. To teach the fundamental techniques and principles in achieving big data analytics with scalability and streaming capability.
5. To introduce to the students several types of big data like social media, web graphs and data streams.
6. To enable students to have skills that will help them to solve complex real-world problems in decision support.

**Course Outcomes:**

1. Explain the motivation for big data systems and identify the main sources of Big Data in the real world.
2. Demonstrate an ability to use frameworks like Hadoop, NOSQL to efficiently store, retrieve and process Big Data for Analytics.
3. Implement several Data Intensive tasks using the Map Reduce Paradigm
4. Apply several newer algorithms for Clustering Classifying and finding associations in Big Data
5. Design algorithms to analyze Big data like streams, Web Graphs and Social Media data.
6. Design and implement successful Recommendation engines for enterprises.

Sr. No.	Module	Detailed Content	Hours	CO Mapping
I	Introduction to Big Data	Data Introduction to Big Data, Big Data characteristics, types of Big Data, Traditional vs. Big Data business approach, Big Data Challenges, Examples of Big Data in Real Life, Big Data Applications	3	CO1
II	Introduction to Big Data Frameworks: Hadoop, NOSQL	What is Hadoop? Core Hadoop Components; Hadoop Ecosystem; Overview of : Apache Spark, Pig, Hive, Hbase, Sqoop What is NoSQL? NoSQL data architecture patterns: Key-value stores, Graph stores, Column family (Bigtable) stores, Document stores, MongoDB	7	CO2
III	Map Reduce Paradigm	Map Reduce: The Map Tasks, Grouping by Key, The Reduce Tasks, Combiners, Details of Map Reduce Execution, Coping With Node Failures.	6	CO3

		Algorithms Using Map Reduce: Matrix-Vector Multiplication by Map Reduce ,Relational-Algebra Operations, Computing Selections by Map Reduce, Computing Projections by Map Reduce, Union, Intersection, and Difference by Map Reduce, Computing Natural Join by Map Reduce, Grouping and Aggregation by Map Reduce, Matrix Multiplication, Matrix Multiplication with One Map Reduce Step . Illustrating use of Map Reduce with use of real life databases and applications.		
IV	Mining Big Data Streams	The Stream Data Model: A Data Stream-Management System, Examples of Stream Sources, Stream Queries, Issues in Stream Processing. Sampling Data in a Stream : Sampling Techniques. Filtering Streams: The Bloom Filter Counting Distinct Elements in a Stream : The Count-Distinct Problem, The Flajolet-Martin Algorithm, Combining Estimates, Space Requirements . Counting Ones in a Window: The Cost of Exact Counts, The Datar-Gionis-Indyk Motwani Algorithm, Query	6	CO4
V	Big Data Mining Algorithms	Frequent Pattern Mining : Handling Larger Datasets in Main Memory Basic Algorithm of Park, Chen, and Yu. The SON Algorithm and Map Reduce. Clustering Algorithms: CURE Algorithm. Canopy Clustering, Clustering with Map Reduce Classification Algorithms: Parallel Decision trees, Overview SVM classifiers, Parallel SVM, K-Nearest Neighbor classifications for Big Data, One Nearest Neighbour.	8	CO5
VI	Big Data Analytics Applications	Link Analysis : PageRank Definition, Structure of the web, dead ends, Using Page rank in a search engine, Efficient computation of Page Rank: PageRank Iteration Using Map Reduce, Topic sensitive Page Rank, link Spam, Hubs and Authorities, HITS Algorithm. Mining Social-Network Graphs : Social Networks as Graphs, Types , Clustering of Social Network Graphs, Direct Discovery of Communities, Counting triangles using Map-Reduce. Recommendation Engines: A Model for Recommendation Systems, Content-Based Recommendations, Collaborative Filtering.	9	CO6

**Laboratory Syllabus:****Lab Prerequisite: DBMS**

Sr.No.	Level 1.Basic 2.Design 3.Advance 4.Project/ Case Study/ Seminar	Detailed Lab/Tutorial Description	Hours
1	1	Assignment on Study of Hadoop ecosystem	02
2	2	Programming exercises on Hadoop Using Hive, Pig, Hbase Sqoop NOSQL, MongoDB	02
3	3	Implementing simple algorithms in MapReduce Matrix multiplication, Aggregates, joins, sorting, searching etc.	02
4	3	Implementing Algorithms using MapReduce (Any 2)	02
5	3	Implementing Frequent Item set Mining	02
6	3	Implementing Clustering algorithms Implementing Classification Algorithms	02
7	4	Big Data Applications (Any 2) <ul style="list-style-type: none"><li>● Implementing Analytics on data streams</li><li>● Implementing Social Network Analysis Algorithms</li></ul>	02
8	4	Implementing Web Graph Algorithms Implementing recommendation Engines	02
9	4	Mini Project: One real life large data application to be implemented (Use standard Datasets available on the web) a) Twitter data analysis b) Fraud Detection c) Text Mining d) Recommendation Engines (list of datasets also given in the text book)	02

**Software Requirements:** Virtual Machine, Hadoop Framework, NOSQL and MongoDB Compilers

**Hardware Requirements:** PC i3 or above, 8 GB RAM

**Theory Assessment:****Internal Assessment for 40 marks:**

Consisting of Two Compulsory Internal assessment of 40 Marks each on 40% syllabus for each test. The final marks will be the average of the score of both the tests.

## End Semester Examination: 60 Marks

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

### Lab Assessments:

**1. Teamwork Assessment:** Term work should consist of 10 experiments. Journal must include at least 2 assignments on content theory and practical of “Database Management System”. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks).

**2. Oral/Viva Assessment:** Practical & oral exam to be conducted by Internal & External examiners. Practical execution (10 marks) & Oral (15 marks)

### Text Books:

1. Radha Shankarmani, M Vijayalakshmi, ”Big Data Analytics”, Wiley Publications
2. Anand Rajaraman and Jeff Ullman “Mining of Massive Datasets”, Cambridge University Press.
3. Alex Holmes “Hadoop in Practice”, Manning Press, Dreamtech Press.
4. Professional NoSQL Paperback, by Shashank Tiwari, Dreamtech Press.
5. MongoDB: The Definitive Guide Paperback, Kristina Chodorow (Author), Michael Dirolf, O'Reilly Publications.

### References:

1. Analytics in a Big Data World: The Essential Guide to Data Science and its Applications, Bart Baesens , WILEY Big Data Series.
2. Big Data Analytics with R and Hadoop by Vignesh Prajapati Paperback, Packt Publishing Limited
3. Hadoop: The Definitive Guide by Tom White, O'Reilly Publications
4. Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data by EMC Education Services
5. NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence by Pramod J. Sadalage, Addison Wesley

Course Code	Course Name	Credits
ET 392	Project A	02

### Course Objectives:

1. To acquaint with the process of identifying the needs and converting it into the problem.
2. To familiarize the process of solving the problem in a group.
3. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

### Course Outcome:

1. Learner will be able to...
2. Identify problems based on societal /research needs.
3. Apply Knowledge and skill to solve societal problems in a group.
4. Develop interpersonal skills to work as member of a group or leader.
5. Draw the proper inferences from available results through theoretical/ experimental/ simulations.
6. Analyze the impact of solutions in societal and environmental context for sustainable development.
7. Use standard norms of engineering practices
8. Excel in written and oral communication.
9. Demonstrate capabilities of self-learning in a group, which leads to life long learning.
10. Demonstrate project management principles during project work.

### Guidelines for Project A :

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students shall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover activity of Project A,B,C
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during major project-A,B &C activity; however, focus shall be on self-learning.
- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.

### Guidelines for Assessment of Major Project:

#### Term Work

1. The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of major project to be evaluated on continuous basis, minimum two reviews in each semester VI,VII and VIII.
2. In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.

3. Distribution of Term work marks for all the three semesters shall be as below;

- A. Marks awarded by guide/supervisor based on log book
- B. Marks awarded by review committee
- C. Quality of Project report

**Oral & Practical:**

Oral & Practical examination of Project-A should be conducted by Internal and External examiners approved by University of Mumbai. Students have to give presentation and demonstration on the Project-A.

3

Admission Year 2022

Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
IL 360	Entrepreneurship	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Wor k	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
IL 360	Entrepreneurship	40	40	40	60	-	-	-	100

### Course Objectives:

1. To understand the basic concepts of entrepreneurship.
2. To understand the role of entrepreneurship in economic development
3. To understand the importance of opportunity recognition and internal and external analyses to the success of a business venture
4. To enable the learners to know the factors contributed in failure of the enterprise

### Course Outcomes: Learner will be able to

1. Analyse the business environment in order to identify business opportunities
2. Identify the elements of success of entrepreneurial ventures
3. Evaluate the effectiveness of different entrepreneurial strategies,
4. Interpret their own business plan

Module	Detailed Contents	Hrs
1	Conceptual definition of entrepreneurs and entrepreneurship, Advantages and Disadvantages of Being an Entrepreneur , Entrepreneurial motivation, Entrepreneurial characteristics	8
2	Recognizing, assessment and Exploiting the Opportunity, Conducting Internal and External Analyses, Determining the Feasibility of the Concept, Selecting a Marketing Strategy	6
3	Entrepreneurial Business Types A. Overview of Franchising and Their Advantages and Disadvantages B. Overview of Buyouts & Their Advantages and Disadvantages C. Overview of Family Businesses and Their Advantages and Disadvantages	6
4	The Overall Business Plan, Purpose of the Business Plan, Components of the Business Plan, Presentation of the Business Plan, Matching the Business Plan to the Needs of the Firm	6
5	The Marketing Plan, Conducting a Market Analysis, Understanding the Target Market, Reaching the Target Market through Locale and Engagement	8
6	Entrepreneurial failure, early stage failure, late stage failure	6

**Assessment:**

Internal Assessment: 40 marks

End Semester Examination: 60 Marks

**Reference Books:**

1. Fundamentals of Entrepreneurship by H. Nandan, PHI
2. Entrepreneurship by Robert Hisrich, Michael Peters, Dean Shepherd, Sabyasachi Sinha, Mc Graw Hill
3. Why startups fail: A new roadmap for entrepreneurial success by Tom Eisenmann

Admission Year 2022-2023

Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
IL 361	E-Commerce and E-Business	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
IL 361	E-Commerce and E-Business	40	40	40	60	-	-	--	100

#### Course Objectives:

1. To understand the factors needed in order to be a successful in ecommerce
2. Identify advantages and disadvantages of technology choices such as merchant server software and electronic payment options.
3. Analyse features of existing e-commerce businesses, and propose future directions or innovations for specific businesses.

#### Course Outcomes: Learner will be able to

1. Appreciate the global nature and issues of electronic commerce as well as understand the rapid technological changes taking place.
2. Define and differentiate various types of E-commerce
3. Discuss various E-business Strategies.

Module	Detail Content	Hrs.
1	<b>E-commerce system:</b> Introduction- scope of electronics commerce, definition of e-commerce, difference between e-commerce and e-business, business models of e-commerce transactions. E-commerce infrastructure: client server technology, two tier client server architecture for e-commerce, drawbacks, three tier architecture for e-commerce.	8
2	<b>Business strategies for e-commerce:</b> Introduction- elements of e-commerce strategy, simplicity, mobile responsiveness, choosing e-commerce store platform, user-based focus, compliance and security measures, e-commerce strategy: strategy overview, strategy task, technology issues. Case study: Flipkart v/s Amazon, competitive edge, marketing strategy, sales strategy	8
3	<b>Design of E-commerce systems:</b> e-commerce types- electronic market, electronics data interchange EDI, modeling of e-commerce system, three tier component model of e-commerce system, e-commerce system design- data model, web modeling, database structure design, process model, user friendly design of e-commerce site.	7
4	<b>Technologies for e-commerce systems:</b> Introduction- technologies for e-commerce, PHP and Java script, SEO, Social Plugins, payment processes, SSL Encryption, hosting server, Service oriented architecture.	7
5	<b>Scalability of e-commerce systems:</b> Web scalability- Vertical scalability , horizontal scalability, Load balancing- working of load balancers, global server load balancers, cloud load balancing- goals of cloud balancing, automated cloud balancing. web caching and buffering	6

6	<b>E-commerce system implementation:</b> E-commerce implementation, - website testing, web maintenance, web advertisement, copyright services, SMS alert services, bulk email services, Web personalization- techniques for gathering information, analysis techniques for website personalization, domain name registration and web hosting- different types of web hosting, different components of web hosting, features in web hosting.	6
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### Assessment:

Internal Assessment: 40 marks

End Semester Examination: 60 Marks

### Reference Books:

1. Electronic Business and Electronic Commerce Management, 2nd edition, Dave Chaffey, Prentice Hall, 2006
2. Elias. M. Awad, " Electronic Commerce", Prentice-Hall of India Pvt Ltd.
3. E-Commerce Strategies, Technology and applications (David Whitley) Tata McGrawHill
4. E-business- theory and practise, Brahm Canzer, cengage learning
5. Secure e-commerce systems (Kindle edition), Amazon publishing, P S Lokhande, B B Meshram, first edition

Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
IL 362	Research Methodology	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
IL 362	Research Methodology	40	40	40	60	-	-	-	100

### Course Objectives:

1. To understand Research and Research Process
2. To acquaint students with identifying problems for research and develop research strategies
3. To familiarize students with the techniques of data collection, analysis of data and interpretation

### Course Outcomes: At the end of the course learner will be able to

1. Prepare a preliminary research design for projects in their subject matter areas.
2. Accurately collect, analyse and report data.
3. Present complex data or situations clearly.
4. Review and analyse research findings.

Module	Detail Content	Hrs.
1	<b>Introduction and Basic Research Concepts</b> 1.1 Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Philosophy and validity of research 1.2 Objectives of Research 1.3 Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical 1.4 Need of Research in Business and Social Sciences 1.5 Issues and Problems in Research	8
2	<b>Types of Research</b> 2.1. Pure and Applied Research 2.2. Descriptive and Explanatory Research 2.3. Analytical Research 2.4 Qualitative and Quantitative Approaches 2.5 Literature review 2.6 Developing the objectives.	8
3	<b>Research Design and Sample Design</b> 3.1 Research Design – Meaning, Types and Significance 3.2 Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors	7
4	<b>Research Methodology</b> 4.1 Meaning of Research Methodology	8

	<b>4.2. Stages in Scientific Research Process:</b> a. Identification and Selection of Research Problem b. Formulation of Research Problem c. Review of Literature d. Formulation of Hypothesis e. Formulation of research Design f. Sample Design g. Data Collection h. Data Analysis i. Hypothesis testing and Interpretation of Data j. Preparation of Research Report	
5	<b>Formulating Research Problem</b> 5.1 Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis.	4
6	<b>Outcome of Research</b> 6.1 Preparation of the report on conclusion reached. 6.2 Validity Testing & Ethical Issues 6.3 Suggestions and Recommendation 6.4 Identification of future scope	4

**Assessment:**

Internal Assessment: 40 marks

End Semester Examination: 60 Marks

**Books/References:**

1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers Distributors.
2. Kothari, C.R., 1985, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2nd ed), Singapore, Pearson Education

Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
IL 363	<b>Introduction to Bioengineering</b>	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
IL 363	Introduction to Bioengineering	40	40	40	60	-	-	--	100

#### Course Objectives:

1. To understand and analyze the human body as a mechanical assembly of linkages and describe the fundamentals of biomechanics.
2. To Study the deformability, strength, visco elasticity of bone and flexible tissues, modes of loading and failure and describe the types and mechanics of skeletal joints.
3. To describe movement precisely, using well defined terms (kinematics) and also to consider the role of force in movement (kinetics).
4. To teach students the unique features of biological flows, especially constitutive laws and boundaries.
5. To teach students approximation methods in fluid mechanics and their constraints.
6. To consider the mechanics of orthopedic implants and joint replacement, mechanical properties of blood vessels and Alveoli mechanics

#### Course Outcomes: Learner will be able to

1. Apply a broad and coherent knowledge of the underlying principles and concepts of biomechanics, particularly in the fields of kinematics and kinetics as applied to human and projectile motion.
2. Understand and describe the properties of blood, bone and soft tissues like articular cartilage tendons and ligaments.
3. Gain broad knowledge about the mechanics of moving systems and familiarity with human anatomy to competently analyze gross movement of the human body.
4. Be able to computationally analyze the dynamics of human movement from the most commonly used measurement devices in the field, such as motion capture and force platform systems.
5. Use knowledge gained to competently interpret the current understanding of human movement and present recommendations for further study.

Module	Detail Content	Hrs.
1	<b>Introduction:</b> Definition of Biomechanics, Selected Historical highlights, The Italian Renaissance, Gait century, Engineering Physiology & Anatomy	6
2	<b>Biomedical Instrumentation:</b> Patient monitoring system, Arrhythmia and ambulatory monitoring instrumentation, cardiac pacemakers, cardiac defibrillators, physiotherapy and electrotherapy equipment, ventilators	8
3	<b>Medical Image Processing:</b> Introduction to X-rays based imaging systems, Magnetic Resonance Imaging (MRI), Positron Emission Tomography (PET), Single-Photon Emission Computerized Tomography (SPECT) scan, Computed Tomography (CT) scan and Ultrasound (sonography)	7

4	<b>Biomaterials:</b> Brief Anatomy, Bone, cartilage, ligament, tendon, Muscles, biofluid their physical properties	6
5	<b>Implants:</b> General concepts of Implants, classification of implants, Soft tissues	6
6	Application of advanced engineering techniques to the human body, case studies.	6

#### Assessment:

Internal Assessment: 40 marks

End Semester Examination: 60 Marks

#### Books/References:

1. Nigg, B.M. and Herzog, W., "BIOMECHANICS of Musculo skeleton system", John Willey & Sons, 1st Edition.
2. Saltzman, W.L., "BIOMEDICAL ENGINEERING: Bridging medicine and Technology", Cambridge Text, First Edition.
3. Winter, D., "BIOMECHANICS and Motor Control of Human Movement", WILEY Interscience Second edition
4. "Biomedical Instrumentation and Measurements" by Leslie Cromwell, Fred J. Weibell, and Erich A. Pfeiffer
5. W. Birkfellner, Applied Medical Image Processing: A Basic Course, CRC Press, Second Edition, 2014
6. Prof. Ghista, Biomechanics, Private Publication UAF, 2009
7. White & Puyator, Biomechanics, Private publication UAE, 2010
8. R. M. Kennedy, A textbook of Biomedical Engineering, GTU, 2010
9. Richard Shalak & ShuChien, Handbook of Bioengineering,
10. Sean P. Flanagan, Flanagan, Biomechanics: A case based Approach, Jones & Bartlett Publishers, 2013
11. Y. C. Fung, Yuan-Cheng Fung, Biomechanics: mechanical Property of living Tissue, Springer, 1996.
12. Carol A. Oatis, The Mechanics and Pathomechanics of Human Movement, Lippincott Williams & Wilkins, 2010

Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
IL 364	<b>Biomedical Instrumentation</b>	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Wor k	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
IL 364	Biomedical Instrumentation	40	40	40	60	-	-	-	100

### Course Objectives:

1. Develop a fundamental understanding of human physiology and anatomy to comprehend the sources of biomedical signals and their role in medical diagnosis and treatment.
2. Understand the origin and characteristics of bioelectric signals and learn about the various types of electrodes, biosensors, smart sensors, and biomedical recorders used in healthcare.
3. Gain knowledge of biomaterials, bone structure, composition, and the biomechanics of soft tissues and joints, as well as their applications in implants, prosthetics, and orthotics.
4. Learn about the operation and application of diagnostic instruments
5. Understand the principles and applications of therapeutic instruments
6. Study the integration of AI in healthcare

### Course Outcomes: Learner will be able to

1. Explain the fundamentals of human physiology and anatomy and identify the sources of biomedical signals critical to medical diagnostics and instrumentation.
2. Analyze the structure and properties of biomaterials, bones, soft tissues, and joints, and evaluate their applications in developing implants, prosthetics, and orthotic devices.
3. Describe the principles, design, and functionality of basic and intelligent medical instrumentation systems.
4. Assess the functionality and clinical applications of diagnostic instruments.
5. Explain the working principles and applications of therapeutic instruments.
6. Illustrate the role of artificial intelligence in healthcare.

