SOMAIYA
VIDYAVIHAR

K J Somaiya Institute of Technology
An Autonomous Institute Permanently Affiliated to the University of Mumbai

Item No.
A.C. Date: --/--/2025

Autonomy Syllabus Scheme III (2023-24)

(As per NEP 2020 Guidelines)

for

Four Year Multidisciplinary

Bachelors of Technology (B. Tech.) Program

in

Electronics and Telecommunication Engineering with

Multiple Entry and Multiple Exit Options

Levels 4.5 - 6

(Third Year Effective from A.Y. 2025-26)

From the Principal's Desk:

To address the changing demands of the digital era, it is required to create a future-ready workforce that can navigate the complexities of an interconnected world, drive innovation, and contribute to the nation's growth. The **National Educational Policy 2020 (NEP 2020)** framed by the Government of India recommends a holistic, inclusive, and flexible approach to ensure equitable access to quality education across all levels, promote multidisciplinary research, and impart skill-based education with integration of technology. As per guidelines by the Department of Higher and Technical Education, Government of Maharashtra, the salient features of NEP 2020 aligned curriculum should include:

- Major (Core) Mandatory and Elective Courses
- Open Elective Courses
- Vocational and Skill Enhancement Courses
- Ability Enhancement Courses, Indian Knowledge System, and Value Education Courses
- Co-curricular Courses and Field Projects / Community Engagement Projects / Internship
- Multidisciplinary Minor Courses
- Option for Bachelor's Degree with Honours (based on Additional Credits)
- Option for Bachelor's Degree – Honours with Research (based on Additional Credits)
- Option for Bachelor's Degree with Double Minors (based on Additional Credits)
- Multiple Entry and Multiple Exit Options

Being an **autonomous institute** since the Academic Year 2021-22, **K. J. Somaiya Institute of Technology (KJSIT)**, has well-adapted newer approaches to reach higher levels of excellence in engineering education. Ahead of its time, the academic reforms at KJSIT have already addressed majority of these NEP 2020 aspects through its existing **Syllabus Scheme I, II, and II B** implemented under the academic autonomy. For a complete alignment with NEP 2020, the **KJSIT Autonomy Syllabus Scheme III** is introduced, to be effective from Academic Year 2023-24 across all the branches, progressively from First Year Engineering.

Specifically, the existing curriculum already comprise state-of-the-art **Major (Core) courses** in theory and practical. With an ideology that the root of innovation is 'interest', the curriculum offers wide range of Elective courses — grouped into **Major-related Electives** and **Inter-disciplinary / Open Electives**. At par with international engineering education, it follows a learner-centric approach as well as promotes MOOCs, where the students can choose to study courses concerning areas of their interests, and the same is continued in Scheme III.

Further, under the theme of "Learning by Doing", the existing curriculum includes Skill-Based Learning (SBL), Activity-Based Learning (ABL), and Technology-Based Learning (TBL) as eXposure (SAT) courses — that assure X factor in all the students of the institute. The SAT courses are practiced across the first three years of engineering, focusing on responsibilities towards society, problem-solving abilities, communication skills, ethics, leadership and teamwork, motivation for life-long learning, skills on emerging areas of technology, skills on different languages, etc. In the Syllabus Scheme III, these SAT courses are now aligned and offered as **Vocational Skill - SAT (VS - SAT) courses**, **Skill Enhancement - SAT (SE - SAT) courses**, **Ability Enhancement - SAT (AE - SAT) courses**, and **Value Education - SAT (VE - SAT) courses**.

Further, **Indian Knowledge System - SAT (IKS - SAT) course** is newly introduced in Scheme III that emphasizes on drawing insights from ancient wisdom to address modern challenges. Also, as an extension to the induction program for the First Year students, the introduced **Co-curricular - SAT (CC - SAT) course** aims to induct incumbents with the institutional practices, culture, and values, as well as encourage participation in co-curricular activities.

The component of **Project-Based Learning (PBL)** included in the Syllabus Scheme II is carried forward to Scheme III, wherein the students develop **Community Engagement / Field Projects** in Second, Third, and Last Year as Mini, Minor, and Major Projects respectively. Scheme III also retains the **Internship** component, offered with credits, to equip graduates with the industry trends, practices, and skills required at national and global level.