Module	Detail Content	Hrs
1	<b>Fundamentals of Bioengineering:</b> A brief on human physiology and anatomy, sources of biomedical signals, basic medical instrumentation system, intelligent medical instrumentation systems, regulation of medical devices.	6
2	<b>Biomaterials and Biomechanics:</b> Introduction to biomaterials, Bone structure & composition, Structure and functions of Soft Tissues, types of joint, Implants, Prosthetics and orthotics.	6
3	<b>Bioelectric signals and electrodes:</b> Origin of Bioelectrical signals, Recording electrodes, Microelectrodes, Biosensors, Smart Sensors, Biomedical recorders.	8
4	<b>Introduction to Diagnostics Instruments:</b> Patient monitoring system,	7

	Arrhythmia and ambulatory monitoring instrumentation, oximeters, Blood flowmeter, Cardiac output measurement, Pulmonary analyzers, Blood gas analyzers, Blood cell counters.	
5	<b>Introduction to Therapeutic Instruments:</b> cardiac pacemakers, cardiac defibrillators, instruments for surgery, physiotherapy and electrotherapy equipment, hemodialysis machine, ventilators	6
6	<b>AI for Health care:</b> Medical Imaging, Surgical Assistance, Personalized medicine, Wearable Devices and monitoring, Healthcare management system	6

#### Assessment:

Internal Assessment: 40 marks

End Semester Examination: 60 Marks

#### Books/References:

1. "Handbook of Biomedical Instrumentation" by R. S. Khandpur
2. "Biomedical Instrumentation and Measurements" by Leslie Cromwell, Fred J. Weibell, and Erich A. Pfeiffer
3. "Medical Instrumentation: Application and Design" by John G. Webster
4. "Biomechanics: Principles and Applications" by Donald R. Peterson and Joseph D. Bronzino
5. "Deep Medicine: How Artificial Intelligence Can Make Healthcare Human Again" by Eric Topol

Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
IL 365	Design of Experiments	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
IL 365	Design of Experiments	40	40	40	60	-	-	--	100

#### Course Objectives:

1. To understand the issues and principles of Design of Experiments (DOE)
2. To list the guidelines for designing experiments
3. To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization

#### Course Outcomes: Learner will be able to...

1. Fundamentals of experiments and its uses
2. Basic statistics including ANOVA and regression
3. Experimental designs such as RCBD, BIBD, Latin square, factorial and fractional factorial designs.
4. Apply statistical models in analyzing experimental data
5. RSM to optimize response of interest from an experiment
6. Use software such as Minitab

Module	Detailed Contents	Hrs
1	<b>Introduction</b> <ol style="list-style-type: none"> <li>1. Why experiment?</li> <li>2. Terms and Component of Experiment</li> <li>3. Experimental Units and Responses</li> <li>4. Types of Data ,Plots and Charts</li> <li>5. Importance of Product Reliability</li> <li>6. Uncertainty of Measurement</li> <li>7. Classification of DOE</li> <li>8. Software for DOE</li> <li>9. Principle of Experimental Design</li> <li>10. Types of Experimental Design</li> </ol>	08
2	<b>Basic Statistics and ANOVA</b> <ol style="list-style-type: none"> <li>1. Random Variable and Probability Distribution</li> <li>2. Normal Distribution</li> <li>3. Sampling Distribution</li> <li>4. Estimation</li> <li>5. Hypothesis Testing</li> <li>6. Determination of Sample size</li> <li>7. Analysis of Variance(ANOVA)</li> </ol>	08

	8. Estimation of model parameters and Adequacy test 9. ANOVA-Pair wise comparison and Tukey's and Fishers LSD test 10. Two way ANOVA 11. Multi way ANOVA 12. Determination of Sample Size for ANOVA	
3	<b>Regression</b> 1. Introduction to Multiple Linear Regression(MLR) 2. Sampling distribution of Regression coefficients 3. MLR: Hypothesis testing and Model Adequacy Test 4. MLR:Diagnostic and Testing for Lack of Fit 5. Regression approach to ANOVA	07
4	<b>Experimental Designs</b> 1. Randomized Complete block design (RCBD) 2. RCBD-Estimation of Parameters 3. RCBD-Balanced Incomplete block design(BIBD) 4. RCBD-Latin square design 5. Introduction to Factorial Design 6. Statistical Analysis of Factorial Design 7. Estimation of parameters and Model Adequacy test 8. Full factorial design 9. Two level factorial design 10. Statistical Analysis of the $2^k$ Design 11. Blocking and Confounding in the $2^k$ Design 12. Fractional Factorial Design	08
5	<b>Response Surface Methods and Designs</b> 1. Introduction to Response Surface Methodology 2. RSM-First order model 3. Experimental design for fitting Response Surfaces 4. RSM-Fitting Second order model 5. Analysis of Second order RSM	06
6	<b>Taguchi Approach</b> 1. Crossed Array Designs and Signal-to-Noise Ratios 2. Analysis Methods 3. Robust design examples	04

#### Assessment:

Internal Assessment: 40 marks

End Semester Examination: 60 Marks

#### Books/References:

1. Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3rd edition, John Wiley & Sons, New York, 2001
2. D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York, 2001
3. George E P Box, J Stuart Hunter, William G Hunter, Statistics for Experimenters: Design, Innovation and Discovery, 2 nd Ed. Wiley
4. W J Diamond, Practical Experiment Designs for Engineers and Scientists, John Wiley and Sons Inc. ISBN:

0-471-39054-2

5. Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T.Voss

Admission Year 2022-2023

Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
IL 366	Design for Sustainability	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
IL 366	Design for Sustainability	40	40	40	60	-	-	--	100

### Course Objectives:

1. Understand the complex environmental, economic, and social issues related to sustainable engineering
2. Become aware of concepts, analytical methods/models, and resources for evaluating and comparing sustainability implications of engineering activities
3. Critically evaluate existing and new methods
4. Develop sustainable engineering solutions by applying methods and tools to research a specific system design
5. Clearly communicate results related to their research on sustainable engineering

### Course Outcomes: Learner will be able to

1. Account for different theoretical and applied design principles and models for sustainable design
2. Account for and critically relate to sustainable design from an ethical, cultural and historical perspective
3. Critically review different design solutions ecological, social and economical consequences, risks, possible uses and functions in the work for a sustainable development
4. Independently apply a specific design theory on a specific challenge within the sustainability field.

Module	Detailed Contents	Hrs
1	Introduction - Need, Evolution of sustainability within Design, environmental - economic sustainability concept, Challenges for sustainable development, Environmental agreement & protocols	6
2	Product Life Cycle Design – Life Cycle Assessment, Methods & Strategies, Software Tools	6
3	Sustainable Product - Service System Design, Definition, Types & Examples ,Transition Path and Challenges, Methods and Tools, Design thinking and design process for sustainable development	8
4	Design for Sustainability – Engineering Design Criteria and Guidelines	6
5	Design for Sustainability – Architecture, Agriculture, Cities & Communities, Carbon Footprint	6
6	Green Building Technologies - Necessity, Principles, low energy materials, effective systems	6

### Assessment:

Internal Assessment: 40 marks

End Semester Examination: 60 Marks

### Books/References:

1. C. Vezzoli, System Design for sustainability. Theory, methods and tools for a sustainable / satisfaction system/design, Rimini, Maggioli Edition, 2007.
2. C. Vezzoli and E. Manzini, Design for Environmental Sustainability, Springer – Verlag, London, 2008.
3. L. Nin and C. Vezzoli, Designing Sustainable Product-Service Systems for all. Milan: Libreria, CLUP, 2005
4. A. Tukker and U. Tischner (eds.), New Business for Old Europe, Product Services, Sustainability and Competitiveness, Greenleaf Publishing, Sheffield, 2008.
5. A. Tukker, M. Charter, C. Vezzoli, E. Sto and M.M. Andersen (eds.), System innovation for Sustainability Perspective on Radical Changes to sustainable consumption and production, Greenleaf Publishing, Sheffield, 2008
6. UNEP, Product-Service Systems and Sustainability. Opportunities for sustainable solutions, CEDEX, Paris, 2002, at <http://www.uneptie.org/pc/sustain/reports/pss/pss-imp-7.pdf>

Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
IL 367	Political Science	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
IL 367	Political Science	40	40	40	60	-	-	--	100

### Course Objectives:

1. Provide a good grounding in the basic concepts of Political Theory.
2. Familiarize learners with fundamental rights and duties.
3. Teach students the structure and process of the electoral system, the features and trends of the party system and create an awareness of the social movements in India.
4. To inculcate the values of renowned thinkers on law, freedom of thought and social justice.
5. To prepare the learners for understanding the importance of Comparative Government and Politics.
6. To train learners in understanding International Relations.

### Course Outcomes: Learner will be able to

1. Acquire conceptual and theoretical knowledge in the basic concepts of political theory.
2. Demonstrate understanding of fundamental rights and duties and directive principles.
3. Perform successfully in expressing the process of the electoral system, the features and trends of the party system and the importance of the social movements in India.
4. Illustrate the contribution of renowned thinkers and relate it to the current scenario.
5. Compare and contrast Indian Government and Politics with European countries.
6. Develop an understanding of International Relations with respect to Indian foreign policy.

Module	Detail Content	Hrs.
1	Understanding Political Theory- Evolution of State, Nation, Sovereignty, Types and Linkages between Power and Authority; Interrelationships between Law, Liberty, Equality, Rights; Justice and Freedom, Democracy vs Authoritarianism	4
2	Constitutional Government in India - Evolution of the Indian Constitution, Fundamental Rights and Duties. Directive Principles. Union-State Relations, Union Legislature: Rajya Sabha, Lok Sabha: Organisation, Functions – Law making procedure, Parliamentary procedure, Government in states: Governor, Chief Minister and Council of Ministers: position and functions – State Legislature: composition and functions. Judiciary: Supreme Court and the High Courts: composition and functions – Judicial activism. Constitutional amendment. Major recommendations of National Commission to Review the Working of the Constitution.	6
3	Politics in India: Structures and Processes- Party system: features and trends – major national political parties in India: ideologies and programmes. Coalition politics in India: nature and trends. Electoral process: Election Commission: composition, functions, role. Electoral	6

	reforms. Role of business groups, working class, peasants in Indian politics, Role of (a) religion (b) language (c) caste (d) tribe. Regionalism in Indian politics. New Social Movements since the 1970s: (a) environmental movements (b) women's movements (c) human rights movements.	
4	Indian Political Thought- Ancient Indian Political ideas: overview. Kautilya: Saptanga theory, Dandaniti, Diplomacy. Medieval political thought in India: overview (with reference to Barani and Abul Fazal). Legitimacy of kingship. Principle of Syncretism, Modern Indian thought: Rammohun Roy as pioneer of Indian liberalism – his views on rule of law, freedom of thought and social justice. Bankim Chandra Chattopadhyay, Vivekananda and Rabindranath Tagore: views on nationalism. M.K. Gandhi: views on State, Swaraj, Satyagraha.	7
5	Comparative Government and Politics- Evolution of Comparative Politics. Scope, purposes and methods of comparison. Distinction between Comparative Government and Comparative Politics.	6
6	Perspectives on International Relations- Understanding International Relations: outline of its evolution as academic discipline. Major theories: (a) Classical Realism and Neo-Realism (b) Dependency (c) World Systems theory. Emergent issues: (a) Development (b) Environment (c) Terrorism (d) Migration. Making of foreign policy. Indian foreign policy: major phases: 1947-1962; 1962-1991; 1991-till date. Sino-Indian relations; Indo-US relations.	7

#### Assessment:

Internal Assessment: 40 marks

End Semester Examination: 60 Marks

#### Books/References:

1. O.P. Gauba. (2021). *An Introduction to Political Theory*. Mayur books
2. Vibhuti Bhushan Mishra. (1987). *Evolution of the Constitutional History of India (1773-1947 : With Special Reference to the Role of the Indian National Congress and the Minorities)*. South Asia Books
3. Chetna Sharma Pushpa Singh. (2019). *Comparative Government and Politics*. SAGE Publications India Pvt Ltd.
4. Henry R. Nau. (1900). *Perspectives on International Relations: Power, Institutions and Ideas*. CQ Press

Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
IL 368	Visual Arts	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
IL 368	Visual Arts	40	40	40	60	-	-	-	100

### Course Objectives:

1. To enable learners to develop aesthetic judgement, visual perception, critical thinking skills in the different forms of art and understand its application.
2. To promote the concept of visual design and understand the different meanings assigned to colours, its impact and problems.
3. To provide the opportunity and scope to use the image editing software for creating images for Web and Video.
4. To inculcate the basic skills required in drawing and painting through exposure in nature and study of still objects.
5. To train students to express their feelings and write imaginatively.
6. To prepare the learners for the use of clay modelling techniques and its industrial applications.

### Course Outcomes: Learner will be able to

1. Acquire the skills necessary for aesthetic judgement, visual perception and critical thinking required in different forms of art.
2. Demonstrate the understanding of the concept of visual design with respect to the different meanings assigned to colours and the problems associated.
3. Illustrate effective use of image editing software for creating images for the Web and Video.
4. Determine the importance of drawing and painting with respect to nature and still objects.
5. Perform successfully in expressing their feelings creatively.
6. Develop the techniques required for clay modelling and sculpture for industrial use.

Module	Detail Content	Hrs.
1	History of Art and Architecture- Changing needs and forms of art from the Palaeolithic period to The Renaissance period with special reference to Roman, Indian and Chinese art	4
2	Introduction and concepts of visual design with special emphasis on the psychological impact of colour	5
3	Introduction to image editing software, tools, application and creating Images for Web and Video. With special reference to Adobe Photoshop	7
4	Fundamentals of Drawing- study of forms in nature, study of objects and study from life, creative painting- basic techniques, tools and equipment, medium of painting.	6
5	Creative writing- Movie critique, book reviews, Poems, short plays and skits, Humorous Essays, Autobiography and short stories.	7
6	Creative sculpture- Introduction to clay modelling techniques, study of	7

	natural and man-made objects in clay, Sculpture with various materials - Relief in Metal Sheets – Relief on Wood – Paper Pulp - Thermocol. Sculpture with readymade materials.	
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**Assessments:**

Internal Assessment: 40 marks

End Semester Examination: 60 marks

**Reference Books:**

1. Gill Martha. (2000). Color Harmony Pastels: A Guidebook for Creating Great Color Combinations. Rockport Publishers.
2. Janson, Anthony F. (1977). History of art, second edition, H.W. Janson. Instructor's manual. Englewood Cliffs, N.J.: Prentice-Hall.
3. Brommer, Gerald F. (1988). Exploring Drawing. Worcester, Massachusetts: Davis Publications.
4. Wendy Burt Thomas. (2010). The Everything Creative Writing Book: All you need to know to write novels, plays, short stories, screenplays, poems, articles, or blogs: All You Need ... - Stories, Screenplays, Blogs and More. Fw Media; 2nd edition.
5. Élisabeth Bonvalot. (2020). Sculpting Book: A Complete Introduction to Modeling the Human Figure.

Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
IL 369	Modern Day Sensor Physics	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Wor k	Practical	Oral	Tota l
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
IL 369	Modern Day Sensor Physics	40	40	40	60	-	-	--	100

#### Course Objectives:

1. Acquire knowledge about the principles and analysis of sensors.
2. Emphasis on characteristics and response of micro sensors.
3. Acquire adequate knowledge of different transducers and Actuators.
4. Learn about the Micro sensors and Micro actuators.
5. Selection of sensor materials for fabrication for different applications

#### Course Outcomes: On successful completion of course learner/student will be able to:

1. Analyze the basics and design the resistive sensors.
2. Identify the materials and designing of inductive and Capacitive Sensors.
3. Analyze various types of Actuators.
4. Design Micro sensors and Micro Actuators for various applications.
5. Implement fabrication process and technologies and compare various Micro machining processes

Module	Detail Content	Hrs.
1	<b>Fundamentals of Sensors :</b> Difference Between Sensor, Transducer And Actuators- Classification Of Sensors: Proprioceptive And Exteroceptive – Active And Passive– Contact And Non-Contact, Selection And Characteristics: Range; Resolution, Sensitivity, Error, Repeatability, Linearity And Accuracy, Primary Sensing Elements.	6
2	<b>Temperature sensors:</b> Principle of operation, construction details, characteristics and applications of Bimetallic thermometer, Resistance thermometer, Thermistor, Thermocouples and Total radiation Pyrometers	8
3	<b>Strain, Force, Torque and Pressure Sensors</b> Strain gauges, strain gauge beam force sensor, piezoelectric force sensor, load cell, torque sensor, Piezo- resistive and capacitive pressure sensor, Manometer, vacuum sensors, Pirani gauge.	6
4	<b>Displacement, Level and Flow Sensors</b> <b>Displacement Sensors:</b> LVDT, RVDT, eddy current, transverse inductive, Hall Effect, magneto resistive, magnetostrictive sensors.	8

	<b>Liquid level sensor:</b> Fabry Perot sensor, ultrasonic sensor, capacitive liquid level sensor. <b>Flow sensors:</b> pressure gradient technique, ultrasonic, electromagnetic sensors and Hot wire anemometer. Micro flow sensor, Coriolis mass flow and drag flow sensor.	
5	<b>Micro Machining Technologies</b> Overview of silicon processes techniques, Photolithography, Ion Implantation, and Diffusion, Chemical Vapor Deposition, Physical vapor Deposition, Epitaxy, Etching, Bulk micromachining, Surface Micromachining, LIGA and other techniques.	6
6	<b>Actuators</b> Definition, types and selection of Actuators; linear; rotary; Logical and Continuous Actuators, Pneumatic actuator, Hydraulic actuator - Control valves and cylinders Electrical actuating systems: Solenoids, Electric Motors- D.C motors - AC motors - Three Phase Induction Motor, Stepper motors -Piezoelectric Actuator.	5

#### Assessment:

Internal Assessment: 40 marks

End Semester Examination: 60 Marks

#### Books/Reference:

1. Robert H Bishop, "The Mechatronics Hand Book", CRC Press, 2002.
2. Thomas. G. Bekwith and Lewis Buck.N, "Mechanical Measurements", Oxford and IBH publishing Co. Pvt. Ltd.,
3. Massood Tabib and Azar, "Microactuators Electrical, Magnetic, thermal, optical, mechanical, chemical and smart structures", First edition, Kluwer academic publishers, Springer, 1999.
4. Manfred Kohl, Shape Memory Actuators, first edition, Springer.
5. Patranabis.D, Sensors and Transducers, Wheeler publisher, 1994.

Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
IL 370	<b>Energy Audit and Management</b>	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
IL 370	Energy Audit and Management	40	40	40	60	-	-	--	100

#### Course Objectives:

1. To impart basic knowledge to the students about current energy scenario, energy conservation, audit and management.
2. To inculcate among the students systematic knowledge and skill about assessing the energy efficiency, energy auditing and energy management.
3. To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management
4. To relate the data collected during performance evaluation of systems for identification of energy saving opportunities.

#### Course Outcomes: Upon successful completion of this course, the learner will be able to

1. To identify and describe the present state of energy security and its importance.
2. To identify and describe the basic principles and methodologies adopted in energy audit of an utility
3. To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.
4. To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities.
5. To analyze the data collected during performance evaluation and recommend energy saving measures

Module	Detail Content	Hrs.
1	<b>Energy Scenario:</b> Energy needs of growing economy, Long term energy scenario, Energy pricing, Energy sector reforms, Energy and environment: Air pollution, Climate change, Energy security, Energy conservation and its importance, Energy strategy for the future, Energy conservation Act 2001 and its features.	4
2	<b>Energy Management and Audit:</b> Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution, Energy audit instruments. <b>Material and Energy balance:</b>	10

	<p>Facility as an energy system, Methods for preparing process flow, Material and energy balance diagrams.</p> <p><b>Financial Management:</b> Investment-need, Appraisal and criteria, Financial analysis techniques- Simple payback period, Return on investment, Net present value, Internal rate of return, Cash flows, Risk and sensitivity analysis, Financing options, Energy performance contracts and role of ESCOs</p>	
3	<p><b>Energy Management and Energy Conservation in Electrical System:</b> Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipments and appliances, star ratings. Energy efficiency measures in lighting system. Lighting control: Occupancy sensors, daylight integration, and use of intelligent controllers. Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.</p>	10
4	<p><b>Energy Management and Energy Conservation in Thermal Systems:</b> Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system. General fuel economy measures in Boilers and furnaces, Waste heat recovery, use of insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities.</p>	10
5	<p><b>Energy Performance Assessment: On site Performance evaluation techniques, Case studies based on:</b> Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.</p>	3
6	<p><b>Energy conservation in Buildings: Energy Conservation Building Codes (ECBC):</b> Green Build Building, LEED rating, Application of NonConventional and Renewable Energy Sources</p>	3

**Assessment:**

Internal Assessment: 40 marks

End Semester Examination: 60 Marks

**Books/References:**

1. Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science
2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System
3. Energy Management Handbook, By W.C. Turner, John Wiley and Sons
4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
5. Energy Management Principles, C.B.Smith, Pergamon Press
6. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
7. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press

Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
IL 371	<b>Maintenance of Electronics Equipment</b>	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
IL 371	Maintenance of Electronics Equipment	40	40	40	60	-	-	--	100

### Course Objectives:

1. To demonstrate use of different instruments used in electronics lab.
2. To understand testing of different active and passive components mounted on PCB
3. To understand functionality TTL and CMOS digital ICs.
4. To understand software required for simulation of electronic circuit.
5. To understand software required for PCB design.
6. To understand concept of designing, manufacturing electronic circuit.

### Course Outcomes:

1. Able to use different types of instruments used in electronics lab
2. Able to test different active and passive components mounted on PCB.
3. Able to understand functionality TTL and CMOS digital ICs.
4. Able to do simulation of electronic circuit.
5. Able to Design PCB using software tools.
6. Able to design, manufacture electronic circuit.

**Detailed Lab/Tutorial Description:** Students will have to perform five to six experiments / tutorials based on the syllabus and design, assemble electronic circuit in lab and write journal and project report as a term work.

SN	Detailed Lab/Tutorial Description	Hrs.
1	Demonstrate working, use of two instruments in electronics laboratory.	4
2	Test the performance of different passive electronic components (fixed/variable), Test the performance of active electronic components like Diode, Transistor.	4
3	Verify the functionality of TTL and CMOS Digital IC's.	4
4	Design of electronic circuit using IC and various active and passive components.	4
5	Simulation of electronic circuit using TINA software. Design of PCB for electronic circuit.	6
6	PCB manufacturing, soldering of components, troubleshooting of the circuit.	8

	Output checking on CRO, Report writing.	
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The students will have to submit a project report in prescribed format and give a presentation at the end of semester.

**Assessments:**

Internal Assessment: 40 marks (IA-I, IA-II Based on practical and project work)

End Semester Examination: 60 marks (Based on practical, project work, report and presentation, question-answer session)

**Books/References:**

1. Troubleshooting and Maintenance of Electronics Equipment, Singh K. Sudeep, Katson Book, New Delhi, II edition, Reprint 2014
2. Troubleshooting Electronic Equipment: Includes Repair and Maintenance, Second Edition, Khandpur R. S., Tata McGraw-Hill Education, New Delhi, India, latest edition.
3. Data Books, National semiconductor.
4. Modern Digital Electronics, Fourth edition, R. P. Jain, Tata McGraw-Hill Education, New Delhi, India.
5. Manuals of instruments in electronics laboratories.

Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
IL 372	Cooking and Nutrition	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
IL 372	Cooking and Nutrition	40	40	40	60	-	-	--	100

**Course Objectives:** The course is aimed to

1. To understand nutrition and of health problems related to diet and various factors affect diet
2. To various statistical tools required to analyze the experimental data in nutrition and community research
3. Gain information about various food constituents, and changes that occur in them during food processing.
4. To gain food-related knowledge and skills so that they can organise and manage family resources effectively according to the needs and lifestyles of family members
5. To be able to make informed judgements and choices about the use of food available.
6. To create interest in the creative side and enjoyment of food and the skills necessary for food preparation and food preservation. And to be aware of relevant mandatory and other necessary safety and hygiene requirements

**Course Outcomes:** On successful completion of course learner/student will be able to

1. To understand the importance and mechanisms of the food components taking place during food processing,
2. To understand nutrition and of health problems related to diet and various factors affect diet
3. To aware how eating patterns and dietary needs depend on age and social group
4. Ability to assess the effectiveness and validity of claims made by advertisers
5. To enhance aesthetic and social sensitivity to dietary patterns and to develop an interest in the creative aspect and enjoyment of food
6. To develop skills necessary for food preparation and food preservation and knowledge of safety and hygiene requirements

Module	Detail Content	Hrs
1	<b>Nutritional terms:</b> proteins (high biological and low biological value), carbohydrates (monosaccharide, disaccharide and polysaccharide), fats, vitamins (A, C, D, E, K, B group – thiamin, riboflavin, nicotinic acid and cobalamin), mineral elements (calcium, iron, phosphorous, potassium, sodium, iodide) water Sources and uses of food energy. Sources and functions of dietary fibre.	3
2	<b>Kitchen equipment &amp; Kitchen planning:</b> Selection, Use and care of: modern cookers, thermostatic control and automatic time-controlled ovens, microwave ovens, slow electric cook pots, refrigerators and freezers, small kitchen equipment, e.g. knives, pans, small electrical kitchen equipment, e.g. food processors, electric kettles, Advantages and disadvantages of microwave ovens, Organisation of cooking area and equipment for efficient work., Selection, Use and care of: work surfaces, flooring, walls and wall	4

	coverings, lighting, ventilation	
3	<b>Meal planning and guidelines:</b> Factors affecting food requirements, Planning and serving of family meals, Meals for different ages, occupations, cultures and religions, Special needs of: people with food allergies and intolerances, people with medical conditions linked to diet, such as diabetes, convalescents, vegetarians, including vegans and lacto-vegetarians, Meals for special occasions, festivals, packed meals, snacks, beverages, Use of herbs, spices and garnishes, Attractive presentation of food, Terminology describing recommended dietary intakes, e.g. Dietary Reference Value (DRV) and Reference Daily Intake (RDI).	6
4	<b>Strategic cooking:</b> Transfer of heat by conduction, convection and radiation. Principles involved in the different methods of cooking, baking, boiling, braising, cooking in a microwave oven, frying, grilling, poaching, pressure cooking, roasting, simmering, steaming, stewing, use of a slow cooker. Reasons for cooking food, Sensory properties of food (flavour, taste, texture), Effect of dry and moist heat on proteins, fats and oils, sugars and starches, and vitamins to include: caramelisation, coagulation, dextrinization, enzymic and non-enzymic browning, gelatinisation, rancidity, smoking point, Preparation and cooking of food to preserve nutritive value, Economical use of food, equipment, fuel and labour.	6
5	<b>Convenience foods and Basic proportions:</b> Foods partly or totally prepared by a food manufacturer – dehydrated, tinned, frozen, ready-to-eat, Intelligent use of these foods, Advantages and disadvantages, Food additives – types and function, Packaging – types, materials used, Labelling – information found on labels, Importance of maintaining proportions, maintaining proportions for : Bakery products, melting, rubbing-in and whisking methods, Pastries – shortcrust, flaky and rough puff, Sauces – pouring and coating, roux and blended methods, Batters – thin (pouring) and coating, Sweet and savoury yeast products	5
6	<b>Food preservation &amp; Kitchen safety and first aid:</b> Food preservation & Kitchen safety and first aid: Reasons for preserving food, Methods of preservation and an understanding of the principles involved: heating – canning, bottling; removal of moisture – dehydrating; reduction in temperature – freezing; chemical preservation – sugar, salt, vinegar; modified atmosphere packaging; irradiation; Awareness of potential danger areas in the kitchen. Safety precautions. First aid for burns and scalds, cuts, electric shock, fainting, shock.	5

#### Assessment:

Internal Assessment: 40 marks

End Semester Examination: 60 Marks

#### Books/References:

1. Fundamentals of Food and Nutrition by Tejmeet Rekhi, Heena Yadav
2. Food Process Engineering And Technology by Akash Pare, B L Mandhyan

Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
IL 373	<b>Environmental Management</b>	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
IL 373	Environmental Management	40	40	40	60	-	-	-	100

### Course Objectives:

1. To promote the safety, health, and welfare of people and the environment through engineering professionals.
2. To encourage students to be productive and contributing members of the environmental profession as practitioners, entrepreneurs, researchers, or teachers.
3. To develop environmental awareness among students that meet specified engineering needs with consideration of public health, safety, and welfare, as well as global, environmental, and legal factors.

### Course Outcomes: On successful completion of the course learner/student will be able to:

1. Understand core concepts and methods from ecological sciences and their application in environmental problem-solving.
2. Recognize different types of toxic substances and analyze toxicological information
3. Acquire and apply environmental knowledge to the engineering field as needed.
4. Assist industries and projects in obtaining environmental clearance and compliance with other environmental laws.
5. Interpret appropriate environment-related legislation.
6. Develop a thorough understanding of practice and procedure followed by various enforcing agencies/bodies/countries.

Module	Detail Contents	Hrs.
1	<b>Fundamentals of Environmental Sciences</b> Definition, Principles, and Scope of Environmental Science. Structure and composition of the atmosphere, hydrosphere, lithosphere, and biosphere. Concept of Ecology- Ecosystem, Food chain, Food web, Ecological pyramid, Ecological succession, limiting factor, and carrying capacity. Global Environmental Concerns (Global warming, Loss in Bio-diversity, Ozone depletion, E-waste management) and Renewable Energy Resources (Solar Energy, Wind Energy, Hydrothermal Energy, etc.)	8
2	<b>Environmental Chemistry Toxic chemicals:</b> Pesticides and their classification and effects. Biochemical aspects of heavy metals (Hg, Cd, Pb, Cr) and metalloids (As, Se), Sewage treatment, Concept of DO, BOD, and COD. Composition of air-chemical processes in the formation of inorganic and organic particulate matter, Thermochemical and photochemical reactions in the atmosphere, Oxygen	8

	and Ozone chemistry. Photochemical smog, Air Quality Index	
3	<b>Fundamentals of Environmental Management</b> Concept of Environmental Management, Need & Objective of Environmental Management, Role of Engineers in Environmental Management, Career Opportunities. The need for sustainable development, Sustainable Development Goals	5
4	<b>Scope of Environmental Management</b> Role and functions of Government as a planning and regulatory agency. Environment Quality Management and Corporate Environmental Responsibility. Total quality Environmental management: ISO 14000, EMS Certification. Environmental Management System Standards (ISO-14000 series). Environment and Social Management Plan	7
5	<b>Overview of Environmental Laws in India</b> Constitutional provisions in India (Articles 48A and 51A). Wildlife Protection Act, 1972 Indian Forest Act, Water (Prevention and Control of Pollution) Act, Air (Prevention and Control of Pollution) Act, Environmental (Protection) Act, 1986, The e-waste (Management) Rules 2016	5
6	<b>Environmental Conventions and Agreements</b> Stockholm Conference on Human Environment 1972, Montreal Protocol, 1987, Earth Summit at Rio de Janeiro, 1992, Agenda-21, Convention on Biodiversity (1992), UNFCCC, Kyoto Protocol, 1997, Copenhagen Summit, Paris Agreement, CITES.	6

#### Assessment:

Internal Assessment: 40 marks

End Semester Examination: 60 Marks

#### Books/References:

1. Environmental Management: Principles and Practice, C J Barrow, Routledge Publishers London, 1999
2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G.Oakwell, Edward Elgar Publishing
3. Environmental Management, V Ramachandra and Vijay Kulkarni, TERI Press
4. Indian Standard Environmental Management Systems — Requirements With Guidance For Use, Bureau of Indian Standards, February 2005
5. Environmental Management: An Indian Perspective, S N Chary and Vinod Vyasulu, Macmillan India, 2000

Subject Code	Subject Name	Credits
ET 401	Microwave & RF Design	04

**Prerequisite:**

Electronic Communication Systems  
Electromagnetic Engineering  
Filter Basics

**Course Objectives:** Students will try:

1. Understand the basics of Microwave Systems.
2. Learn working principles of waveguides and passive components.
3. Illustrate Microwave generators.
4. Discuss Microwave Semiconductor Devices.
5. Design of composite filters
6. Design small signal RF Amplifiers

**Course Outcomes:** Learners will be able to:

1. Analyze microwave networks and components using scattering parameters and design impedance matching networks.
2. Solve problems on waveguides and identify passive components.
3. Describe the construction and operation of Microwave generators/Tubes.
4. To describe Microwave Semiconductor Devices and the measurements techniques and parameters measured as frequency, VSWR, power etc.
5. To design the RF Filters
6. To design small signal RF amplifiers

Sr. No.	Module	Detailed Content	Hours	CO Mapping
01	Introduction to Microwaves	1.1 Microwave Frequency Bands in Radio Spectrum, Characteristics, Advantages and Applications of Microwaves. 1.2 Scattering Parameters: Characteristics and Properties. 1.3 Design of Impedance matching network using distributed parameters. Quarter Wave Transformer 1.4 Strip lines , Micro strip lines and coupled lines, Coplanar Waveguides and its applications	06	CO1
02	Waveguides	2.1 Rectangular and circular waveguides:	08	CO2

	and Passive Devices and semiconductor devices	Construction, Working and Mode analysis. 2.2 Resonators, Re-entrant cavities, Microwave Junctions, Hybrid ring, Directional couplers, Attenuators and Ferrite devices such as Isolators, and Circulators.		
03	Microwave Tubes	Microwave Tubes : 3.1 Two Cavity Klystron, Reflex Klystron. 3.2 Helix Travelling Wave Tube and Cross Field Amplifier. 3.3 Backward Wave Oscillator ,Cylindrical Magnetron , Gyrotron	08	CO3
04	Microwave Semiconductor devices and Measurements	4.1 Diodes: Gunn, Varactor, PIN, Tunnel, Point Contact, Schottky Barrier 4.2, IMPATT, TRAPATT, and BARITT 4.3 Measurement of VSWR, Frequency, Power, Noise, Q-Factor, Impedance, Attenuation	05	CO4
05	RF Filter Design	5.1 Composite Filters, Filter Design Using I.L method, Microstrip Low pass filter design Using Kuroda's Identity, Low pass filter Design 5.2 RF High pass, band pass and band stop filter Design	06	CO5
06	RF Small signal Amplifier Design	6.1 Characteristics and various gains of amplifier, RF amplifier Design for maximum gain and specific Gain, 6.2 Low Noise amplifier -Design and its applications	06	CO6

#### Text Books:

1. Samuel Liao, Microwave Devices and Circuits, Prentice Hall
2. David Pozar, Microwave Engineering, Wiley Publication, Fourth Edition
3. Annapurna Das and S. K Das, —Microwave Engineering, McGraw Hill Education, Third Edition
4. Ludwig R. and Bogdanov G, RF Circuit Design, Prentice Hall, 2007.
5. Microwave Circuit Analysis And Amplifier Design ,Samuel Liao

#### References:

1. Colin, Foundations of Microwave Engineering, Second Edition, Wiley Interscience, 2<sup>nd</sup> Edition
2. Devendra Misra, — Radio Frequency and Microwave Communication Circuits- Analysis and Designs, John Wiley & Sons, 2nd Edition

# List of experiments

Sr. No	TITLE OF EXPERIMENT	H/W or S/W	Hours	CO mapping
1	Introduction to Microwave test bench and components	MW Test Bench	2	CO1,CO2
2	Measure and plot power frequency characteristics of the reflex klystron (Microwave Tube)	MW Test Bench	2	CO3
3	Measurement of VSWR using slotted Line section	MW Test Bench	2	CO4
4	Measure the wavelength of rectangular waveguide	MW Test Bench	2	CO2
5	To study and plot the VI characteristics of Gunn Diode	MW Test Bench	2	CO4
6	Generate and study the field patterns of various modes inside a rectangular waveguide	Virtual Lab Kanpur IIT	2	CO2
7	Generate and study the field patterns of various modes inside a rectangular waveguide cavity	Virtual Lab Kanpur IIT	2	CO2
8	To design a Low Pass Filter (LPF) for Cutoff Frequency of 4 GHz, Impedance of 50Ω and 3 rd Order 3dB ripple Chebyshev Filter using FR4 substrate in CST Studio.	CST Tool	2	CO5
9	To design the Hybrid Coupler (Power Divider) for Cutoff Frequency of 900 MHz using FR4 substrate using CST Studio.	CST Tool	2	CO1,CO2
10	To plot Stability circles, Gain circles for given amplifier data	VSmith Tool	2	CO6
11	To design a maximum gain amplifier with biased BJT of 1 GHz with following S- parameter, $S_{11} = 0.60 \angle -155^\circ$ ; $S_{12} = 0.0 \angle 0^\circ$ ; $S_{21} = 6 \angle 180^\circ$ ; $S_{22} = 0.48 \angle -20^\circ$ using VSmith Simulator.	VSmith Tool	2	CO6
12	To plot noise figure circles and gain circles for source and load sections of 3 GHz	Vsmith Tool	2	CO6

	of input and output matching networks for a GaAs FET low noise amplifier with following Specification, $S_{11} = 0.6 \angle -60^\circ$ , $S_{12} = 0.05 \angle 26^\circ$ , $S_{21} = 1.9 \angle 81^\circ$ , $S_{22} = 0.5 \angle 60^\circ$ , $O_{pt} = 0.62 \angle 100^\circ$ , $F_{min} = 1.6$ dB and $R_n = 20\Omega$ .			
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#### Lab Assessments:

**Term work Assessment:** At least 08 Experiments including 02 simulations covering the entire syllabus must be given during the “Laboratory session batch wise”.

Computation/simulation based experiments are also encouraged. The experiments should be student centric and attempt to make experiments more meaningful, interesting and innovative.

**Oral/Viva Assessment:** The practical and oral examination will be based on the entire syllabus.

Subject Code	Subject Name	Credits
ET 402	Human Values and Social Ethics	02

**Course Objectives:** The objective of the course is four fold:

1. Development of a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence.
2. Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence
3. Strengthening of self-reflection.
4. Development of commitment and courage to act.

**Course Outcomes:** By the end of the course, students are expected.

1. To become more aware of themselves, and their surroundings (family, society, nature);
2. They would become more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind.
3. They would have better critical ability.
4. They would also become sensitive to their commitment towards what they have understood (human values, human relationship and human society).
5. They would be able to apply what they have learnt to their own self in different day-to-day settings in real life.

SN	Details	Hours
1	<b>Ethics and Values :</b> Meaning & Concept of Ethics Difference between Ethics and Values Ethical code of conduct	03
2	<b>Professional Ethics :</b> Professional Ethics vs Personal ethics Components of professional ethics Professional values and its importance	05

3	<b>Ethics and Society :</b> Relevance of values and ethics in social work Ethical dilemmas Values and ethical principles of social work <ul style="list-style-type: none"> <li>· Service</li> <li>· Dignity and worth of a person</li> <li>· Importance of Human relationships</li> <li>· Integrity</li> <li>· Competence</li> <li>· Social Justice</li> </ul>	05
4	<b>Ethics in Technical writing</b> Documenting sources Presentation of Information Ethics & Plagiarism	06
5	<b>Ethics and Technology Development :</b> Risk management and Individual rights Moral issues in development and application of technology Privacy/confidentiality of information Managing Technology to ensure fair practices	06

#### Assessment:

Term Work: 50 Marks (Continuous Evaluation)

#### Reference Books:

1. Martin Cohen, *101 Ethical Dilemmas* Routledge, 2nd edition, 2007.
2. M. Govindarajan, S. Natarajan & V.S. Senthilkumar, *Professional Ethics and Human Values*, Prentice Hall India Learning Private Limited, 2013.
3. Mike W. Martin, *Ethics in Engineering*, McGraw Hill Education; Fourth edition, 2017.

Course Code	Course Name	Credits
ET 403	IoT Driven App Development	04

**Prerequisite:**

IoT Basics and Smart Sensors, Automation

**Course Objectives:**

1. To introduce the architecture of IoT systems and enable students to understand the role and design considerations of application layers in IoT ecosystems.
2. To develop students' skills in integrating IoT devices with backend platforms using cloud services, databases, and APIs for reliable data management.
3. To impart knowledge of mobile/web front-end development and data visualization techniques for real-time monitoring and control of IoT systems.
4. To equip students with the ability to build real-time communication interfaces using protocols like MQTT and WebSockets for seamless device-app interaction.
5. To enable students to integrate smart features such as GPS-based control, BLE connectivity, and AI models in IoT applications for enhanced user experience.
6. To guide students in conceptualizing, designing, and deploying a complete IoT-driven application as a capstone project, demonstrating the full development lifecycle.

**Course Outcomes:**

1. Understand and explain the layered architecture of IoT systems and the role of mobile/web applications within the ecosystem.
2. Design and implement backend services and cloud integration using platforms like Firebase and REST APIs for IoT data exchange.
3. Develop intuitive and responsive front-end user interfaces for IoT applications using mobile development platforms.
4. Implement real-time, bidirectional communication between IoT devices and applications using MQTT/WebSocket protocols.
5. Integrate location services, BLE, and lightweight AI models into IoT applications to enable intelligent, context-aware features.
6. Plan, develop, test, and deploy a complete IoT-based mobile/web application as a capstone project.