The duality of PBL and Internship enables student involvement in research, innovation, and entrepreneurship, which are the fulcrums of higher education.

As a new introduction in line with NEP 2020, the Syllabus Scheme III incorporates mandatory **Multidisciplinary Minor courses** in Innovation and Entrepreneurship, Biotechnology, IoT and Cloud Computing, Geographical Information System, Very Large Scale Integration (VLSI) and Artificial Intelligence. These courses promote interdisciplinary thinking and broaden the career prospects, enabling students to develop solutions to real-world problems by combining expertise from multiple domains.

Aligned with NEP 2020, the Scheme III retains the initiative taken through Scheme II / II B of offering **Honours courses** for students who are desirous of pursuing focused interest in 06 emerging areas of technology recognized by AICTE: Internet of Things, Artificial Intelligence & Machine Learning, Cyber Security, Virtual and Augmented Reality, Data Science, and Blockchain. These Honours courses correspond to high-end industry standards and offer multi-fold opportunities of specialization.

As per NEP 2020, the above curricular aspects of Four Years UG Engineering Programme shall be offered with **Multiple Entry and Multiple Exit options**, leading to the conferment of:

- **One Year UG Certificate in Technology:** Awarded after completing First Year of Engineering and acquiring additional 08 credits immediately after First Year.
- **Two Years UG Diploma in Technology:** Awarded after completing Second Year of Engineering and acquiring additional 08 credits immediately after Second Year.
- **Three Years Bachelor's Degree in Vocation (B.Voc.):** Awarded after completing Third Year of Engineering and acquiring additional 08 credits immediately after Third Year.
- **Four Years Bachelor's Degree in Technology (B.Tech.) with Multidisciplinary Minor:** Awarded after completing Fourth Year of Engineering.
- **Four Years Bachelor's Degree in Technology (B.Tech.) Honors with Multidisciplinary Minor:** Awarded after completing Fourth Year of Engineering and acquiring additional 18 credits through Honours courses in respective major discipline over Third & Fourth Year of Engineering.
- **Four Years Bachelor's Degree in Technology (B.Tech.) Honors with Research and Multidisciplinary Minor:** Awarded after completing Fourth Year of Engineering and acquiring additional 18 credits through a research project in respective major discipline during Fourth Year of Engineering.
- **Four Years Bachelor's Degree in Technology (B.Tech.) with Double Minors (Multidisciplinary & Specialization):** Awarded after completing Fourth Year of Engineering and acquiring additional 18 credits through additional courses in another Engg. / Tech. discipline during Second to Fourth Year of Engineering.

Through the implementation of Autonomy Syllabus Scheme III (as per NEP 2020 Guidelines), strategic planning, and joint efforts of all stakeholders, KJSIT is endeavouring to enhance the quality of engineering education and set a benchmark for all the autonomous institutes nationwide.

Dr. Vivek Sunnapwar
Principal and Chairman - Academic Council

Preface by Chairperson – Board of Studies (BoS):

In today's world, lot of technological developments are taking place in the field of Electronics & Telecommunication Engineering in order to meet the current requirements. Hence, there is always a requirement for continuous enrichment of course content in the field of education on regular basis to maintain a good quality of education by the regular revision of curriculum. This will help our students with the upgraded knowledge, help in achieving better employability, opportunities to work with start -ups, chances for good internships at premier organizations/industries and other avenues of higher studies.

The revised curriculum of Scheme-III (Electronics and Telecommunication Engineering) under the autonomy has focussed on all these above mentioned factors and aims to provide strong foundation along with required analytical concepts in the field of electronics & telecommunication. The curriculum is designed keeping in mind the guidelines of NEP-2020. Some of the salient features of the syllabus are as mentioned below.

1. The curriculum is designed with a total of number of 174 credits along with the inclusion of Skill, and Technology and Project based learning.

2. The skill based courses are introduced in the second and third year in which students are exposed to hard/ soft skills. Students are also introduced with the community engagement projects in the second year in current technologies.

3. Third year students are introduced with technology based learning along with skill based courses. The community engagement projects are introduced to the third year students in the specialized core fields

4. Students are introduced to National/Foreign Languages in the second year to make them proficient at job locations as per the requirement.

5. The curriculum is designed to incorporate the electives in (department and institute level) covering the thrust areas that will provide more focussed approach for the students in problem solving and also to be at par with the current industry requirements.