**Theory Syllabus:**

Sr. No.	Module	Detailed Content	Hours	CO Mapping
I	IoT System Architecture & App Ecosystem	IoT architecture: Device, Network, Data, Application layers IoT protocols recap (MQTT, CoAP, HTTP, WebSockets) RESTful APIs in IoT Cloud vs Edge computing integration with apps Overview of mobile/web app roles in IoT solutions Security and privacy considerations	6	1
II	Backend Integration for IoT Applications	Firebase / Google Cloud IoT Core / AWS IoT basics Database integration (Firebase Realtime DB, MongoDB, InfluxDB) Building RESTful APIs with Node.js or Python Flask for IoT devices Webhooks and pub-sub architectures Authentication (OAuth2.0, API Keys, JWT)	6	2

III	Front-End Development for IoT Apps	Mobile UI/UX for real-time IoT monitoring App development using Flutter / React Native / Android Studio (Java/Kotlin) Dashboard design principles for IoT apps Using charts, gauges, toggle controls, etc. Working with data refresh, alerts, and notifications	6	3
IV	Real-Time Communication & App Control	WebSockets / MQTT for app-device interaction Cloud-to-device and device-to-app messaging Push notifications (Firebase Cloud Messaging) Trigger-based control (event-driven actions) Offline-first and fallback design for IoT apps	7	4
V	Advanced App Features: Location, AI, and Edge Analytics	Location tracking using GPS and geofencing Integrating TensorFlow Lite models in IoT apps Visualization of edge AI results in app Voice-based control integration (Google Assistant, Alexa APIs) BLE and local connectivity options	7	5
VI	Capstone Project Development & Deployment	Problem statement formulation App planning, wireframing, and technology stack selection Development (Frontend + Backend + IoT integration) Testing and debugging Deployment to Play Store or as APK (for mobile apps) or Web Project presentation and documentation	7	6

#### Lab Syllabus

Sr. No.	Level 1. Basic 2. Design 3. Advanced 4. Project/Case Study/ Seminar	Detailed Lab/Tutorial Description	Hours
1	Basic	ESP32 to Firebase – Real-Time Data Logging	02
2	Basic	Mobile App to Visualize Live Sensor Data	02
3	Basic	IoT-Based Device Control via Mobile App	02
4	Design	MQTT-Based Messaging Between App and Device	02
5	Design	Push Notification to App on Sensor Threshold Breach	02
6	Design	IoT Dashboard with Charts and Gauges	02
7	Advanced	Geofencing-Based Control of IoT Devices	02
8	Advanced	BLE-Based Local IoT Device Communication	02
9	Advanced	TensorFlow Lite in App for Predictive Alerts	02
10	Project	Full Stack Capstone – Smart Monitoring and Control System	02

**Software Requirements:**

Arduino IDE, Flutter SDK, Android Studio, Firebase, Google Cloud Platform, AWS IoT, Visual Studio Code, Node.js, Python (Flask), Postman, Mosquitto MQTT Broker, HiveMQ Broker, Git, GitHub, TensorFlow Lite, Firebase CLI, Flutter Location Plugin, Flutter BLE Plugin

**Hardware Requirements:**

ESP32 Dev Board, Other prototyping boards, DHT11 Sensor, DHT22 Sensor, Relay Module (1/2/4 channel), LED, Resistors, Breadboard, Jumper Wires, USB Cable, Power Bank, Android Smartphone, Moisture Sensor, LDR Sensor, Ultrasonic Sensor, Bluetooth Module

**Theory Assessment:****Internal Assessment for 40 marks:**

Consisting of Two Compulsory Internal assessment of **40 Marks each** on 40% syllabus for each test. The final marks will be the average of the score of both the tests.

**End Semester Examination: 60 Marks**

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

**Laboratory Assessment:****Term work for 25 marks:**

At least 10 Experiments from the above mentioned list must be performed during the “Laboratory session batch wise”. A mini project based on the entire syllabus must be performed by every student individually (can be hardware or Computation/simulation based project must be encouraged). Term work assessment must be based on the overall performance of the student with experiments and assignments graded from time to time.

**End Semester Practical/Oral Examination: 25 Marks**

Pair of Internal and External Examiner should conduct practical/viva based on contents. Distribution of marks for practical/viva examination shall be as follows:

Practical Examination: 15 Marks Oral Examination: 10 Marks

**Text Books:**

1. Bahga, A., & Madiseti, V. (2015). Internet of Things: A hands-on approach. Universities Press. ISBN: 9780996025515
2. Raj, P., & Raman, A. C. (2017). The Internet of Things: Enabling technologies, platforms, and use cases. CRC Press. <https://doi.org/10.1201/9781315375204>
3. Kleppe, M. (2021). Android app development for beginners. Packt Publishing. ISBN: 9781801074787

**References:**

1. Reddy, B. V. R., Raghunandan, B., & Reddy, D. M. (2018). *Internet of Things (IoT)*. Cengage Learning India. ISBN: 9789353502384
2. Dongre, Y., & Phalnikar, R. (2021). *Mobile app development using Android and Firebase*. TechKnowledge Publications. ISBN: 9789391448253
3. Richardson, M., & Wallace, S. (2016). *Getting started with Raspberry Pi*. Maker Media. ISBN: 9781449344214
4. Seneviratne, P. (2017). *Building smart homes with Raspberry Pi Zero*. Packt Publishing. ISBN: 9781786466952
5. Roberts, R., & Sloan, J. D. (2014). *Bluetooth low energy: Developing BLE applications for iOS and Android*. Apress. <https://doi.org/10.1007/978-1-4842-0022-9>

Subject Code	Subject Name	Credits
ET 404	Communication System Design and Integration	04

### Prerequisite:

Mobile Communication Systems, Robotics, Microcontroller, Antenna, Microwave Engineering

### Course Objectives:

1. Understand protocol processing systems.
2. Study basics of Drone technology.
3. Understand the fundamentals of Digital SLR camera System.
4. Inculcate the software and hardware integration in mobile system.
5. Understand the design considerations of RF transceiver system.
6. Inculcate the techniques to analyze the performance of real time systems.

### Course Outcomes: Six (Based on Bloom's Taxonomy)

1. Explain the computer communication principles: Protocols, Architecture and multimedia and optical networking.
2. Describe working principle and application of drone technology.
3. Describe working principle and application of DSLR system.
4. Identify and explain the software and hardware integration in mobile system.
5. Describe the design considerations of RF transceiver system.
6. Demonstrate the techniques to analyze the performance of real time systems.

### Theory Syllabus:

Sr.No.	Module	Detailed Content	Hours	CO Mapping
I	Computer Communication System	<b>Protocol processing Systems</b> :Network processing hardware, Basic packet processing algorithms. Protocol Software, Switching Fabrics SONET-DWDM ,DSL ,ISDN ,ATM <b>Multimedia Networking</b> : Protocols for real time interactive application-RSVP, Network Requirements for Audio/ Video Transform, Multimedia Coding and Compression.	06	CO1

II	Drone System	<b>Introduction to UAVs</b> , Classification of UAVs, Drones / Quadcopters Working Principle and Design, Sensors used in drones & Calibration <b>PID Controller Implementation and Tuning</b> , Flight controller, Remote Controller, Quadcopter dynamics <b>Applications of UAVs</b> in various fields Land surveying, Urban city planning, Agriculture, Disaster management	06	CO2
III	DSLR System	Introduction to digital SLR cameras and Photography, DSLR block diagram, DSLR features, Memory Cards and Storage, Selection of lenses, Camera controls.	05	CO3
IV	Mobile System	Introduction to mobile system, Introduction to mobile software's: Android, IOS, Introduction to mobile app development  Introduction to mobile hardware's: Bluetooth, Wi-Fi, GPS, Accelerometer, Camera, Fingerprints sensors Hardware and software integration	09	CO4
V	RF Transceiver Design	Communication System Requirements, Selection of Circuits and Components, Design and integration of transmitting Antenna, Amplifier, Filters, Oscillator, Mixer, Phase locked loop, Receiver requirements, Link budget analysis, Design of LNA and its integration Antenna, filter, oscillator and mixer, Image rejection techniques	09	CO5
VI	Performance Analysis of Real time System	EMI-EMC issues, Fading, Validation of prototype, Open air testing	04	CO6

### Theory Assessment:

### Internal Assessment for 40 marks:

Consisting of Two Compulsory Internal assessment of **40 Marks each** on 40% syllabus for each test. The final marks will be the average of the score of both the tests.

### End Semester Examination: 60 Marks

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

**Text Books:**

1. David M Pozar, Microwave Engineering, John Wiely and Sons, 2005
2. Ludwig R. and Bogdanov G, RF Circuit Design, Prentice Hall, 2007.
3. Henry W. Ott, “Electromagnetic Compatibility Engineering”, John Wiely andSons, 2005
4. W. Prasad Kodali, “Engineering Electromagnetic Compatibility: Principles, Measurements, Technologies, and Computer Models”, 2nd Edition, ISBN: 978-0-7803-4743-4, January 2001, Wiley-IEEE Press

**References:**

1. Theory, Design, and Applications of Unmanned Aerial Vehicles- by A. R. Jha Ph.D. (Author), 2016
2. Handbook of Unmanned Aerial Vehicles- Editors: Valavanis, K., Vachtsevanos, GeorgeJ. (Eds.), 2014.
3. Guillermo Gonzalez, ‘Microwave Transistor Amplifiers Analysis and Design’, Prentice Hall, 2<sup>nd</sup> Edition.
4. Devendra Misra, ‘Radio Frequency and Microwave Communication Circuits - Analysis and Design’, John Wiley & Sons, 2<sup>nd</sup> Edition.
5. Ramesh Garg, InderBahl and Maurizio Bozzi, “Microstrip Lines and Slot Lines, Artech House, 3<sup>rd</sup> Edition.

Subject Code	Subject Name	Credits
ET 405	Advanced VLSI	04

#### Course Objectives:

1. To provide knowledge of Wafer preparation and fabrication for VLSI Technology
2. To provide knowledge of IC fabrication processes and advanced IC technologies.
3. To provide knowledge of IC fabrication processes and design rules.
4. To disseminate knowledge about novel semiconductor measurement.
5. To provide knowledge about different VLSI Technology.
6. To disseminate knowledge about novel VLSI devices and materials.

#### Course Outcomes: Upon successful completion of the course students will be able to

1. Analyze and demonstrate a clear understanding of various MOS fabrication processes & CMOS fabrication flow.
2. Analyze and design layout of MOS based Circuits.
3. Demonstrate a clear understanding of Semiconductor Measurements & Testing.
4. Analyze SOI and GaAs technology.
5. Develop different fabrication process.
6. Understand advanced technologies, Novel Devices and materials in Modern VLSI Technology

**Prerequisite:** Electronic Devices and Circuits , Digital Circuit Design, Basics of VLSI Design

#### DETAILED THEORY SYLLABUS:

Sr. No.	Module	Detailed Content	Hours
1	Semiconductor manufacturing requirements and Crystal growth techniques	Semiconductor Manufacturing: Semiconductor technology trend, Clean rooms, Wafer cleaning and Gettering. Semiconductor Substrate: Crystal structure, Crystal defects, Czochralski growth, Float Zone growth, Bridgman growth of GaAs, Wafer Preparation and specifications	08
2	Semiconductor Device Fabrication Processes-1	Epitaxy: Classification, Molecular Beam Epitaxy Silicon Oxidation: Thermal oxidation process, Kinetics of growth, Properties of Silicon Dioxide, Oxide Quality. Device Isolation: LOCOS, Shallow Trench Isolation (STI). Deposition: Physical Vapor Deposition-Evaporation and Sputtering, Chemical Vapor Deposition: APCVD, LPCVD, PECVD Diffusion: Nature of diffusion, Diffusion in a concentration gradient, diffusion Equation, diffusion systems, problems in diffusion. Ion Implantation: Penetration range-Nuclear& Electronic stopping and Range, implantation damage, Annealing-Rapid thermal annealing, ion implantation systems.	07
3	Semiconductor Device Fabrication Processes-2	Etching & Lithography: Etching: Basic concepts and Classification Lithography: Introduction to Lithography process,	07

		Types of Photoresist, Types of Lithography: Electron beam, Ion beam and X-ray lithography. Metallization and Contacts: Introduction to Metallization, Schottky contacts and Ohmic contacts. CMOS Process Flow: N well, P-well and Twin tub, CMOS Latch Up Design rules, Layout of MOS based circuits (gates and Combinational logic), Buried and Butting Contact.	
4	Measurement and Testing	Semiconductor Measurements: Conductivity type, Resistivity, Hall Effect Measurements, Drift Mobility. Testing: Technology trends affecting testing, VLSI testing process and test equipment, test economics and product quality	06
5	VLSI Technologies	SOI Technology: SOI fabrication using SIMOX, Bonded SOI and Smart Cut ,PD ,SOI and FD SOI Device structure and their features. Advanced Technologies: low $\kappa$ and high $\kappa$ , BiCMOS, H $\kappa$ MG Stack, Strained Silicon. GaAs Technologies: MESFET Technology, MMIC technologies, MODFET	06
6	Novel Devices and Materials	Multigate Devices: Various multigate device configurations-double gate, triple gate (FinFET) and Gate All Around (Nanowire). Nanowire: Concept, VLS method of fabrication, Nanowire FET, Types: Horizontal and Vertical Nanowires, III-V compound Materials in Nanowires. 2-D Materials and FET: Graphene& CNT FET, MOS2 and Black Phosphorous	05

#### DETAILED LAB SYLLABUS:

**Software Requirements:** NANOHUB, MICROWIND

Sr. No.	Detailed Lab Description
1	To study the CZ process for Silicon Crystallization.
2	Implement NMOS inverter with resistive load using NANOHUB and study its Characteristics.
3	Various effects of Temperature on Thermal Oxidation using NANOHUB.
4	Design of CMOS Inverter using Microwind.
5	Design of CMOS NAND using Microwind.
6	Design of CMOS NOR using Microwind.
7	Design of CMOS EXOR using Microwind.
8	To implement the given function $Y=A+BC$ using Microwind.
9	Design of 6T SRAM using Microwind.
10	Case Study IEEE paper.

### **Theory Assessments:**

1. **Internal Assessment:** Two Internal assessments will be conducted for 40 marks each with average marks of both assessments as final score.

2. **End Sem Theory Examination:**

- Question paper will consist of 4 questions, each carrying 20 marks.
- Total 3 questions need to be solved.
- Q.1 will be compulsory, based on the entire syllabus.
- Remaining questions will be randomly selected from all the modules.
- Weightage of marks should be proportional to number of hours assigned to each module.

### **Lab Assessments:**

1. **Term work Assessment:**

- Term work should consist of 10 experiments.
- Journal must include at least 2 assignments
- Mini Project to be performed

Total 25 Marks (Experiments: 10-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks, Mini Project: 5-marks)

2. **Oral/Viva Assessment:**

Based on the above contents and entire syllabus.

### **Text Books:**

1. James D. Plummer, Michael D. Deal and Peter B. Griffin, "Silicon VLSI Technology", Pearson, Indian Edition.
2. Stephen A. Campbell, "The Science and Engineering of Microelectronic Fabrication", Oxford University Press, 2nd Edition.
3. Sorab K. Gandhi, "VLSI Fabrication Principles", Wiley, Student Edition.
4. G. S. May and S. M. Sze, "Fundamentals of Semiconductor Fabrication", Wiley, First Edition.
5. Kerry Bernstein and N. J. Rohrer, "SOI Circuit Design Concepts", Kluwer Academic Publishers, 1st edition.

### **References:**

1. Jean-Pierre Colinge, "FinFETs and Other Multigate Transistors", Springer, 1<sup>st</sup> edition
2. M. S. Tyagi, "Introduction to Semiconductor Materials and Devices", John Wiley and Sons, 1st edition.
3. James E. Morris and Krzysztof Iniewski, "Nanoelectronic Device Applications Handbook", CRC Press.
4. Glenn R. Blackwell, "The electronic packaging", CRC Press.
5. Michael L. Bushnell and Vishwani D. Agrawal, "Essentials of Electronic Testing for digital, memory and mixed-signal VLSI circuits", Springer.
6. G.S. May and S. M. Sze, "Fundamentals of Semiconductor Fabrication", Wiley, First Edition

Course Code	Course Name	Credits
ET 406	Blockchain for Communication	04

**Prerequisite:**

Java and scripting , Database and Management , Computer Communication and Network

**Objectives:**

1. To understand basics of Blockchain technology
2. To understand concept of cryptocurrency and Bitcoin
3. To understand concepts of Ethereum Blockchain
4. To learn the concepts of Hyperledger
5. To understand solidity programming language and concepts of smart contracts
6. To learn and develop various applications of Blockchain

**Outcomes:** Learner will be able to...

1. Understand working knowledge of the emerging block chain technology.
2. Discuss concept of cryptocurrency and Bitcoin
3. Apply the knowledge of Ethereum Blockchain
4. Understand and analyze the working of Hyperledger
5. Explore basics of solidity programming language and smart contracts
6. Develop various applications of Blockchain

**Theory Syllabus**

Sr. No.	Module	Detailed Content	Hours	CO Mapping
I	Introduction to Blockchain	What is Blockchain, Blockchain Technology Mechanism Networks, Blockchain Origins, Objective of Blockchain, Blockchain challenges, Transactions and Blocks, P2P systems, Keys as Identity, Digital signatures, hashing and public key cryptosystems, private vs public blockchain	04	CO1
II	Bitcoin and Cryptocurrency	What is Bitcoin, The Bitcoin Network, The Bitcoin Mining Process, Mining Developments, Bitcoin Wallets, Decentralization and Hard Forks, Ethereum Virtual Machine (EVM), Merkle Tree, Double-Spend Problem, Blockchain and Digital Currency, Transactional Blocks, Impact of	08	CO2

		Blockchain Technology on Cryptocurrency		
III	Introduction to Ethereum Blockchain	What is Ethereum, Introduction to Ethereum, Consensus Mechanisms, How Smart Contracts Work, Metamask Setup, Ethereum Accounts, Receiving Ether's What's a Transaction?, Smart Contracts.	07	CO3
IV	Introduction to Hyperledger	What is Hyperledger? , Distributed Ledger Technology & its Challenges, Hyperledger & Distributed Ledger Technology, Hyperledger Fabric, Hyperledger Composer.	05	CO4
V	Solidity Programming Language	Solidity -Language of Smart Contracts, Installing Solidity & Ethereum Wallet, Basics of Solidity, Layout of a Solidity Source File & Structure of Smart Contracts, General Value Types (Int, Real, String, Bytes, Arrays, Mapping, Enum, address)	08	CO5
VI	Blockchain Applications	Blockchain Applications: Internet of Things, Medical Record Management System, Do-main Name Service and future of Blockchain	04	CO6

### Lab Syllabus

**Lab Prerequisite:** Cryptography, DataStructure, Networking, OOP

Sr. No.	Level 1. Basic 2. Design 3. Advanced 4. Project/Case Study/Seminar	Detailed Lab Description	Hours
1	Basic	Understanding the concept of Hash in Blockchain	02
2	Advanced	Working of Bitcoin mining and how blocks are added in the Blockchain.	02
3	Advanced	Setting up bitcoin wallet	02
4	Basic	Creating and Building Up Crypto Token	02
5	Advanced	Setting up Metamask and MIST Wallet	02
6	L3	Set up Hyperledger Fabric Blockchain using Hyperledger Composer locally	02
7	L1	Advanced Storage smart contract with function to add elements to array,function to read individual elements of	02

		array , function to read all elements of array and function to return length of array.	
8	L1 , L3	Create a smart contract for Hotel Room	02
9	L1 , L3	Create a smart contract that implements the simplest form of a cryptocurrency. The contract allows only its creator to create new coins (different issuance schemes are possible). Anyone can send coins to each other without a need for registering with a username and password, all you need is an Ethereum keypair	02
10	L1 , L3	Simple Open Auction Smart Contract  The general idea of the following simple auction contract is that everyone can send their bids during a bidding period. The bids already include sending money / Ether in order to bind the bidders to their bid. If the highest bid is raised, the previous highest bidder gets their money back. After the end of the bidding period, the contract has to be called manually for the beneficiary to receive their money - contracts cannot activate themselves.	02
11	L4	Practical use cases of Blockchain - Case study	02

**Software Requirements:** Remix Browser - online compiler

#### **Theory Assessment:**

##### **Internal Assessment for 40 marks:**

Consisting of Two Compulsory Internal assessment of **40 Marks each** on 40% syllabus for each test. The final marks will be the average of the score of both the tests.

#### **End Semester Examination: 60 Marks**

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

#### **Lab Assessments:**

**Term work Assessment:** At least 08 Experiments including 02 simulations covering the entire syllabus must be given during the —Laboratory session batchwise—. Computation/simulation based experiments are also encouraged. The experiments should be student centric and attempts should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for a maximum batch of four students. Termwork assessment must be based on the overall performance of the student with every experiment/tutorials and mini-projects (if included) are graded from time to time.

**Oral/Viva Assessment:** The practical and oral examination will be based on the entire syllabus.

## **Text Book**

1. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder, Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction, Princeton University Press (July 19, 2016).
2. Arshdeep Bahga, Vijay Madisetti, Blockchain Applications: A Hands-On Approach Paperback, VPT; 1st edition (31 January 2017)
3. Baset, Salman A., Blockchain Development with Hyperledger, Packt, 2019
4. Parikshit Jain, A Practical Guide To Blockchain And Its Applications, Bloomsbury India, 1st Edition, February 2019

## **Reference Books**

1. Antonopoulos, Mastering Bitcoin: Unlocking Digital Cryptocurrencies
2. Satoshi Nakamoto, Bitcoin: A Peer-to-Peer Electronic Cash System
3. DR. Gavin Wood, "ETHEREUM: A Secure Decentralized Transaction Ledger," Yellow paper. 2014.
4. Nicola Atzei, Massimo Bartoletti, and Tiziana Cimoli, A survey of attacks on Ethereum smart contracts

Course Code	Course Name	Credits
ET 407	AIML in Communication	04

### Prerequisite:

Fundamentals of Mathematics, Communication systems, Artificial Neural Networks.

### Course Objectives:

1. To understand the concept of data cleaning and data transformation.
2. To understand and apply the basic methods of feature extraction and feature evaluation.
3. To understand and apply both supervised and unsupervised machine learning algorithms to improve performance of equalizers.
4. To develop routing algorithms using machine learning to resolve real-world problems in Network design.
5. To become familiar with various Neural Networks methods for controlling ATM calls.
6. To understand fault management techniques in Communication systems.

### Course Outcomes: Learner will be able to...

1. Able to Understand the fundamentals of pattern recognition and machine learning.
2. Able to Understand the issue of dimensionality and apply suitable feature extraction methods considering the characteristics of a given problem..
3. Able to apply Self organizing maps and distribution Learning methods for the adaptive equalization.
4. Able to create solutions to real-world problems of Network design and Management using reinforcement learning and Hopfield optimization techniques.
5. Understand and apply Network control methods for performance enhancement of communication systems.
6. Analyze the performance of communications systems by estimating various faults in the systems.

### Theory Syllabus

Sr. No.	Module	Detailed Content	Hours	CO Mapping
I	Introduction	Basic definitions; Hypothesis space and inductive bias; Data cleaning; Data transformation; Evaluation; Model visualization; Cross-validation; Linear Regression	04	CO1

II	Data Interpretation & feature extraction	Curse of dimensionality; Principal component analysis; Fisher linear discriminant, Feature extraction from multivariate data, image data; Feature evaluation. Text recognition for Conversion of Telephone, Speech recognition.	04	CO2
III	Equalisers	Adaptive equalization and channel equalization by distribution Learning, Equalization of varying channels using RBFNN, Adaptive signal recovery, Self organizing maps in nonlinear multipath channels.	08	CO3
IV	Network design and Management	Adaptive Routing, Distributed reinforcement learning scheme for network routing. Optimal traffic routing using Self organization principle, Hopfield optimization techniques for routing in computer networks, Q-routing approach to adaptive traffic control. NN for network topology design.	06	CO4
V	Network Control	ATM call control by Neural Network. ATM Multimedia traffic prediction. Optimization for switching. Control ATM call traffic by reinforcement learning	04	CO5
VI	Fault Management	Learning index rules and adaption functions for a communication network, Identify faults in switching systems using Distributed neural network.	08	CO6

### Lab Syllabus

Sr. No.	Level 1. Basic 2. Design 3. Advanced 4. Project/Case Study/Seminar	Detailed Lab/Tutorial Description	Hours
1	Basic	To study various steps to clean the data.	02
2	Basic	Minimizing the error function and fitting the best line or hyperplane using linear regression.	02
3	Design	Write a program to reduce the dimensionality of the data set.	02
4	Design	Design an Algorithm to extract features from multivariate data.	02
5	Design	Write a program for equalization of varying channels using RBFNN	02

6	Advanced	Design adaptive routing algorithm using reinforcement learning	02
7	Advanced	Design optimal traffic routing algorithm using the Self organizing Maps.	02
8	Advanced	Write a algorithm to control ATM call traffic by using reinforcement learning	02
9	Project	Design an algorithm to identify faults in switching systems using Distributed neural network	02

### Theory Assessment:

### Internal Assessment for 40 marks:

Consisting of Two Compulsory Internal assessment of **40 Marks each** on 40% syllabus for each test. The final marks will be the average of the score of both the tests.

### End Semester Examination: 60 Marks

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

### Lab Assessments:

**Term work Assessment:** At least 08 Experiments including 02 simulations covering the entire syllabus must be given during the —Laboratory session batch wise—. Computation/simulation based experiments are also encouraged. The experiments should be student centric and attempts should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for a maximum batch of four students. Term work assessment must be based on the overall performance of the student with every experiment/tutorials and mini-projects (if included) are graded from time to time.

**Oral/Viva Assessment:** The practical and oral examination will be based on the entire syllabus.

### Text Books:

1. T. Mitchell, Machine Learning, McGraw Hill.
2. M. Gopal, Applied Machine Learning, McGraw Hill.

### References:

1. B.Yegnanarayana, Artificial Neural Networks, Prentice Hall of India.
2. Satish Kumar, Neural Networks – A Classroom Approach, Tata McGraw-Hill.
3. A. Ethem, Introduction to Machine Learning, PHI Learning Pvt. Ltd.
4. S N Sivanandam, Introduction to Neural Networks, McGraw-Hill edu. Pvt. Ltd.

Course Code	Course Name	Credits
ET 408	MIMO Systems for 5G	04

### Prerequisite:

Wireless and mobile communication, Antenna and Digital Communication.

### Course Objectives:

1. To get familiar with the basics of the diversity schemes involved in the MIMO system.
2. To understand planning and design of the capacity of deterministic and random MIMO channels and fading channels.
3. To inculcate the design considerations of MIMO antenna system
4. To study various space time coding techniques.
5. To explore various algorithms used to detect the received signal in MIMO systems.
6. To study the advances in MIMO Communication Systems.

### Course Outcomes: Learner will be able to...

1. Classify and explain the diversity schemes involved in MIMO with advantages, applications, channel models and power allocation.
2. Calculate the capacity of deterministic and random MIMO channels and fading channels.
3. Classify and compare SISO antenna with MIMO antenna
4. Explain the different space time coding techniques like STBCs, STTCs and Space time turbo codes.
5. Describe various algorithms used to detect the received signal in MIMO systems like Maximum likelihood, MMSE, ZFE.
6. Discuss the advances in MIMO Communication Systems.

### Theory Syllabus

Sr. No.	Module	Detailed Content	Hours	CO Mapping
I	Introduction to MIMO channel models	Diversity-multiplexing trade-off, transmit diversity schemes, advantages and applications of MIMO systems, Fading Channel Models: Uncorrelated - fully correlated - separately correlated - keyhole MIMO fading models, parallel decomposition of MIMO channel, Power allocation in MIMO: Uniform - adaptive - near optimal power allocation	07	CO 1

II	MIMO channel capacity	Indoor RF communication and its Propagation models, Capacity for deterministic MIMO Channels: SISO – SIMO – MISO – MIMO, Capacity of random MIMO channels: SISO – SIMO – MISO – MIMO (Unity Channel Matrix, Identity Channel Matrix), Capacity of independent identically distributed channels, Capacity of separately correlated Rayleigh fading MIMO channels, Capacity of keyhole Rayleigh fading MIMO channel,	05	CO2
III	MIMO Antenna	Introduction to MIMO antenna, Massive MIMO antenna system and its applications, Performance Parameters of MIMO antenna system (Return loss, Isolation/mutual coupling between antenna elements, Envelope correlation coefficient, Total active reflection coefficient and Channel capacity loss etc.), Mutual coupling reduction techniques in MIMO antenna	04	CO3
III	Space-time codes	Advantages, code design criteria, Alamouti space-time codes, SER analysis of Alamouti space-time code over fading channels, Space-time block codes, Space-time trellis codes, Performance analysis of Space time codes over separately correlated MIMO channel, Space-time turbo codes, BLAST Architectures: VBLAST – HBLAST – SCBLAST – DBLAST	08	CO4
IV	MIMO detection techniques	Maximum Likelihood, Zero Forcing, Minimum Mean Square Error, Zero Forcing Equalization with Successive Interference Cancellation, Minimum Mean Square Error Successive Interference Cancellation, Lattice Reduction based detection	08	CO5
V	Advances in MIMO systems	Spatial modulation, MIMO based cooperative communication and cognitive radio, multiuser MIMO, cognitive-femtocells and large MIMO systems for 5G wireless, MIMO Applications in RADAR, Satellite Communication, Wi-Fi	07	CO6

### Lab Syllabus

Sr. No.	Level 1. Basic 2. Design 3. Advanced 4. Project/Case Study/Seminar	Detailed Lab/Tutorial Description	Hours
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1	Design	Performance analysis of 2 x 2 MIMO systems using different modulation techniques with ML detection algorithm.	02
2	Design	Performance analysis of 2 x 2 MIMO systems using different modulation techniques with ML detection algorithm in correlated and uncorrelated channel conditions.	02
3	Design	Performance analysis of 2 x 2 MIMO systems using different modulation techniques with VB last detection algorithm.	02
4	Design	Performance analysis of 2 x 2 MIMO systems using different space time coding techniques with ML detection algorithm.	02
5	Design	Performance analysis of 2 x 2 MIMO systems using different space time coding techniques with V-Blast detection algorithm.	02
6	Design	Performance analysis of a Multi-user MIMO system using BPSK modulation technique with SIC and V-Blast detection algorithm.	02
7	Design	To design a 2 element MIMO antenna system and to study the effect of spacing between antenna elements on the radiation characteristics of MIMO antenna.	02
8	Design	To design a 2 element MIMO antenna system, using various diversity techniques.	02
9	Design	To design Massive MIMO antenna system and to analyze the effect of number of antenna elements and operating frequency on the performance of MIMO system	02
10	Study	Deployment of access points for indoor (in-house, basement, tunnel) RF communication.	LO6

### Software Requirements:

1. Ns-2: <http://www.isi.edu/nsnam/ns/>
2. Virtual Lab : <http://vlab.amrita.edu/index.php?sub=78&brch=256>
3. Scilab Experiments Book:  
[https://www.google.co.in/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0ahUKEwjgwcclodTTAhVJrI8KHTQUC9AQFggqMAA&url=http%3A%2F%2Fscilab.in%2Ftextbook\\_companion%2Fenerate\\_book%2F3446&usg=AFQjCNGDs2a6AHGKL93l3\\_j8Ra1UN-5SQQ&sig2=yT9ep5\\_ZlhFRDVsv-GmsWw&cad=rja](https://www.google.co.in/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0ahUKEwjgwcclodTTAhVJrI8KHTQUC9AQFggqMAA&url=http%3A%2F%2Fscilab.in%2Ftextbook_companion%2Fenerate_book%2F3446&usg=AFQjCNGDs2a6AHGKL93l3_j8Ra1UN-5SQQ&sig2=yT9ep5_ZlhFRDVsv-GmsWw&cad=rja)

**Online Repository Sites:**

1. <http://nptel.ac.in/courses/117105132>

**Theory Assessment:****Internal Assessment for 40 marks:**

Consisting of Two Compulsory Internal assessment of **40 Marks each** on 40% syllabus for each test. The final marks will be the average of the score of both the tests.

**End Semester Examination: 60 Marks**

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

**Laboratory Assessment:****Term work 25 Marks**

At least 08 Experiments covering the entire syllabus must be given during the "**Laboratory session batch wise**". Computation/simulation based experiments are also encouraged. The experiments should be student centric and attempts should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four student

Term work assessment must be based on the overall performance of the student with every experiment graded from time to time.

**Oral/Viva Assessment:** The practical and oral examination will be based on the entire syllabus.

**Text Books:**

1. Tolga M. Duman and Ali Ghayeb, "Coding for MIMO Communication Systems", John Wiley & Sons Ltd., 2007.
2. R. S. Kshetrimayum, "Fundamentals of MIMO Wireless Communications", Cambridge University Press, 2017.
3. T. L. Marzetta, E. G. Larsson, H. Yang and H. Q. Ngo, Fundamentals of Massive MIMO, Cambridge University Press, 2016.
4. B. Kumbhani and R. S. Kshetrimayum, "MIMO Wireless Communications over Generalized Fading Channels", CRC Press, 2017.

**References:**

1. A. Chockalingam and B. S. Rajan, *Large MIMO systems*, Cambridge University Press, 2014.
2. Ezio Biglieri, Robert Calderbank and Anthony Constantinides. "MIMO Wireless Communications".
3. Single and Multi Carrier MIMO Transmission for Broadband Wireless Systems by R. Prasad, Rahman and S.S. Das.
4. Mohammad Sharawi "Printed MIMO antenna

Course Code	Course Name	Credits
ET 409	Cloud Computing	04

**Prerequisite:** Computer Network, Operating System

**Course Objectives:**

1. Basics of cloud computing.
2. Key concepts of virtualization.
3. Different Cloud Computing services
4. Cloud Implementation, Programming and Mobile cloud computing
5. Key components of Amazon Web Services
6. Resources Management In Cloud Computing

**Course Outcomes:**

1. Define Cloud Computing and memorize the different Cloud service and deployment models
2. Describe the importance of virtualization along with their technologies.
3. Use and Examine different cloud computing services
4. Analyze the components of open stack & Google Cloud platform and understand Mobile Cloud Computing
5. Describe the key components of Amazon web Service
6. Design and develop resources management In Cloud Computing

Sr. No.	Module	Detailed Content	Hours	CO Mapping
I	Introduction to Cloud Computing	Introduction to Cloud Computing, Cloud Characteristics, Cloud Computing Components, Comparing of Cloud Computing with Peer to Peer architecture, Client Server , Distributed, Grid, Cloud Deployment model (Cloud types- Public, Private, Community, Hybrid), Service Models- (IaaS,PaaS,SaaS)	04	CO1
II	Virtualization	Introduction & benefit of Virtualization – Implementation Levels of Virtualization- VMM Design Requirements and Providers– Virtualization at OS level – Middleware support for Virtualization – Virtualization structure/tools and mechanisms: Hypervisor and Xen Architecture,	07	CO2

		Binary Translation with full Virtualization, Para Virtualization with Compiler Support - CPU Virtualization – Memory Virtualization and I/O Virtualization – Virtualization in Multicore processors		
III	Cloud Computing Services	Compute Services - Amazon Elastic Compute Cloud, Google Compute Engine, Windows Azure Virtual Machines Storage Services - Amazon Simple Storage Service, Database Services - Amazon Relational Data Store, Amazon DynamoDB, Application Services - Application Runtimes & Frameworks, Queuing Services, Email Services, Notification Services, Media Services ,Content Delivery Services - Amazon CloudFront, Windows Azure Content Delivery Network Analytics Services - Amazon Elastic MapReduce, Deployment & Management Services - Amazon Elastic Beanstalk, Amazon CloudFormation Identity & Access Management Services - Amazon Identity & Access Management, Open Source Private Cloud Software - CloudStack, Eucalyptus, OpenStack	10	CO3
IV	Cloud Application Design	Design Considerations for Cloud Applications - Scalability, Reliability & Availability, Security, Maintenance & Upgradation, Performance  Cloud Application Design Methodologies - Service Oriented Architecture, Cloud Component Model, IaaS, PaaS and SaaS services for cloud applications, Model View Controller, RESTful Web Services,  Data Storage Approaches - Relational (SQL) Approach, Non-Relational (No-SQL) Approach	06	CO4
V	Cloud Security	AAA Administration for Clouds -AAA model – SSO for Clouds – Authentication management and Authorization management in clouds – Accounting for Clouds	06	CO5
VI	Cloud Computing Applications	Cloud Computing for Health care, Education, Transportation, Manufacturing Industry, Energy System, Mobile Computing Multimedia Cloud - Introduction, Streaming Protocols - RTMP Streaming, HTTP Live Streaming, HTTP Dynamic Streaming Case Studies - Live Video Streaming App , Video Transcoding App, Edge Computing, FOG Computing	06	CO6

## Detailed Lab Syllabus

### Prerequisite:

Software Requirements: XEN/ Vmware ESXi, Open Stack, Google App Engine/ Windows Azure, Amazon Web Service

Sr. No.	Level 1. Basic 2. Design 3. Advanced 4. Project/Case Study/Seminar	Detailed Lab/Tutorial Description	Hours
1	Basic	Study of NIST model of cloud computing.	02
2	Basic	Understand different types of virtualizations, Host and bare metal hypervisors and implement horizontal scalability.	02
3	Basic	Install Google App Engine. Create a hello world app and other simple web applications using python/java.	02
4	Design	Use GAE applications. Launcher to launch the web	02
5	Design	Working and Installation of Microsoft Azure	02
6	Design	Simulate identity management in a private cloud.	02
7	Design	Explore Storage as a Service for remote file access using web interface	02
8	Advanced	Deploy web applications on commercial cloud	02
9	Advanced	To create and access VM instances and demonstrate various components such as EC2, S3	02
10	Advanced	To demonstrate components SimpleDB, DynamoDB.	02

### Theory Assessment:

#### Internal Assessment for 40 marks

Consisting of Two Compulsory Internal assessment of **40 Marks each** on 40% syllabus for each test. The final marks will be the average of the score of both the tests.

**End Semester Examination: 60 Marks**

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

**Lab Assessments:**

- 1. Term work Assessment:** At least 08 Experiments including 02 simulations covering the entire syllabus must be given during the —Laboratory session batch wise—. Computation/simulation-based experiments are also encouraged. The experiments should be student centric and attempts should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for a maximum batch of four students. Term work assessment must be based on the overall performance of the student with every experiment/tutorial and mini-projects (if included) are graded from time to time.
- 2. Oral/Viva Assessment:** The practical and oral examination will be based on the entire syllabus.

Course Code	Course Name	Credits
ET 410	Data Science	04

**Prerequisite:**

Database Management System, Big Data Analytics, Python

**Course Objectives:**

1. Understand the Fundamentals of Data Science
2. Apply Data Management and Predictive Modeling Techniques
3. Implement Feature Engineering and Text Analytics
4. Visualize Data Effectively Using Modern Tools
5. Explore Generative AI for Data Science
6. Recognize and Apply Ethical Principles in Data Science

**Course Outcomes:**

1. Explain the concept, scope, goals, and applications of data science; distinguish data science from business intelligence; and describe the role and responsibilities of a data scientist. (Understand (L2))
2. Apply data collection, cleaning, and preparation techniques, and implement predictive models using probability, statistics, and core machine learning algorithms such as regression, decision trees, Naive Bayes, SVM, and clustering. (Apply & Analyze (L3, L4))
3. Perform feature engineering, model selection, and evaluation using metrics such as confusion matrix and ROC curve; clean and process textual data to prepare it for analytics and modeling. (Apply & Analyze (L3, L4))
4. Create and interpret data visualizations using Python, R, and Tableau including bar charts, scatter plots, geospatial and time series plots, and build dashboards for effective data communication. (Create & Evaluate (L5, L6))
5. Differentiate between generative and discriminative AI, and apply generative AI tools (e.g., GPT-3.5, ChatCSV, tomat.ai) for data querying and enhancement in real-world data science workflows. (Apply (L3))
6. Evaluate ethical principles in data science including data ownership, privacy, informed consent, and responsibilities of data scientists, applying the Five Cs and professional safeguards. (Evaluate (L5))

**Theory Syllabus:**

Sr. No.	Module	Detailed Content	Hours	CO Mapping
I	Introduction to data science	Definition, working, defining goal, benefits and uses of Data Science, Data science vs BI, The data science process, Role of a Data Scientist.	4	1

II	Data management and Predictive modeling	Data management - Create the data set, Data collection methods, Data preparation - importance of data 'cleaning', validity and quality. Data analysis Predictive Modeling - Probability and Statistics Basics, Common machine learning models(Machine Learning Algorithms: Linear Regression, Logistic Regression, Multinomial Logistic Regression, Decision Trees, Naive Bays, SVM, Clustering)	9	2
III	Feature Extraction and Text Analytics	Feature engineering, Model selection, Performance metrics and hyperparameter optimization, Confusion Matrix, Model Deployment. Introduction to text Analytics, Need of Text Analytics, Understanding Text, Cleaning Text Data Sets	7	3
IV	Data visualization and Tools	Introduction to Data Visualization, Visualization Tools (Area Plots,Histograms,Bar Charts, Pie Charts, Box Plots, Scatter Plots,Waffle Charts, Word Clouds), Visualizing Geospatial Data, visualizing time series data, Importance of data visualization Dashboards. Data Visualization using R, Python and Tableau.	8	4
V	Generative AI	Introduction to generative AI and discriminative AI. Distinguish generative AI from discriminative AI. Capabilities of generative AI and its use cases in the real world. Applications of generative AI in different sectors and industries. Generative AI models and tools for text, code, image, audio, and video generation. Leverage generative AI tools, like GPT 3.5, ChatCSV, and tomat.ai, available to Data Scientists for querying and preparing data. Examine real-world scenarios where generative AI can enhance data science workflows.	6	5
VI	Ethics of data science	Responsibilities of actuaries around data science and AI, Data Science Ethics, Doing good data science, Owners of the data, Valuing different aspects of privacy, Getting informed consent, The Five Cs, Developing ethical and professional safeguards	5	6

### Lab Syllabus

Sr. No	Level 1. Basic 2. Design 3. Advanced 4. Project/ Case Study/ Seminar	Detailed Lab/Tutorial Description	Hours
1	Basic	Data Preparation and Preprocessing using Python.	02
2	Design	Logistic Regression (Binary): Classify whether a student will pass/fail based on study hours and attendance. Evaluate using accuracy, precision, recall.	02

3	Design	Decision Tree Classifier: Predict whether a loan application is approved using a decision tree. Plot the tree structure.	02
4	Design	Naive Bayes Classifier: Classify SMS messages as spam or ham using text data. Calculate probabilities manually for one record.	02
5	Design	Feature Scaling: Apply normalization and standardization (Min-Max, Z-score) on numerical features and visualize effect.	02
6	Advanced	Model Comparison: Compare Logistic Regression, Decision Tree, and SVM on the same dataset (e.g., breast cancer or iris) using consistent metrics.	02
7	Advanced	Build Flask App for ML Model: Deploy a model using Flask API to serve predictions via web interface.	02
8	Basic	R Visualization using ggplot2: Use ggplot2 to create a scatter plot, bar chart, and histogram with a dataset (e.g., mtcars or iris).	02
9	Design	Introduction to Dashboards using Tableau: Create a dashboard in Tableau with multiple charts (bar, pie, map) to visualize sales or population data.	02
10	Advanced	Integrate OpenAI API to ask questions about a dataset (like ChatCSV).	02
11	Project	Micro Project	04

### Software Requirements: Google Colab

### Theory Assessment:

### Internal Assessment for 40 marks:

Consisting of Two Compulsory Internal assessment of 40 Marks each on 40% syllabus for each test. The final marks will be the average of the score of both the tests.