6. The contents of the curriculum is designed taking into consideration the IT domain developments into account and at the same time keeping the focus on core specialization of the program intact

7. The internships are made mandatory and credit based for all the students in semester VIII. The students are provided with the flexibility to carry out internship for entire semester. That helps them to acquaint with the industry work culture

As Chairman BOS, I take this opportunity to thank all the internal and external BOS members, subject experts, industry representatives, alumni, and various other stakeholders for their sincere efforts and valuable inputs in the preparation of course contents, in reviewing the contents and critically analysing the contents.

Dr. Jayashree V. Khanapuri
Head and Chairperson,
Electronics and Telecommunication Engineering Department, KJSIT

Board of Studies (BoS) in Electronics and Telecommunication Engineering – K. J. Somaiya Institute of Technology (KJSIT):

1. **Dr. Jayashree Khanapuri**
   Professor and Head – Department of Electronics and Telecommunication Engineering,
   Chairperson – BoS in Electronics and Telecommunication Engineering, KJSIT
2. **Dr. Namrata Ansari**
   Professor – Department of Electronics and Telecommunication Engineering and Dean – Academics, KJSIT
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   Assistant Professor – Department of Electronics and Telecommunication Engineering, KJSIT
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   Assistant Professor – Department of Electronics and Telecommunication Engineering, KJSIT
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   Assistant Professor – Department of Electronics and Telecommunication Engineering, KJSIT
6. **Ms. Rashmi Adatkar**
   Assistant Professor – Department of Electronics and Telecommunication Engineering, KJSIT
7. **Dr. Kiran Rathod**
   Assistant Professor – Department of Electronics and Telecommunication Engineering, KJSIT
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   Assistant Professor – Department of Electronics and Telecommunication Engineering, KJSIT
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   Assistant Professor – Department of Electronics and Telecommunication Engineering, KJSIT
10. **Mr. Martand Jha**
    Assistant Professor – Department of Electronics and Telecommunication Engineering, KJSIT
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    Assistant Professor – Department of Electronics and Telecommunication Engineering, KJSIT
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14. **Mr. Harshawardhan Ahire**
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16. **Mr. Amit Kukreja**
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18. **Ms. Sandhya Deshpande**
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19. **Dr. Priya Hankare**
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20. **Ms. Swati Shinde**
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21. **Mr. Sagar Mhatre**
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22. **Dr. Deepak Bhoir**
    Professor and Dean Academics, Fr. Conceicao Rodrigues College of Engineering, Bandra, Mumbai
23. **Dr. Virendra Shete**
    Professor, MIT – School of Engineering, Pune
24. **Dr. Vivek Agarwal**
    Professor, Department of Electrical Engineering, IIT Bombay
25. **Mr. Alister D'silva**
    Director, Absolute Motion Pvt. Ltd., Mumbai

Nomenclature and Alignment of Verticals and Components

Verticals as per NEP 2020 Guidelines	Components Aligning with KJSIT Autonomy Syllabus Scheme I / II / II B	Nomenclature for KJSIT Autonomy Syllabus Scheme III Aligned with NEP 2020 Guidelines
Basic and Engineering Science Courses	Basic Science (BS) Course	Basic Science (BS) Courses
	Engineering Science (ES) Course	Engineering Science (ES) Courses
Major Courses	Professional Core (PC) Courses	Major / Professional Core (PC) Courses
	Professional Elective - Department-level (PE-DLC) Courses	Major / Professional Elective - Department-level (PE-DLC) Courses
Generic / Open Elective Courses	Open Elective - Institute-level (OE-ILC) Courses	Open Elective - Institute-level (OE-ILC) Courses
Multidisciplinary Minor Courses	-	Multidisciplinary Minor (MM) Courses
Vocational Skill Courses	Workshop I; Workshop II; SAT Courses – TBL	Vocational Skill - SAT (VS-SAT) Courses
Skill Enhancement Courses	SAT Courses – SBL (Program Specific)	Skill Enhancement - SAT (SE-SAT) Courses
Ability Enhancement Courses	Professional Communication Skills; SAT Course – SBL (Foreign and/or Indian Modern Languages)	Ability Enhancement - SAT (AE - SAT) Courses
Indian Knowledge System Courses	-	Indian Knowledge System - SAT (IKS - SAT) Courses
Value Education Courses	SAT Course – ABL (National, Global, Societal and Environmental Aspects); Business Communication & Ethics	Value Education - SAT (VE - SAT) Courses
Field Projects / Community Engagement Projects	PBL – Mini, Minor, Major	Community Engagement – Project-Based Learning (PBL)
Internship / Apprenticeship	Internship	Internship (INT)
Co-curricular Courses	Student Induction Program	Co-curricular - SAT (CC - SAT) Courses

Other Abbreviations:

- SAT – Skill/Activity/Technology-Based Learning (Exposure Courses)
- TH – Theory
- P – Practical
- TUT – Tutorial
- T1 – Test 1
- T2 – Test 2
- CA – Continuous Assessment Test (T = T1 + T2)
- ESE – End Semester Exam
- TW – Term Work
- O – Oral Exam
- P – Practical Exam
- P&O – Practical & Oral Exam

Programs Offered with Multiple Entry Multiple Exit Options

Level 4.5: UG Certificate in Technology

Major Discipline:	Electronics and Telecommunication Engineering
Years of Study:	01 Year
Semesters:	1 and 2
Credits:	42
Additional Requirements:	08 Credit Bridge Course Corresponding to Skill-Based Courses / Internship / Mini Projects in Major during Summer Vacation after 1st Year

Level 5: UG Diploma in Technology

Major Discipline:	Electronics and Telecommunication Engineering
Years of Study:	02 Years
Semesters:	1, 2, 3, 4
Credits:	85
Additional Requirements:	08 Credit Bridge Course Corresponding to Skill-Based Courses / Internship / Mini Projects in Major during Summer Vacation after 2nd Year

Level 5.5: Bachelor's Degree in Vocation (B. Voc.)

Major Discipline:	Electronics and Telecommunication Engineering
Years of Study:	03 Years
Semesters:	1, 2, 3, 4, 5, 6
Credits:	130
Additional Requirements:	08 Credit Bridge Course Corresponding to Skill-Based Courses / Internship / Mini Projects in Major during Summer Vacation after 3rd Year

Level 6: B.Tech. in Technology with Multidisciplinary Minor

Major Discipline:	Electronics and Telecommunication Engineering
Offered Multidisciplinary Minors:	• Innovation and Entrepreneurship • Biotechnology • IoT and Cloud Computing • Geographical Information System • VLSI • Artificial Intelligence
Years of Study:	04 Years
Semesters:	**Major –** 1, 2, 3, 4, 5, 6, 7, 8 **Multidisciplinary Minors** – 4, 5, 6
Credits:	174

Level 6: B.Tech. in Technology - Honors and Multidisciplinary Minor

Major Discipline:	Electronics and Telecommunication Engineering
Offered Honors and Multidisciplinary Minors:	**Honors:** • Internet of Things* • Artificial Intelligence & Machine Learning • Cyber Security • Virtual and Augmented Reality • Data Science • Blockchain **Multidisciplinary Minors:** • Innovation and Entrepreneurship • Biotechnology • IoT and Cloud Computing* • Geographical Information System • VLSI • Artificial Intelligence * Can be chosen for either Honors or Minors, not both
Years of Study:	04 Years
Semesters:	**Major –** 1, 2, 3, 4, 5, 6, 7, 8 **Multidisciplinary Minors** – 4, 5, 6 **Honors** – 5, 6, 7, 8
Credits:	192 (= Major with Multidisciplinary Minors: 174 + Honors: 18)

Level 6: B.Tech. in Technology - Honors with Research and Multidisciplinary Minor

Major Discipline:	Electronics and Telecommunication Engineering
Offered Multidisciplinary Minors:	• Innovation and Entrepreneurship • Biotechnology • IoT and Cloud Computing • Geographical Information System • VLSI • Artificial Intelligence
Years of Study:	04 Years
Semesters:	**Major –** 1, 2, 3, 4, 5, 6, 7, 8 **Multidisciplinary Minors** – 4, 5, 6 **Honors with Research** – 7, 8
Credits:	192 (= Major with Multidisciplinary Minors: 174 + Honors with Research: 18)

Level 6: B.Tech. in Technology with Double Minors (Multidisciplinary & Specialization)