### End Semester Examination: 60 Marks

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

### Lab Assessments:

**1. Teamwork Assessment:** Term work should consist of 10 experiments. The journal must include at least 2 assignments on content theory, practicals of “Data Science” and a micro project based on the entire syllabus must be performed by every student individually. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments:

05-marks).

**2. Oral/Viva Assessment:** Practical & oral exam to be conducted by Internal & External examiners. Practical execution (10 marks) & Oral (15 marks)

**Text Books:**

1. Davy Cielen, Arno D. B. Meysman, Mohamed Ali, —Introducing Data Science, Manning Publication.
2. Sanjeev Wagh, Manisha S. Bhende And Anuradha D. Thakare, —Fundamentals of Data Science, Thakare, Taylor and Francis Group, CRC Publication.
3. Kevin P. Murphy, “Machine Learning a Probabilistic Perspective”, The MIT Press
4. Ben Auffarth, “Generative AI with LangChain”, Packt Publishing, 1st edition 2024
5. Ethics and Data Science, D J Patil, Hilary Mason, Mike Loukides, O’ Reilly, 1st edition 2018

**References:**

1. Noel Cressie, Christopher K. Wikle , “Statistics for Spatio-Temporal Data, Wiley
2. Rachel Schutt and Cathy O’Neil, —Doing Data Science, O’Reilly Media
3. Joel Grus, Data Science from Scratch: First Principles with Python, O’Reilly Media
4. Practical Tableau by Ryan Sleeper, O’Reilly Media, Inc., April 2018
5. Alger Fraley, “The Artificial Intelligence and Generative AI Bible,” 2024 Edition

**Links:**

1. Python Course Link: [https://spoken-tutorial.org/tutorial-search/?search\\_foss=Python+3.4.3&search\\_language=English](https://spoken-tutorial.org/tutorial-search/?search_foss=Python+3.4.3&search_language=English)
2. R programming Course Link: [https://spoken-tutorial.org/tutorial-search/?search\\_foss=R&search\\_language=English](https://spoken-tutorial.org/tutorial-search/?search_foss=R&search_language=English)

Course Code	Course Name	Credits
ET 491	Project B	04

### Lab Objectives:

1. The Project work enables the students to develop the required skills and knowledge gained during the programme by applying them for the analysis of a specific problem or issue, via a substantial piece of work which is carried out over an extended period.
2. It enables the students to demonstrate proficiency in the design of a research project, application of appropriate research methods, collection and analysis of data and presentation of results.
3. To improve the team building, communication and management skills of the students.
4. To introduce students to the vast array of literature available of the various research challenges in the field of Electronics & telecommunication engineering.
5. To create awareness among the students of the characteristics of several domain areas where Electronics & telecommunication engineering can be effectively used.

### Course Outcomes: Upon successful completion of this course, the learner will be able to

1. Discover potential research areas in the field of Electronics & telecommunication engineering.
2. Conduct a survey of several available literatures in the preferred field of study.
3. Compare and contrast the several existing solutions for research challenges.
4. Demonstrate an ability to work in teams and manage the conduct of the research study.
5. Formulate and propose a plan for creating a solution for the research plan identified.
6. To report and present the findings of the study conducted in the preferred domain

### Guidelines:

#### 1. Project Topic:

- To proceed with the project work it is very important to select a right topic. Project can be undertaken on any domain of electronics and telecommunication programmes. Research and development projects on problems of practical and theoretical interest should be encouraged.
- Project work must be carried out by the group of at least two students and maximum four and

must be original.

- Students can certainly take ideas from anywhere, but be sure that they should evolve them in the unique way to suit their project requirements.
- The project work can be undertaken in a research institute or organization/company/any business establishment.
- Students must consult an internal guide along with external guide (if any) in selection of topic.
- Head of department and senior staff in the department will take decisions regarding selection of projects.
- Students has to submit a weekly progress report to the internal guide whereas internal guide has to keep track on the progress of the project and also has to maintain attendance report. This progress report can be used for awarding the term work marks.
- In case of industry projects, visit by an internal guide will be preferred.

## **2. Project Report Format:**

At the end of semester a project report should preferably contain at least following details:-

- Abstract
- Introduction
- Literature Survey
  - a) Survey Existing system
  - b) Limitation of the Existing system or research gap
  - c) Problem Statement and Objective
  - d) Scope
- Proposed System
  - a) Analysis/Framework/ Algorithm
  - b) Details of Hardware & Software
  - c) Design details
  - d) Methodology (your approach to solve the problem)
- Implementation Plan for next semester
- Conclusion
- References

## **3. Term Work:**

Distribution of marks for term work shall be as follows:

- a) Weekly Attendance on Project Day
- b) Contribution in the Project work
- c) Project Report (Spiral Bound)
- d) Term End Presentation (Internal)

The final certification and acceptance of TW ensures the satisfactory performance on the above aspects

#### **4. Oral Exam:**

Oral examination of Project B should be conducted by Internal and External Examiners. Students have to give a presentation and demonstration on the Project-B

Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
IL 470	Digital Business Management and Digital Marketing	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
IL 470	Digital Business Management and Digital Marketing	40	40	40	60	-	-	--	100

#### Course Objectives:

1. To familiarize with digital business concepts.
2. To acquaint oneself with E-commerce.
3. To give insights into E-business and its strategies.
4. To understand digital marketing plans.

**Course Outcomes:** After completion of this course, learner will be able to

1. Identify drivers of digital business.
2. Illustrate various approaches and techniques for E-business and management.
3. Prepare an E-business plan.
4. Develop a digital marketing plan.

Module	Detail Content	Hrs.
1	Introduction to E-Business, Making Functional Areas E-Business Enabled : Value chain and supply chain, inter and intra organizational business processes, ERP	6
2	Making Functional Areas E-Business Enabled : E-marketing, E-Selling, E-Supply Chain Management, E-Procurement.	6
3	Technologies for E-Business: Internet and Web based system, Security and payment systems, Supply chain integration technologies: EDI, RFID, Sensors, IoT, GPS, GIS; Supply chain integration technologies: Web services and cloud.	8

4	Marketing concept, Coordinated marketing, Meta marketing, Holistic marketing dimensions, : Case Analysis, Case Discussion; Marketing Environment.	6
5	Marketing decisions, Customer delivered value, Buyer Behaviour, Input - output map, Case Discussion, Marketing Planning, Price, Distribution, Advertising and Promotion, Case Discussion.	8
6	Marketing mix, Product policy, New products, PLC, Marketing organization, Product Management.	5

#### **Assessment:**

##### **Internal Assessment: 40 marks**

1. Consisting of One Compulsory Class Tests of 40 Marks
2. Continuous evaluation: Class Test/ Assignments / Quiz/ Case studies/ Seminar presentation of 40 Marks

##### **End Semester Examination: 60 marks**

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the syllabus.

#### **Books/References:**

1. Digital Business and E-Commerce Management, 6th Ed, Dave Chaffey, Pearson, August 2014.
2. Management Information Systems: Managing the Digital Firm, Laudon and Laudon, Pearson
3. Marketing Management- Analysis, Planning and Control, Prentice Hall, 14th Edition, 2015
4. NPTEL Course on E-business; [https://onlinecourses.nptel.ac.in/noc24\\_mg16/preview](https://onlinecourses.nptel.ac.in/noc24_mg16/preview); Refer Week 1 and Week 2 for Module 1; Week 3 and Week 4 for Module 2; and Week 5, Week 6 and Week 7 for Module 3.
5. NPTEL Course on Integrated Marketing Management; [https://onlinecourses.nptel.ac.in/noc24\\_mg27/preview](https://onlinecourses.nptel.ac.in/noc24_mg27/preview) Refer Week 1 and Week 2 for Module 4; Week 3 and Week 4 for Module 5; and Week 5, Week 6 and Week 7 for Module 6.

Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
IL 471	Business Analytics	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
IL 471	Business Analytics	40	40	40	60	-	-	--	100

**Course Objectives: The course is aimed to:**

1. To understand the importance of business analytics .
2. To learn how to explore and summarize the data with statistical methods.
3. To study how to represent and process the data.
4. To provide hands-on experience with data visualization techniques and hypothesis testing.
5. Discuss the ethical implications of data privacy and security in business analytics.
6. Encourage critical thinking and problem-solving skills through practical applications.

**Course Outcomes: On successful completion of course learner/student will be able to:**

1. Understand the fundamentals of business analytics.
2. Students will be able to evaluate the quality of data and its impact on analytical outcomes.
3. Apply statistical techniques to analyze data
4. Creation of informative data visualizations and draw meaningful conclusions from testing.
5. Demonstrate ethical decision-making skills when faced with ethical dilemmas in business analytics.
6. Apply analytical techniques learned throughout the course to solve real-world business problems.

Module	Detail Content	Hrs.
1	<b>Introduction to Business Analytics</b> : Definition, scope and importance of business analytics, introduction to business planning, types of plans, levels of planning, overview of analytical tools and techniques.	3
2	<b>Exploring Data:</b> Introduction to different types of data (structured, semi-structured, and unstructured data). Extract, transform and load (ETL) data - ETL fundamentals, data	7

	extraction, data transformation, data mapping and Conversion. descriptive statistics measure of central tendency (mean, median, mode) and dispersion (variance, standard deviation), probability theory, conditional probability and bayes' theorem, random variables and probability distributions: discrete (binomial, poisson) and continuous (normal, exponential) distributions.	
3	<b>Statistical Analysis:</b> Business analytics with excel: importance of excel functionalities, analysis with pivot tables, dashboard creation. Statistical analysis with Python, correlation and regression analysis, time series analysis.	6
4	<b>Data visualization and Hypothesis testing:</b> Principles of effective data visualization, tableau for business Intelligence- tableau workspace and types of charts, data preparation and chart creation, filters and analytics in Tableau, tableau dashboards. Understanding UML diagrams, UMLtools for Business process analysis BPMN (Business Process Model and Notation) in business process Analysis, BPMN diagrams. Null and alternative hypotheses: Formulating hypotheses for testing (anova, chi-square tests, t-tests).	10
5	<b>Ethical considerations in Business Analytics:</b> Privacy, security and confidentiality of data, bias and fairness of data, Types of biases ( sampling bias, selection bias, algorithmic bias) and their impact on analytics, strategies for detecting and mitigating biases in data, transparency and Accountability of data.	5
6	<b>Application and case studies:</b> Real-world case studies in various industries (e.g., Customer segmentation and targeting, Market forecasting, Social media analytics, Fraud detection, Demand forecasting, Customer churn analysis etc.) Application of analytics techniques to solve business problems	8

#### Assessment:

##### Internal Assessment: 40 marks

1. Consisting of One Compulsory Class Tests of 40 Marks
2. Continuous evaluation: Class Test/ Assignments / Quiz/ Case studies/ Seminar presentation of 40 Marks

##### End Semester Examination: 60 marks

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the syllabus.

**Books and References:**

1. Business Analytics: A Practitioner's Guide" by Sandhya Kuruganti and Ram Ramesh
2. "Business Analytics: Data Analysis and Decision Making" by S. Christian Albright and Wayne L. Winston
3. "Business Analytics: The Science of Data-Driven Decision Making" by U Dinesh Kumar
4. Ethical Data and Information Management: Concepts, Tools, and Methods" by Katherine O'Keefe
5. "Princip and Practice of Management", by J.S. Chandan, SK Mandal, Vikas Publishing House.
6. "Business Analytics", by Dr. Mohd Imran Khan, Published By : Lovely Professional University.

Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
IL 472	IPR and Patenting	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
IL 472	IPR and Patenting	40	40	40	60	-	-	--	100

#### Course Objectives:

1. To introduce fundamental aspects of Intellectual property Rights to learner who are going to play a major role in development and management of innovative projects in industries.
2. To get acquaintance with Patent search, patent filing and copyright filing procedure and applications, and can make career as a patent or copyright attorney.
3. To make aware about current trends in IPR and Govt. steps in fostering IPR,

#### Course Outcomes: Learner will be able to...

1. Understand the importance of IPR, types of Patent type and its importance in industries.
2. Able to search, draft and file the patent and copyright application to patent office.
3. Learn the recent trends of IPR and can open the way for the students to catch up Intellectual Property (IP) as a career option:
  - a) R&D IP Counsel in research organization
  - b) Government Jobs – Patent Examiner
  - c) Private Jobs
  - d) Patent agent and Trademark agent.

Module	Detail Content	Hrs.
1	<b>Overview of Intellectual Property:</b> Introduction and the need for intellectual property right (IPR) - Kinds of Intellectual Property Rights: Patent, Copyright, Trade Mark, Design, Geographical Indication, Plant Varieties and Layout Design – Genetic Resources and Traditional Knowledge – Trade Secret - IPR in India : Genesis and development – IPR in abroad - Major International Instruments concerning Intellectual Property Rights: Paris Convention, 1883, the Berne Convention, 1886, the Universal Copyright Convention, 1952, the WIPO Convention, 1967, the Patent Cooperation Treaty, 1970, the TRIPS Agreement, 1994	9
2	<b>Patents:</b> Patents - Elements of Patentability: Novelty, Non-Obviousness (Inventive Steps), Industrial Application - Non - Patentable Subject Matter - Registration Procedure, Rights and Duties of Patentee, Assignment and	7

	license, Restoration of lapsed Patents, Surrender and Revocation of Patents, Infringement, Remedies & Penalties - Patent office and Appellate Board	
3	<b>Copyright:</b> Nature of Copyright - Subject matter of copyright: original literary, dramatic, musical, artistic works; cinematograph films and sound recordings - Registration Procedure, Term of protection, Ownership of copyright, Assignment and license of copyright - Infringement, Remedies & Penalties – Related Rights - Distinction between related rights and copyrights	6
4	<b>Trademark:</b> Concept of Trademarks - Different kinds of marks (brand names, logos, signatures, symbols, well known marks, certification marks and service marks) - Non-Registrable Trademarks - Registration of Trademarks - Rights of holder and assignment and licensing of marks - Infringement, Remedies & Penalties - Trademark's registry and appellate board.	6
5	<b>Patent Acts:</b> Section 21 of the Indian Patent Act, 1970 (and corresponding Rules and Forms) with specific focus on Definitions, Criteria of Patentability, Non-Patentable Subject Matters, Types of Applications, and Powers of Controllers. Section 25 - Section 66 of the Indian Patent Act, 1970 with specific focus on the Oppositions, Anticipation, Provisions of Secrecy, Revocations, Patent of Addition, and Restoration of Patents. Section 67 - Section 115 of the Indian Patent Act, 1970 with specific focus on Patent Assignments, Compulsory Licensing, Power of Central Government, and Infringement Proceedings. Section 116 - Section 162 of the Indian Patent Act, 1970 with specific focus on Convention/PCT Applications, Functions of Appellate Board and other Provisions. Amendment Rules 2016 with emphasis on important revisions to examination and Hearing procedures; provisions for start-ups and fees.	9
6	<b>Indian IP Policy:</b> India's New National IP Policy, 2016 – Govt. of India step towards promoting IPR – Govt. Schemes in IPR – Career Opportunities in IP – IPR.	3

#### Assessment:

##### Internal Assessment: 40 marks

3. Consisting of One Compulsory Class Tests of 40 Marks
4. Continuous evaluation: Class Test/ Assignments / Quiz/ Case studies/ Seminar presentation of 40 Marks

##### End Semester Examination: 60 marks

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the syllabus.

#### Books/References:

1. Nithyananda, K V. (2019). Intellectual Property Rights: Protection and Management. India, IN: Cengage Learning India Private Limited.
2. Neeraj, P., & Khusdeep, D. (2014). Intellectual Property Rights. India, IN: PHI learning Private Limited.

3. Ahuja, V K. (2017). Law relating to Intellectual Property Rights. India, IN: Lexis Nexis.
4. World Intellectual Property Organisation. (2004). WIPO Intellectual property Handbook. Retrieved from [https://www.wipo.int/edocs/pubdocs/en/intproperty/489/wipo\\_pub\\_489.pdf](https://www.wipo.int/edocs/pubdocs/en/intproperty/489/wipo_pub_489.pdf)

Admission Year 2022-2023

Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
IL 473	Medical Image Processing	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
IL 473	Medical Image Processing	40	40	40	60	-	-	--	100

#### Course Objectives:

1. To introduce the learners to the basic theory of digital image processing.
2. To expose learners to various available techniques and possibilities of this field.
3. To prepare learners to formulate solutions to general image processing problems.

#### Course Outcomes: Learner will be able to

1. Record, extract and analyze key information about teeth, muscles, bones etc
2. Acquire the fundamental concepts of a digital image processing
3. Analyze images in the spatial and frequency domain.

Module	Detail Content	Hrs.
1	<b>Medical Imaging Systems:</b> Properties, advantages and disadvantages of X-rays based imaging systems, Magnetic Resonance Imaging (MRI) imaging, Gamma-rays based imaging systems, Positron emission tomography (PET), Single-photon emission computerized tomography (SPECT) scan, Computed Tomography (CT) scan, Ultrasound (sonography), Endoscopy, and Thermography based imaging systems. Difference between different medical imaging systems. Nature of Biomedical images, Objectives of biomedical image analysis, Difficulties in biomedical image acquisition and analysis.	7
2	<b>Medical Imaging Toolkits:</b> ImageJ (and/or FIJI), ITK-Snap, SimpleITK, MITK, FreeSurfer, SLICER, OsiriX. Image Formats: dicom (.dcm), Nifti (.nii), Minc (.mnc), Analyze (img/hdr), Raw (.raw), MHD (.mhd) and MHA (.mha)	5
3	<b>Medical Image Detection and Recognition:</b> Medical image parsing, Deep Learning for Medical Image Recognition, Automatic Interpretation of Carotid Intima-Media Using Convolutional Neural Networks, Deep Cascaded Networks for Sparsely Distributed Object Detection, Deep Voting and Structured Regression for Microscopy Image Analysis.	6

4	<b>Medical Image Registration:</b> Intensity-based methods, Cost functions - correlation, least squares, mutual information, robust estimators. Optimization techniques - fixed-point iteration, gradient descent, Nelder-Mead simplex method. MRI motion compensation, Convolutional Neural Network for Robust and Real-Time 2-D Registration.	6
5	<b>Medical Image Segmentation Networks:</b> Comparative study and analysis of U-Net family of segmentation: U-Net, V-Net, 3D U-Net, H-DenseUNet, GP-Unet, UNet++, MDU-Net, DUNet, RA-UNet, nnU-Net, SUNet, IVD-Net, LADDERNET, Attention U-Net, R2U-Net, MultiResUNet, U-NetPlus, CE-Net, CIA-Net, U2-Net, ScleraSegNet, AHCNet, MFP-Unet, ResUNet-a, RAUNet, 3D U2-Net, SegNAS3D, U <sup>2</sup> -Net, UNET 3+.	9
6	<b>Deep Learning for Healthcare:</b> Deep learning for different healthcare applications: Diabetic Retinopathy, Knee Osteoarthritis, Histological and Microscopic Elements Detection, Gastrointestinal Diseases Detection, Cardiac Imaging. Lesion detection: Brain tumor detection, prostate lesion detection, Lung nodule detection.	6

#### Assessment:

##### Internal Assessment: 40 marks

1. Consisting of One Compulsory Class Tests of 40 Marks
2. Continuous evaluation: Class Test/ Assignments / Quiz/ Case studies/ Seminar presentation of 40 Marks

##### End Semester Examination: 60 marks

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the syllabus.

#### Books/References:

1. W. Birkfellner, Applied Medical Image Processing: A Basic Course, CRC Press , Second Edition, 2014
2. I. Bankman, Handbook of Medical Image Processing and Analysis, Academic Press , Second Edition, 2008
3. Rangaraj M. Rangayyan, “Biomedical Image Analysis”, CRC Press, 2000.
4. Zhou et al “Deep learning for Medical image analysis” Elsevier 2018.
5. R. C. Gonzalez, Digital Image Processing, Pearson Education India , Third Edition, 2013
6. S. Jayaraman, T. Veerakumar, S. Esakkirajan, Digital Image Processing, McGraw Hill Education , 2017
7. A K Jain, “Fundamental of Digital Image Processing”, Prentice Hall, 2002.

Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
IL 474	Biomechanics	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
IL 474	Biomechanics	40	40	40	60	-	-	--	100

#### Course Objectives:

1. Introduce basic biomechanical terminologies and principles relevant to the human body.
2. Analyze the kinematics and forces acting on muscles and joints using free-body diagrams.
3. Perform biomechanical assessments of the upper and lower limb joints to understand movement mechanics.
4. Examine the mechanical properties of hard and soft tissues and their implications for human movement.