Major Discipline:	Electronics and Telecommunication Engineering
Offered Multidisciplinary Minors and Specialization Minors:	**Multidisciplinary Minors:** • Innovation and Entrepreneurship • Biotechnology • IoT and Cloud Computing • Geographical Information System • VLSI • Artificial Intelligence **Specialization Minors:** 06 additional courses (of minimum 12 week each), in another Engg. / Tech. discipline / Emerging Areas through MOOC
Years of Study:	04 Years
Semesters:	**Major –** 1, 2, 3, 4, 5, 6, 7, 8 **Multidisciplinary Minors** – 4, 5, 6 **Specialization Minors** – 3, 4, 5, 6, 7, 8
Credits:	192 (= Major with Multidisciplinary Minors: 174 + Specialization Minors: 18)

Credit Distribution Structure for Four Year Multidisciplinary B.Tech. Degree Program in Electronics and Telecommunication Engineering with Multiple Entry Multiple Exit Options

Level	Semester	Faculty: Science and Technology					Faculty: Any	Vocational Skills (VS) & Skill Enhancement (SE) Courses		Ability Enhancement (AE), Indian Knowledge System (IKS), Value Education (VE) Courses			Field Projects / Community Engagement (CE) Projects, Internship (INT), and Co-curricular (CC) Courses			Credits	Cumulative Credits
		Basic Science (BS) Courses	Engineering Science (ES) Courses	Major / Professional Core (PC) Courses	Major / Professional Elective - Department-level (PE-DLC) Courses	Multi-disciplinary Minor (MM) Courses	Open Elective - Institute-level (OE-ILC) Courses	VS - SAT Courses	SE - SAT Courses	AE - SAT Courses	IKS - SAT Courses	VE - SAT Courses	CE - Project-Based Learning (PBL)	INT	CC - SAT Courses		
Level 4.5	I	9	8					1				1			2	21	42
	II	9	8					1		2	1					21	
Exit Option with UG Certificate in Technology with Additional 08 Credit Bridge Course Corresponding to Skill-Based Courses / Internship / Mini Projects in Major																	
Level 5.0	III	4		15					1				1			21	85
	IV	4		11		4			1	1			1			22	
Exit Option with UG Diploma in Technology with Additional 08 Credit Bridge Course Corresponding to Skill-Based Courses / Internship / Mini Projects in Major																	
Level 5.5	V			11	4	3			1			2	1			22	130
	VI			8	4	3	3	2					3			23	
Exit Option with Bachelor's Degree in Vocation (B. Voc.) with Additional 08 Credit Bridge Course Corresponding to Skill-Based Courses / Internship / Mini Projects in Major																	
Level 6.0	VII			8	7		3						6			24	174
	VIII			8										12		20	
Total		**26**	**16**	**61**	**15**	**10**	**6**	**4**	**3**	**3**	**1**	**3**	**12**	**12**	**2**	**174**	

Program Structure for Third Year UG Technology (EX)

SEMESTER VI

TEACHING SCHEME

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		Course Category
		TH – P – TUT	Total	TH – P – TUT	Total	
EXC601	Image Processing and Machine Vision	3 – 0 – 0	03	3 – 0 – 0	03	PC
EXC602	Electromagnetics and Antenna	3 – 0 – 0	03	3 – 0 – 0	03	PC
EXDLC603	Major / Professional Elective - Department-level Course – II	3 – 0 – 0	03	3 – 0 – 0	03	PE-DLC
MMC604	Multidisciplinary Minor Course	3 – 0 – 0	03	3 – 0 – 0	03	MM
ILC605	Open Elective - Institute-level Course – I	3 – 0 – 0	03	3 – 0 – 0	03	OE-ILC
EXL601	Image Processing and Machine Vision Laboratory	0 – 2 – 0	02	0 – 1 – 0	01	PC
EXL602	Electromagnetics and Antenna Laboratory	0 – 2 – 0	02	0 – 1 – 0	01	PC
EXDLL603	Major / Professional Elective - Department-level Lab – II	0 – 2 – 0	02	0 – 1 – 0	01	PE-DLC
EXPR64	Community Engagement PBL – Innovation-Based Major Project A	0 – 6 – 0	06[$]	0 – 3 – 0	03	PBL
EXXT612	Vocational Skill – SAT XII: Technology Based Learning	0 – 4[*] – 0	04	0 – 2 – 0	02	VS-SAT
Total		**15 – 16 – 0**	**31**	**15 – 8 – 0**	**23**	

[*]SAT can be conducted as TH or P or both as required. [$]Load of learner, not the faculty.