#### Course Outcome: Students will be able to

1. Accurately define key biomechanical terms.
2. Effectively create and interpret free-body diagrams for joint analysis.
3. Analyze joint mechanics in the upper limb and lower limb, identifying critical forces.
4. Apply gait analysis principles to differentiate between healthy and pathological movement patterns.
5. Explain the mechanical properties of hard tissues and their relevance to biomechanics.
6. Examine biofluid mechanics and blood flow dynamics in the cardiovascular system.

Module	Detail Content	Hrs.
1	<b>Introduction:</b> Introductory Mechanics – Statics and Dynamics – Basic Principles. The human body as a biomechanical system – basic terminologies	6
2	<b>Joint Mechanics:</b> Kinematics of muscles and joints - free-body diagrams and equilibrium, forces and stresses in joints Biomechanical analysis of joints of upper limb - Shoulder, Elbow, wrist, hand and fingers	7
3	<b>Analysis of Joints:</b> Upper limb as a mechanical system – analysis of reaching as movement	7

	of a multi-link serial chain – forward kinematics, analysis of fingertip forces as a parallel manipulator Biomechanical analysis of joints – Spine, Hip, Knee, Ankle.	
<b>4</b>	<b>Gait Analysis:</b> Introduction to Postural stability and Gait analysis. Gait analysis in health and disease - basics.	<b>6</b>
<b>5</b>	<b>Tissue Mechanics:</b> Mechanics of Hard Tissues - Definition of Stress and Strain, Deformation Mechanics, structure and mechanical properties of bone - cortical and cancellous bones, Wolff's law of bone remodeling; Soft Tissues - Structure, functions, material properties – tendon function, elasticity in a tendon, models of non-linear elasticity in a tendon – physiological and non-physiological regimes, Davis' law of soft tissue remodeling.	<b>7</b>
<b>6</b>	<b>Biofluid mechanics:</b> Visco-elastic properties of soft tissues, Models of visco-elasticity: Maxwell & Voight models. Basic Biofluid mechanics - Flow properties of blood in the intact human cardiovascular system.	<b>6</b>

#### Assessment:

##### Internal Assessment: 40 marks

3. Consisting of One Compulsory Class Tests of 40 Marks
4. Continuous evaluation: Class Test/ Assignments / Quiz/ Case studies/ Seminar presentation of 40 Marks

##### End Semester Examination: 60 marks

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the syllabus.

#### Books/References:

1. David A. Winter, Biomechanics and Motor Control of Human Movement .
2. Margareta Nordin and Victor H. Frankel, Basic Biomechanics of the Musculoskeletal System.
3. Francisco Valero-Cuevas, Fundamentals of Neuromechanics.
4. Susan Hall, Basic Biomechanics.
5. Irving Hermann, Physics of Human Body.

Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
IL 475	Product Design	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
IL 475	Product Design	40	40	40	60	-	-	--	100

#### Course Objectives:

1. To familiarize with fundamental product design concepts
2. To acquaint with product design methodologies
3. To understand product design needs and issues in industry

#### Course Outcomes: Learner will be able to

1. Demonstrate product design and development process.
2. Analyze a product in perspective of aesthetic and ergonomic considerations.
3. Illustrate considerations of Design for Manufacturing and Assembly in product development.
4. Apply appropriate tools and techniques in the design of solutions that are usable and functional for various applications.
5. Design the products as per the customer/industry requirements
6. Apply principles of economy and demonstrate legal and social issues pertaining to product development.

Module	Detail Content	Hrs.
1	Product definition, specification, Phases of product development: conceptual, embodiment and detailed design, product and technology development cycle, Concept generation and evaluation methods, product architecture, Product life cycle Management with case studies, Product analysis. Creativity and Idea generation technique, importance of Quality Dimensions: Performance, Features, aesthetics, Ergonomics, Reliability, Sustainability, Serviceability, Brand value, Value Vs cost, Importance of shape, color, feature & Resemblance.	6

2	Design Factors: Ergonomics, Aesthetics, Anthropometry, Comforts, Economic factors Axiomatic design principles and case studies. Design Thinking, Design by Innovation and collaboration Material and Process selection Methods, Expert systems. Computer Database Approach, performance indices decision matrix, AHP and fuzzy approach, Introduction to material and process selection software.	6
3	Design for Manufacturing (DFM) and Design for Assembly (DFA) Designs for Maintainability and Reliability and some methods for reliability assessment, Designs for Environment, Design for Robustness: Taguchi Designs & Design of Experiments (DOE).	8
4	Product Design Tools and Techniques: Value Engineering / Value Analysis: definition, methodology- FAST, Benchmarking, Supplier involvement robust design, QFD, Design & process FMEA. Reverse Engineering, Concurrent engineering & Sequential engineering, Case studies.	8
5	Product Development Cycle and Importance of Prototyping. Types of prototypes. Principal and advantages & Different Type of Generative Manufacturing process, Viz. Stereo lithography, FDM, SLS etc. Factors Concerning to RP: Consideration for Adoptions, Advantages, Accuracy and Economic Consideration. Introduction to Assembly Modeling, Top-Down and Bottom-Up Approaches of AM, Mating Conditions, representation Schemes. Generation of Assembly Sequences. Case studies	6
6	Economics of Product Development: Product costing, Principals of Economy, Engineering Economy and Design Process, Economic Analysis, Inflation, Time Value of Money, Numerical on Internal Rate of Return and Net Present Value (NPV) method. Legal and social issues, Patents and IP acts.	6

#### Assessment:

##### Internal Assessment: 40 marks

1. Consisting of One Compulsory Class Tests of 40 Marks
2. Continuous evaluation: Class Test/ Assignments / Quiz/ Case studies/ Seminar presentation of 40 Marks

##### End Semester Examination: 60 marks

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the syllabus.

#### Reference Books:

1. Product Design and Manufacturing by A.K.Chitale, R.C.Gupta, PHI.
2. Product Design and Development by Ulrich Karl T. and Eppinger Steven D, McGraw Hill.
3. Engineering Design by Dieter George E., McGraw Hill.

4. Handbook of Product Design for Manufacturing by Bralla, James G, McGraw Hill.
5. Product Design by Kevin Otto & Kristin Wood

Admission Year 2022-2023

Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
IL 476	Technologies for Rural Development	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
IL 376	Technologies for Rural Development	40	40	40	60	-	-	--	100

#### Course Objectives:

1. To understand the concept of rural technology
2. To understand the characteristics of rural resources and its importance in Rural Development.
3. To understand various technologies required for Rural Development
4. Rural planning and implementation of rural development projects
5. To generate awareness regarding government policies (monitoring and documentation).

#### Course Outcomes: Learner will be able to

1. Understand various natural resources and their importance in rural development.
2. Get exposure to various challenges and problems with regard to availability and use of natural resources.
3. Develop and implement various technologies for rural development
4. Explore various schemes for rural development

Module	Detail Content	Hrs.
1	<b>Rural Resources-</b> Understanding the Characteristics and nature of Rural Resources Importance of different resources in Rural Development. Natural resource management(NRM)	03
2	<b>Concept of Information and Communication Technologies (ICT's) in Rural Development-</b> Evolution of ICT's, Communication Functions of ICT's, Nature and Scope of ICT's, Information Haves and Information Have Nots in the Rural Areas, Strengths and Weaknesses of ICT's in Rural India, Application of ICT's for Rural Development in India, Satellite Communication support for Rural Development, Telecommunication	06

	support for Rural Development, Computer Communication support for Rural Development	
3	<b>Management Information System for Rural Development in India</b> Basic concepts Role of MIS in the management of agricultural extension programs Design of a MIS in an agricultural extension organization Need for automation ,Organization of a database Networking and , End-user computing Illustrative computer-based MIS , Rural Energy system	08
4	<b>The Role of Rural Technology</b> – Global approach in Innovative Rural technology Innovative technologies in Production and Postharvest management, Innovation in productivity and Sustainable management(Bio fertilizer) Innovation Commercial Production Technologies Technology for Rural Women, difficulties in adoption of rural technology.	06
5	<b>Globalisation of Rural Economy-</b> Globalisation and aims and objectives; Impact of Globalisation on rural economy, Design and Innovation in Integrated Rural Health Management, SEZ's and Agriculture. Agricultural value chain	04
6	<b>Government Schemes and initiatives-</b> Various government schemes, participation of various Stake holders for development and Protection of Rural resources	03

#### Assessment:

##### Internal Assessment: 40 marks

1. Consisting of One Compulsory Class Tests of 40 Marks
2. Continuous evaluation: Class Test/ Assignments / Quiz/ Case studies/ Seminar presentation of 40 Marks

##### End Semester Examination: 60 marks

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the syllabus.

#### Books/References:

1. Rural Resource Management: A Geographical Perspective by Paul Cloke (Author), C. Park
2. Rural Development: Principles, Policies and Management, Katar Singh, Sage Publications India Pvt. Ltd., 2009
3. Mosse, D., & Cooke, B. (2001). People's knowledge, participation and patronage: Operations and Representations in Rural Development.
4. ICTs: Digital Opportunities in Agricultural Extension, Dipaj De Basavaprabhu Jirli Shaik N. Meer

5. S.S. Singh., Principles and Practices of Agronomy. 1985. Kalyani Publishers, Ludhiana
6. Indian Economy by Datt, Rudra & Sundharam, New Delhi: S. Chand, 2008.
7. W.T.O and Indian Economy by Deogirikar, A. B. Jaipur: Shri Niwas Publications, 2004
8. S.S. Singh., Principles and Practices of Agronomy. 1985. Kalyani Publishers, Ludhiana
9. Indian Economy by Datt, Rudra & Sundharam, New Delhi: S. Chand, 2008.
10. W.T.O and Indian Economy by Deogirikar, A. B. Jaipur: Shri Niwas Publications, 2004
11. Maheshwari, S. (1985). Rural development in India: A Public Policy Approach. SAGE Publications Pvt. Limited.
12. Indian Economy by Datt, Rudra & Sundharam, New Delhi: S. Chand, 2008.
13. Government of India, "Various Five-Year Plans (1st to 12th)" Planning Commission, New Delhi

Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
IL 477	Economics	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
IL 477	Economics	40	40	40	60	-	-	--	100

#### Course Objectives:

1. Provide a good grounding in the basic concepts of Micro and Macroeconomics.
2. Familiarize learners with concept of demand, supply, price, income and equilibrium.
3. Teach students to represent Indifference curve in regular as well as in exceptional cases with respect to consumer behaviour, consumer preferences and Risk Aversion.
4. To inculcate the skills required to understand the concept of Production function with single and two variable inputs.
5. To create an awareness of the different market structures and its impact on the price and output of a product.
6. To prepare the learners in understanding the Keynesian System of Money, Interest and Income and its impact in society with respect to Inflation.

#### Course Outcomes: Learner will be able to

1. Acquire conceptual and theoretical knowledge of Micro and Macroeconomics and learn to think critically about issues and topics of the subject.
2. Demonstrate the understanding of the concepts of demand, supply, price, income and equilibrium and relate it to the existing scenario in the society.
3. Perform successfully in representing the Indifference curve in relation to the prevalent consumer behaviour and consumer preferences.
4. Illustrate the skills required for maximising output and minimising cost for effective production.
5. Determine the importance of the existence of different market structures and its impact in society.
6. Develop an understanding of the Keynesian System of Money, Interest and Income and formulate anti- inflationary policies.

Module	Detail Content	Hrs.
1	Introduction to Micro and Macro Economics	5
2	Demand & Supply: Concept of demand & supply functions, Price, Income & Cross elasticities of demand, Elasticity of Supply, Market demand functions, Concept of equilibrium, Impact of changes in demand & supply on equilibrium	7

3	Theory of Consumer Behaviour: Concept of cardinal and ordinal utility, consumer's equilibrium, Consumer's preferences, Risk Aversion and Indifference Curve Analysis, & its properties, Shapes of Indifference Curves in exceptional cases	7
4	The Theory of Production: Concept of Production function, Production with a single variable input, Production with two variable inputs, Optimal input combination, Constrained output maximization, Cost minimization, Elasticity of substitution	6
5	Theory of Cost: Different concept of cost, Short-run and Long-run cost analysis, modern concept. Market Structures a. Perfect Competition Short-run and long-run equilibrium of the firm and Industry, Stability of equilibrium, Concept of imperfect competition; short run and long run price and output decisions of a monopoly firm; concept of a supply curve under monopoly; comparison of perfect competition and monopoly,	4
6	The Keynesian System: Money, Interest and Income Money in the Keynesian theory, Interest Rate Determination (Liquidity Preference Theory), Money Market, Bond market and Commodity Market, Monetary policies and fiscal policies, Inflation and Unemployment Inflation, Role and Effects of inflation, Anti- inflationary policies	7

#### Assessment:

##### Internal Assessment: 40 marks

1. Consisting of One Compulsory Class Tests of 40 Marks
2. Continuous evaluation: Class Test/ Assignments / Quiz/ Case studies/ Seminar presentation of 40 Marks

##### End Semester Examination: 60 marks

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the syllabus.

#### Reference Books:

1. Dr. Samwel Nyagucha Ores. (2019). Micro and Macro Economics: Understanding the Basics of Economics. New Generation Publishing.
2. Daron Acemoglu and James A. Robinson. (2013). Why Nations Fail: The Origins of Power, Prosperity and Poverty. Profile Books

Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
IL 478	Journalism, Media and Communication studies	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
IL 478	Journalism, Media and Communication studies	40	40	40	60	-	-	--	100

#### Course Objectives:

1. Provide a good grounding in the basic concepts of Journalism, Mass communication and Media.
2. Familiarize learners with reporting and editing practices.
3. Teach students to write editorials, feature articles, interviews, reviews, criticism etc.
4. To inculcate the skills required for writing in online newspapers, blogs, email and cell phone.
5. To prepare the learners for understanding the importance of Press laws and Ethics.
6. To train learners in advertising techniques and Public Relation Communication

#### Course Outcomes: Learner will be able to

1. Acquire conceptual and theoretical knowledge of Journalism, Mass Communication and Media Studies and learn to think critically about issues and topics of the subject.
2. Demonstrate the understanding of reporting and editing from Newspaper and the Organization.
3. Perform successfully in writing effective editorials, featured articles reviews etc.
4. Illustrate the skills required for writing in online newspapers, blogs, emails etc.
5. Determine the importance of Press Laws and Ethics.
6. Develop an understanding of the techniques required for advertising and Public Relation Communication.

Module	Detail Content	Hrs.
1	Introduction to Journalism, Communication, Media and Cultural Studies-Basics of Mass communication, Pioneers of Indian Journalism, Introduction to newspapers, magazines and other publications. Introduction to broadcast journalism with special reference to television	5
2	Reporting and Editing Practices-Reporting different news, stories from Newspaper, and Organization. Principles of editing, rewriting, and translation	7

3	Writing for Print- Newspaper Content Writing Opinion pieces, editorials, feature articles, interviews, profiles, reviews, criticism etc.	7
4	Writing for Media- Introduction to New Media Writing for Online newspapers Blogs Cell phone Communication E-mail	6
5	Press Laws and Ethics- Origin and definition of Law, Law and Morality, Types of Law – Civil and Criminal, Press Legislations, Freedom of the Press Defamation Contempt of Court	4
6	Public Relations and Advertising- Introduction to Public Relations Stages of PR Communication with Public Need and Meaning of Advertising, Advertising strategies and Sales Promotion	7

#### Assessment:

##### Internal Assessment: 40 marks

1. Consisting of One Compulsory Class Tests of 40 Marks
2. Continuous evaluation: Class Test/ Assignments / Quiz/ Case studies/ Seminar presentation of 40 Marks

##### End Semester Examination: 60 marks

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the syllabus.

#### Books/References:

1. Rangaswamy, Parthasarathi, (1985). Journalism in India, Sterling Publication, New Delhi.
2. Jeffrey, Robin, (2009). India's Newspaper Evolution, Oxford University Press, Delhi.
3. Singh, Devvrat. (2012). Indian Television: Content, Issues and Challenges, HarAnand Publications Delhi.
4. Daryl L. Frazell, George Tuck. (1996). Principles of Editing: A Comprehensive Guide for Students and Journalists Principles of Editing: A Comprehensive Guide for Students and Journalists. McGraw-Hill
5. Barry Newman. (2015). News to Me: Finding and Writing Colorful Feature Stories. Paperback
6. The Associated Press. (2017). The Associated Press Stylebook: and Briefing on Media Law. Revised, Updated Edition. Paperback.
7. Kristina Halvorson. (2012) Content Strategy for the Web, 2nd Edition. New Riders

Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
IL 479	Operation Research for Management	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
IL 479	Operation Research for Management	40	40	40	60	-	-	--	100

**Course Objectives:** The course is aimed

1. To acquaint the students with basics of Operation Research.
2. To learn the different Linear Programming methods.
3. To make the students aware of the topic “sensitivity Analysis”
4. To learn the different methods of solving Transportation & Assignment Problems.
5. To Understand sequencing Models & related Problems.
6. To explore the different methods used in Game Theory.

**Course Outcomes:** On successful completion of course learner/student will be able to apply:

1. The basic concepts of Operation Research to solve optimization problems..
2. The different Linear Programming methods to solve Problems.
3. The understanding of Linear Programming to sensitivity analysis.
4. The different methods to solve Transportation & assignment Problems.
5. The concept of sequencing models to related problems.
6. The understanding of Game Theory and solve related Problems.

**Detailed Theory Syllabus:**

Module	Detailed Contents	Hrs.
1	<b>Introduction to Operation Research:</b> Canonical & standard form of a Linear Programming Problem, Simplex method , multiple solutions of L.P.P, Infeasible solution & unbounded solution	6
2	<b>Linear Programming Model:</b> Artificial variables , Big M-penalty method , Duality in Linear Programing, dual simplex method, revised simplex method.	8

3	<b>Sensitivity Analysis:</b> Changes in the right handside of the constraint equations ' $b_i$ ' changes in the cost coefficients ' $c_j$ ' changes in the coefficients of the constraints ' $a_{ij}$ '.	6
4	<b>Transportation &amp; Assignment Problems:</b> NorthWest Corner method , Vogel's approximation method, Hungarian method, maximization problem, unbalanced transportation problem	8
5	<b>Sequencing models &amp; related Problems:</b> Processing n-jobs on two machines , processing n-jobs on m-machines	6
6	<b>Game Theory :</b> Two – person zero sum game with & without saddle points, solution of mixed strategy games , Matrix reduction by dominance.	5

#### Assessment:

##### Internal Assessment: 40 marks

1. Consisting of One Compulsory Class Tests of 40 Marks
2. Continuous evaluation: Class Test/ Assignments / Quiz/ Case studies/ Seminar presentation of 40 Marks

##### End Semester Examination: 60 marks

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the syllabus.

#### Books and References:

1. Operations Research : Prem Kumar Gupta , D.S.Hira ; S. Chand & company Ltd.
2. Operations Research ; An Introduction : Hamdy .A.Taha ; Prentice Hall of India
3. Introduction to Operation Research : Frederick.S.Hillier,Gerald.J.Lieberman McGraw Hill Education ( India) Private Ltd.
4. Operation Research : R. Paneerselvan, PHI Learning Private Ltd.

Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
IL 480	Weather and Climate Informatics	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
IL 480	Weather and Climate Informatics	40	40	40	60	-	-	--	100

#### Course Objectives:

1. To promote the safety, health, and welfare of people and the environment through engineering professionals.
2. To encourage students to be productive and contributing members of the environmental profession as practitioners, entrepreneurs, researchers, or teachers.
3. To develop environmental awareness among students that meet specified engineering needs with consideration of public health, safety, and welfare, as well as global, environmental, and legal factors.

**Course Outcomes:** On successful completion of the course learner/student will be able to:

1. Present the international climate change legal and policy framework and explain key issues under negotiation.
2. Describe the expected consequences of climate change and the role of adaptation.
3. Provide a rationale for climate change mitigation and propose actions in key sectors.
4. Identify main streams of climate change finance.
5. Outline basic elements of planning processes to deliver climate change action.
6. Analyse principal challenges and opportunities for climate change action.

Module	Detailed Contents	Hrs
1	<b>Introduction to Climate Change Science:</b> An overview of key concepts such as climate, weather and the greenhouse gas effect. Human contribution to climate change and provides an overview of important greenhouse gases and their main sources. The main observed changes in the climate since the industrial revolution. Future trends and impacts of climate change on surface temperature, ocean pH, and sea-level.	5

2	<b>Introduction to the International Legal and Policy Framework to address Climate Change:</b> An overview of the international legal and policy framework to address climate change. Brief history of international climate change negotiations and introduces the United Nations Framework Convention on Climate Change (UNFCCC). Key provisions of the UNFCCC, its organisational structure, and different Party groups under the Convention. The Kyoto Protocol and its associated bodies.	6
3	<b>ICT Trends and their Implications for Tackling Climate Change:</b> Information Needs in Adaptation and Mitigation, Communication on Climate Change, Scope and Definition of ICTs, ICT Trends and their Implications for Tackling Climate Change, e-Waste and Recycling, Green Computing	6
4	<b>Weather and Climate Informatics:</b> <b>Climate Change and Climate Modelling:</b> Global environmental issues in climate change due to human activities or natural climate variations. Understanding and Using Climate Data, The Climate data analysis, Seasonal Climate Forecasting, Climate Extremes, Uncertainty, and Impacts	5
5	<b>Data Challenges and Opportunities in Climate Informatics:</b> Issues with Cross-Class Comparisons, Climate System Complexity. Challenge: Cloud-Computing-Based Reproducible Climate Data Analysis	4
6	LAB WORK or Case Study Software Lab: Introduction to basic data analysis tools. Survey of numerical methods employed in atmospheric and related sciences: theory, application, and programming. OR Report on a Case study	4

**Assessment:**

**Internal Assessment: 40 marks**

1. Consisting of One Compulsory Class Tests of 40 Marks
2. Continuous evaluation: Class Test/ Assignments / Quiz/ Case studies/ Seminar presentation of 40 Marks

**End Semester Examination: 60 marks**

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the syllabus.

**Books/References:**

1. Environmental Management: Principles and Practice, C J Barrow, Routledge Publishers London, 1999
2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G.Oakwell, Edward Elgar Publishing
3. Environmental Management, V Ramachandra and Vijay Kulkarni, TERI Press
4. Indian Standard Environmental Management Systems — Requirements With Guidance For Use, Bureau of Indian Standards, February 2005
5. Environmental Management: An Indian Perspective, S N Chary and Vinod Vyasulu, Macmillan India, 2000

Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
IL 481	Maintenance of Mechanical Equipment	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
IL 481	Maintenance of Mechanical Equipment	40	40	40	60	-	-	--	100

#### Lab Objectives:

1. To understand use of different types of hand tools, importance of right tool for right job.
2. To understand importance of preventive and breakdown maintenance, industrial safety
3. Understand assembly of lathe cross slide, spindle.
4. Understand Plumbing tools and pipe fitting minor domestic jobs.
5. To make aware about Importance of work skill in maintenance, also about related electrical, chemical activities
6. Encourage & create start up in maintenance and reconditioning field

#### Outcomes: Learner will be able to...

1. Know the use of various tools and equipment used in maintenance
2. Know, how to apply particular strategy, scheduling, planning of maintenance
3. Develop student for a start-up activity.

Module	Detailed Contents	Hrs
1	Need and role of maintenance in industry. Preventive and breakdown/shut down maintenance. Planning maintenance schedule, records, Spare parts, procuring & inventory control. In house spares making. (indigenous and import substitutes) Need of plant & process knowledge	4
2	Tools and equipment used in mechanical maintenance, (Torque wrench, Jacks and pullers spanners.... etc) their classification. Importance Selection of right tool for right job. Types of fits. Ball Bearings' classification Study of Related electrical equipments, starter switch,, motor, contactors ...etc	6
3	Lathe machine functioning demonstration with, making a simple job.	8

4	Dismantling and assembly of cross slide, tool post. Lathe spindle study	12
5	Domestic plumbing and other Various domestic, “Do it yourself type jobs. Eg. : Window and split air conditioner periodic cleaning, ceiling fan fitting, mixer repairing, curtain rod fitting on wall..etc.	6
6	Industrial safety. Rules and instructions for mechanical safety in industry and safety precautions related to domestic equipment. Risk assessment.	4

**Assessment:**

Internal Assessment: 40 marks

End Semester Examination: 60 marks

**Books/References:**

1. Maintenance Engineering – 1 December 2010 , Sushil Kumar Srivastava
2. Handbook for Mechanical Maintenance Engineers – 30 May 2020 , Gyani Mahato
3. Maintenance Engineering Dr. G.K. Vijayaraghavan, Dr. L. Govindarajan

Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
IL 482	Physical Education	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
IL 482	Physical Education	40	40	40	60	-	-	--	100

#### Course Objectives:

1. To understand the components of Physical Fitness.
2. To understand the modern development and social aspects of physical education
3. To understand general troop games, recreational games and the importance of playing to achieve health & wellness.
4. To acquaint students with principles of nutrition and the application of human energy.
5. To understand the role of food in physical performance.
6. To understand the need for wellness & weight management.
7. To understand common sports injuries, first aid & their treatment.
8. To understand the application of Yoga in physical education & sports.
9. To enable the student to understand the basic structure & function of the human body and the effect of exercise on the body as a whole.

#### Course Outcomes: Learner will be able to

1. Maintain a health-enhancing level of fitness throughout the program as well as be able to collect and analyse personal fitness data.
2. Gain knowledge regarding the application of yoga to Physical Education and Sports
3. Understand the anatomy and Physiology of Asanas and Pranayamas.
4. Acquire the knowledge regarding the effect of exercise on the body as a whole
5. Develop an understanding of the concept of personality, factors affecting personality development
6. To understand proportional body weights and their management
7. To understand nutrition and balance diet

Module	Detail Content	Hrs.
1	<b>Physical Fitness</b> 1.1 Concept, definition and meaning of Physical fitness, activity and exercise 1.2 Component of Physical fitness, Benefit of Physical fitness & exercise. 1.3 Principles of physical fitness 1.4 Definition and concept of wellness and factors affecting Physical fitness & wellness	8

	1.5 Concept and importance of physical conditioning, warming up and cooling down of all age groups	
2	<b>Nutrition and Dietary Requirement</b> 2.1 Nutrition components and balanced diet 2.2 Meaning and definition of doping and ergogenic aids 2.3 Prevention and first-aid of common injuries during Physical training 2.4 Need of Energy, Carbohydrate and Protein 2.5 Concept training nutrition and competition nutrition	6
3	<b>Wellness, Weight management and Holistic health</b> 3.1 Meaning, concept and components of Wellness 3.2 Manipulation of energy balance to induce weight loss and weight gain 3.3 Methods of weight management 3.4 Concept, types and cause of obesity and its management. 3.5 Waist hip ratio, larger heart, BMI, calculation of Training Heart Rate	6
4	<b>Human body system, function and effect of exercise</b> 4.1 Meaning and Importance of the study of Human anatomy in physical education & sports 4.2 Classification and functions of bones and joints 4.3 Movements of various joints 4.4 Structural classification of muscle, types of muscle and effect of exercise on the musculoskeletal system. 4.5 Structure and Effect of exercise on the cardiorespiratory system 4.6 Digestion and effect of exercise on the digestive system 4.7 Nervous system and effect of exercise on the nervous system.	6
5	<b>Yoga and meditation</b> 5.1 Concept of Yoga and misconception about Yoga 5.2 Comparison of Physical Education exercise and Yogic exercise. 5.3 Meaning, Types and principles of Meditation 5.4 Principles governing various exercises in Yoga(Asana, Pranayam, Bandha, Mudra, Kriya) 5.5 Yoga for stress management and emotional stability 5.6 Application of Yoga in sports & physical education and effect of Yogic exercise on different systems of the human body.	8
6	<b>General &amp; recreational troop games and its method of skill training</b> 6.1 The game soccer and its rules and regulation 6.2 The game Volleyball, Basketball and its rules and regulations 6.3 The Indoor games and their rules and regulations 6.4 Method of sports skill developing training 6.5 Recreational games and their importance in day to day life	6

#### Assessment:

##### 1. Term Papers (40 Marks):

Two theory papers will be conducted for 40 marks each with average marks of both papers as the final score. One hour theory paper as per the pattern of the semester-end examination will be conducted.

## **2. Projects/Assignments(30 Marks):**

Project on Nutrition (10 Marks): The learner will be given one project on the calculation of Basal metabolic rate. He /she will submit the report of the same in a prescribed format based on which the learner will be evaluated for 10 marks by the concerned teacher/s

Projects/Assignment on Yoga education (10 Marks): The learner will be given an assignment on yoga education such as gathering/compiling the information about the various aspects of asanas and asking to prepare and submit the report of the same based on which the concerned subject teacher will give marks out of 10.

Assignments on Sports Injuries (10 Marks): The learner will be given two assignments on the specific sports injuries and their remedial aspects based on the report submitted in the prescribed format by him/her as well as observations, the concerned teacher/s will give marks out of 10.

## **3. Physical Activities(25 Marks):**

- a. To perform 8 Asanas in a group (10)
- b. To perform one Pranayama and one Kriyas(5)
- c. To perform any five exercises of Motor Fitness. (5)
- d. To perform any five exercises of HRPF(5)

**4. Trekking/ Hiking (05 Marks)-** The learner should be provided experience of participating in the organization and the actual conduct of the co-curricular activities viz. Hiking/Trekking and the assessment of 05 marks should be done based on learners actual participation and involvement in the same.

## **Reference Books:**

1. Padmakshan Padmanabhan 'Handbook of Health & Fitness', Indus Source; First edition, Indus Source Books, Wadala Mumbai. 2014.
2. Adams, William.C. 'Foundation of Physical Education Exercises and Sports Sciences', Lea and Febigor, Philadelphia, 1991.
3. Dr. Kamlesh M.L. 'Principles and History of Physical Education and Sports', Friends Publication (India) New Delhi, 2004
4. Bates M. 'Health Fitness Management (2nd Ed.) USA : Human Kinetics.2008
5. Fink, H.H., Burgoon,L.A., & Mikesky. Practical Applications in Sports Nutrition. Canada : Jones and Bartlett Publishers. 2006.
6. Worthington, Vivian. History of Yoga. London : Routledge and Kegan Paul Ltd. 1982.
7. Rajan, M. Yoga Stretching and Relaxation for Sportsman. Delhi : Allied publishers. 1985.
8. Crouch James E. – Essential Human Anatomy A Text – Lea & Febriger , Philladelphia
9. Murgesh N. – Anatomy, Physiology and Health Education, Sathya, Chinnalapatti, 1990
10. Giam, C.K. Sport Medicine Exercise and Fitness. Singapore : P.G. Medical Book. 1994.

Course Code	Course Name	Scheme	Theory	Practical	Tutorial	Total
IL 483	Vehicle Safety	Contact Hours	3	-	-	3
		Credits	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal Assessment			End Sem Exam				
		IA 1	IA 2	Average					
IL 483	Vehicle Safety	40	40	40	60	-	-	-	100

#### Course Objectives:

1. To familiarize basic concepts of vehicle safety.
2. To familiarize accident reconstruction analysis methods
3. To acquaint with different issues related to vehicle safety in India

#### Course Outcomes: Learner will be able to

1. Comprehend Vehicle design from safety point of view.
2. Apply concepts of accident reconstruction analysis in real world.
3. Enumerate interrelationship among occupant, restraint systems and vehicles in accidents.
4. Illustrate role and significance of seat in Rear crash safety
5. Demonstrate different active and passive safety systems available in vehicles
6. Contribute to the society by being proactive to the cause of safety on roads and in vehicles

Module	Detailed Contents	Hrs.
1	Introduction to vehicle safety-the integrated approach and its classification SAVE LIVES- by WHO Importance of Risk evaluation and communication, Concepts of Universal design, India's BNVSAP and its outcomes	6
2	Crash and distracted driver, Human error control Crash Testing, Use of Dummies, evolution and built of dummies. Relevance of Star ratings, NCAPs around the world- Accident Data, Biomechanics and Occupant Simulation Vehicle Body Testing, Dynamic Vehicle Simulation Tests Occupant Protection, Compatibility, Interrelationship Among Occupants, Restraint Systems and Vehicle in Accidents	8
3	Significance of Rear Crash Safety Role of seat in Rear crash safety Self aligning head restraints Pedestrian Protection testing and systems Under run Protection Devices	6

4	Introduction to Accident Analysis Reconstruction methods Skid distances and Critical speed from Tire Yaw marks Reconstruction of Vehicular Rollover Accidents Analysis of Collisions Reconstruction Applications Impulse Momentum Theory Crush Energy Photogrammetry for accident constructions	8
5	Antilock braking system Electronic Stability Program Low tire pressure warning system Collision avoidance systems	5
6	Basic Vehicle Operations and Road/Helmet Safety Activity	6

**Assessment:**

**Internal Assessment: 40 marks**

1. Consisting of One Compulsory Class Tests of 40 Marks
2. Continuous evaluation: Class Test/ Assignments / Quiz/ Case studies/ Seminar presentation of 40 Marks

**End Semester Examination: 60 marks**

Weightage of each module in the end semester examination will be proportional to the number of respective lecture hours mentioned in the syllabus.

**Books/References:**

1. Automotive vehicle safety by George Peters and Barbara Peters, CRC Press, 2002.
2. Vehicle Accident Analysis and Reconstruction Methods by Raymond M. Brach and R. Matthew Brach, SAE International, Second Edition, 2011.
3. Role of the seat in rear crash safety by David C. Viano, SAE International, 2002.
4. Automotive Safety Handbook by Ulrich W. Seiffert and Lothar Wech, SAE International, 2007. Public Safety Standards of the Republic of India

Course Code	Course Name	Credits
ET 492	Project C	04

### Course Objectives:

1. The primary objective is to meet the milestones formed in the overall project plan decided in Project B.
2. The idea presented Major Project B in should be implemented in Project C with results, conclusion and future work.
3. The project will culminate in the production of a thesis by each individual student.

### Course Outcomes: Upon successful completion of this course, the learner will be able to

1. Discover potential research areas in the field of Electronics & telecommunication engineering.
2. Conduct a survey of several available literature in the preferred field of study.
3. Compare and contrast the several existing solutions for research challenges.
4. Demonstrate an ability to work in teams and manage the conduct of the research study.
5. Formulate and propose a plan for creating a solution for the research plan identified.
6. To report and present the findings of the study conducted in the preferred domain.

### Guidelines:

### Project Report Format:

At the end of the semester the student needs to prepare a project report which should be prepared as per the guidelines issued by the department. Along with the project report a CD containing: project documentation, Implementation code, required utilities, Software's and user Manuals need to be attached.

### Term Work:

Students have to submit a weekly progress report to the internal guide and the internal guide has to keep a track on the progress of the project and also has to maintain the attendance report. This progress report can be used for awarding the term work marks. In case of industry projects, visits by internal guides will be preferred to get the status of the project. Distribution of marks for term work shall be as follows:

- a. Weekly Attendance on Project Day
- b. Project work contributions as per objective
- c. Project Report (Hard Bound)
- d. Term End Presentation (Internal)

The final certification and acceptance of TW ensures the satisfactory performance on the above aspects.

### Oral Exam:

Oral examination of Project C should be conducted by Internal and External Examiners. Students have to give a presentation and demonstration on Project C.

Course Code	Course Name	Teaching Scheme	Contact Hours				Credits Assigned				
			TH	Pract	Tut	Total	TH	Pract	Tut	Total	
ET493	Internship	Teaching Scheme	-		16	-	16	-	8	-	8
			Internal Assessment		End Sem Exam		Term Work	Pract	Oral	Total Marks	
		IA1	IA2	Avg	TH	Hrs					
		-	-	-	-	-	100	-	100	200	

### Course Description:

Provides the student with an opportunity to gain knowledge and skills from a planned work experience in the student's chosen career field. Internship or placements are directly related to the student's program of study and provide learning experiences not available in the classroom setting. Internships provide entry-level, career-related experience, and workplace competencies that employer's value when hiring new employees. Internships may also be used as an opportunity to explore career fields.

#### 1. Course Objectives: The course is aimed to:

1. To identify relevant industries to solve societal/environmental problems.
2. To familiarize the process of solving the problem in a corporate environment.
3. To provide an opportunity to apply theoretical knowledge and skills into practice.
4. To develop networking with professionals while learning new skills.
5. To get an exposure or real time experience on live industry projects.
6. To understand the code of conduct and professional ethics and handle the work environments.

#### 2. Course Outcomes: On successful completion of course learner/student will be able to:

1. Attain an exposure to real life organizational situations and achieve hands on experience in an organization
2. Build proficiency in a range of business or industry skills appropriate to the field of the internship/placement.
3. Develop professional and intercultural communication through written, verbal, and non-verbal means.
4. Articulate software development lifecycle (SDLC) phases in developing software projects and in writing the project document.
5. Refine and clarify professional and career goals through critical analysis of the internship experience or research project.
6. Inculcate the self-learning to know the job opportunities, higher studies and build a professional network.

#### 3. Guidelines regarding Internship:

1. To get hands-on experience of the real world, every candidate is required to undertake an individual internship in an organization of repute. The duration of Internship will be a minimum of 14 weeks to a maximum of 20 weeks.
2. The internship duration /slot will start immediately after completion of semester VII examinations and it will end on the last instructional date of the semester VIII (as per the academic calendar).
3. All students enrolled in semester VII have to submit the Application Form in the prescribed format to the Internship Cell/ Internship Coordinator at least a month prior to the last instructional day of semester VII
4. Students shall submit an implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of the internship.
5. In case of an internship offered through the college selection process, the student is eligible for only one offer and cannot appear for further process once selected.

6. The applications will be scrutinized by the internship approval committee at college /department level for its merit. The decision of the committee will be final and further grievances will not be entertained.
  1. The college will assign a mentor for each student who will monitor the student's progress throughout the duration of the internship. The students are expected to be in contact with the mentor on a regular basis.
  2. Students can join an internship only after getting an approval from the internship-committee.
  3. In case any student attempts to join an internship bypassing college procedure, it will not be considered for credit completion of semester VIII and hence for award of the B.Tech degree.
7. Faculty Internship Advisor or Internship Education Program Advisor may give input to students during internship, however, focus shall be on self-learning by the student.
8. A log book to be prepared by each student, wherein students can record weekly work progress, faculty Internship Advisor can verify and record notes/comments.
9. Students should make an Internship report as per the format provided.

**4. Suggested Internships Categories:** Following are the suggested categories of a valid Internships:

1. Industrial Internship- Private, Public, LLP or Start-up company
2. Incubation center - Under start-up or pre-incubation registered with Incubation center, Innovation / Entrepreneurship related activities.
3. Government Sector - BSNL, BEL, BHEL, ONGC, GMRT, Railways etc.
4. Government Research organization - IIT's, NIT's, IITM, IISR, DIAT, ISRO, TIFR etc.
5. Research lab - NCL, CSIR, CME, CPR, HEMRL, DRDO, Police Research Centre etc.
6. Institutional Internship through UGROP.
7. Internships other than UG project work offered by PI/CoPI of any Research project, live Industry projects, different technical activity clubs, learning at departmental Lab/ Tinkering Lab/ Institutional workshop etc.

**5. Internship Attendance Guidelines:**

1. Students are required to report to work on time and according to the requirements of the student's individualized work schedule.
2. Students are expected to conform to all attendance policies established by the employer and must notify the Faculty Internship Advisor in the event of absence from work.
3. When the employer is open for business on college holidays, the student is expected to report to work as scheduled.
4. Individual work schedules are established by agreement of the student, employer, and Faculty Internship Advisor.

**6. Internship Report Format:**

At the end of semester a project report should preferably contain at least following details:

**1. Introduction**

- 1.1 About the Organization
- 1.2 About the Internship
- 1.3 Purpose of Internship
- 1.4 Scope and Objectives of Internship
- 1.5 Roles and Responsibility
- 1.6 Organization of the Internship Report

**2. Internship Activities**

- 2.1 Responsibilities and Tasks Assigned
- 2.2 Weekly Overview of Internship Activities

### **3. Work Accomplishments**

- 3.1 Details of Work Carried Out
- 3.2 Challenges Faced
- 3.3 Achievements and Benefits to the Company/Society

### **4. Learning through Internship**

- 4.1 Technology Used
- 4.2 Methodology Adopted
- 4.3 Skills Acquired/Enhanced

### **5. Conclusion**

- 5.1 Summary of Key Points
- 5.2 Overall Internship Experience

### **Bibliography**

### **7. Internship Evaluation Guidelines:**

The institute shall ask the Internship offering Organization to allocate a mentor to the students to monitor and update the progress of the student and undertake a ground work to make internship more effective. The institute (concerned department) will allocate an internal faculty mentor to the students. The faculty mentor will undertake continuous evaluation of the students and will be responsible for submission of his/her grades. The interactions may be through Email/Skype/ Video Conferencing. etc. or a personal visit by faculty mentor to the internship site, as the need be or the policy of the institute. The student needs to submit the internship joining report duly signed by the mentor from the organization and the mentor from the institute to the department within two weeks from the commencement of the internship.

A. Suggested distribution of Term Work of 100 marks for internship shall be awarded based on:

- Selection of relevant industry and weekly progress report/ log book: **20 marks**
- Internal mock assessment as per defined rubrics/parameters: **20 marks**
- Evaluation/Feedback by industry/employer: **20 marks**
- Quality of work carried out during Internship and presentation: **20 marks**
- Quality of internship report and presentation: **20 marks**

B. Suggested distribution of Oral/Practical of 100 marks for internship shall be awarded based on:

- Selection of relevant industry and its requirements & scope: **20 marks**
- Quality of work carried out during Internship and presentation: **20 marks**
- Depth of knowledge, technology used and skills acquired during Internship: **20 marks**
- Work carried out, achievements and benefits to the company/society: **20 marks**
- Effectiveness of presentation and response to question(s): **20 marks**