Professional Electives - Department Level Elective Courses and Labs (PE-DLC – II)

	Course Code	Course Title and Group^
Major / Professional Elective - Department-level Course – II	EXDLC6031	Group A: Machine Learning
	EXDLC6032	Group B: IoT and Industry 4.0
	EXDLC6033	Group C: Robotics
	EXDLC6034	Group D: Database Management System

Multidisciplinary Minor Course

	Course	Course Code	Course Title
Multidisciplinary Minor Course	Innovation and Entrepreneurship	MMIEC604	Strategic Management and IPR for Start-ups
	Biotechnology	MMBTC604	Industrial Biotechnology
	IoT and Cloud Computing	MMICCC604	Advanced IoT & Capstone Project
	Geographical Information Systems	MMGISC604	Geomatics
	Very Large Scale Integration	MMVLSIC604	VLSI for Digital Signal Processing
	Artificial Intelligence	MMAIC604	Machine Learning

Open Elective - Institute-level – I

Open Elective	Course Code	Course Name
Open Elective - Institute-level Course – I	ILC6051	Product Life Cycle Management
	ILC6052	Reliability Engineering
	ILC6053	Management Information System
	ILC6054	Design of Experiments
	ILC6055	Operation Research
	ILC6056	Cyber Security and Laws
	ILC6057	Disaster Management and Mitigation Measures
	ILC6058	Energy Audit and Management
	ILC6059	Development Engineering

SEMESTER VI

EXAMINATION SCHEME

Course Code	Course Name	CA Marks			ESE		TW / O / P Marks				Total Marks
		T1	T2	T = T1 + T2	Marks	Duration (in Hrs)	TW	O	P	P&O	
EXC601	Image Processing and Machine Vision	20	20	40	60	2.5	-	-	-	-	100
EXC602	Electromagnetics and Antenna	20	20	40	60	2.5	-	-	-	-	100
EXDLC603	Major / Professional Elective - Department-level Course – II	20	20	40	60	2.5	-	-	-	-	100
MMC604	Multidisciplinary Minor Course	-	-	-	-	-	50	50	-	-	100
ILC605	Open Elective - Institute-level Course– I	20	20	40	60	2.5	-	-	-	-	100
EXL601	Image Processing and Machine Vision Laboratory	-	-	-	-	-	25	-	-	25	50
EXL602	Electromagnetics and Antenna Laboratory	-	-	-	-	-	25	-	25	-	50
EXDLL603	Major / Professional Elective - Department-Level Lab – II	-	-	-	-	-	25	-	-	-	25
EXPR64	Community Engagement PBL – Innovation-Based Major Project A	-	-	-	-	-	25	-	-	50	75
EXXT612	Vocational Skill – SAT XII: Technology Based Learning	-	-	-	-	-	50	-	-	-	50
Total		**80**	**80**	**160**	**240**	**-**	**200**	**50**	**25**	**75**	**750**

Course Code	Course Name	Credits (TH+P+TUT)
EXC601	**Image Processing and Machine Vision**	**3+0+0**
Prerequisite:	1. Signals and Systems 2. Discrete Time Signal Processing	
Course Objectives:	1. To introduce students to the fundamental concepts of Image Processing and Image Enhancement Techniques 2. To make the students well versed with image morphology and restoration techniques 3. To impart knowledge on the concepts of the students to segmentation and feature extraction 4. To teach modern techniques of Classification and Basics of Machine Vision.	
Course Outcomes:	1. Explain the basic fundamentals required for Image processing 2. Explain the theory and models in Image Processing. 3. Implement image-processing operations on 2D signals in spatial & frequency domain. 4. Discuss segmentation and restoration of 2D signals in spatial & frequency domain. 5. Explain the image representation techniques. 6. Describe the image classification of 2D signals	

Module No & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisites and Course Outlines	Prerequisite Concepts and Course Introduction	-	02	02
1. Digital Image Fundamentals and Processing	1.1 Introduction – Steps in Digital Image Processing, concept of Sampling and quantization, spatial and intensity resolution, Relationships between pixels: Neighbourhood relations between pixels, Distance measures, connectivity of pixels, Definitions of path, Region and Boundary. Numericals on distance measures and connectivity	1, 2	02	04
	1.2 Point Processing: Image Negative, Log Transform, Power Law transform, Bit plane slicing, Contrast stretching, Histogram equalization and Histogram Specification		02	

Module No & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
2. Image Enhancement with Time Domain and Frequency Domain Filters	2.1 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 High boost Filtering, Using First-Order Derivatives —The Gradient- Sobel, Prewitt and Roberts masks	2 & 3	03	08
	2.2 Frequency Domain Filtering: Introduction to 2-D DFT and its application in frequency domain filtering, Wavelet transform, Haar transform		02	
	2.3 Frequency Domain Filtering Fundamentals, Fourier Spectrum and Phase angle, Steps for Filtering in the Frequency Domain, Correspondence Between Filtering in the Spatial and Frequency Domains, Frequency domain Image Smoothing and sharpening filter - Ideal, Butterworth, Gaussian	2	03	
3. Image Morphology and Restoration	3.1 Morphology: Erosion and Dilation, Opening and Closing, The Hit-or-Miss Transformation, Boundary extraction , Hole filling, Thinning and thickening	3	03	06
	3.2 Restoration: A Model of the Image Degradation/Restoration Process, Noise models, Removal periodic noise, Principle of Inverse filtering.	4	03	
4. Image Segmentation	4.1 Point, Line, and Edge Detection: Detection of Isolated Points, Line detection, edge models, Canny's edge detection algorithm, Edge linking: Hough transforms and Graph Theoretical Method.	2,3	05	08
	4.2 Thresholding: Foundation, Role of illumination and reflectance, Basic global thresholding	2	01	
	4.3 Region Based segmentation: Region Growing, Region Splitting and Merging.		02	
5. Introduction to Machine Vision and Descriptors	5.1 Principle of machine vision, chain code, simple geometric border representation, Fourier Descriptors, (Specify Different Techniques), Regional Descriptors based on Histogram and Texture Features.	5	03	05

Module No & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	5.2 Introduction to Texture, co-occurrence matrix		02	
6. Machine Vision Algorithms	6.1 Knowledge representation, Classification Principles, Classifier Design, Classifier Learning, Confusion Matrix	6	02	08
	6.2 Introduction to clustering, K-means clustering algorithm, Introduction, Bayes decision theory continuous case, Maximum Likelihood Classification Bayesian classifier, Introduction to Support Vector Machine. Comparison of Supervised and Unsupervised Classification		06	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
			Total:	**42**

Books:	
Text Books	1. "Digital Image Processing", 3rd Edition Gonzales and Woods PHI publications Indian Edition 2013 2. "Introduction to Image Processing", 2nd Edition Jayaraman, Isakkirajan Wiley 2009 3. "Digital Image Processing", 1st Edition S. Sridhar Oxford Education Press 2014 4. "Pattern Recognition and Machine Learning", 3rd Edition Christopher M. Bishop; Springer Publication Series 2006
Reference Books	1. Image Processing, Analysis, and Machine Vision 3rd Edition Milan Sonka, Vaclav Hlavac, Roger Boyle Pearson Edition 2013 2. Fundamentals of Image Processing 1st Edition Anil Jain Prentice Hall of India 1989 3. Digital Image Processing 3rd Edition W. Pratt Wiley Publication 2002 4. Image Processing and Pattern Recognition: Fundamentals and Techniques 1st Edition Frank Y Shish Wiley- IEEE Press, 2010 5. Pattern classification and scene analysis 2nd Edition R. O. Duda and P. E. Hart Wiley Inter Science Publication 2009
Useful Links:	
Some important links of NPTEL Courses 1. https://onlinecourses.nptel.ac.in/noc21_ee78/preview 2. https://onlinecourses.nptel.ac.in/noc21_cs70/course	

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1 (T-1)	20 marks
2.	Class Test 2 (T-2)	20 marks

Class Tests (20 Marks):

Two class tests of 20 marks each should be conducted in a semester. The first-class test is to be conducted when approx. 40% syllabus is completed and second-class test when additional 40% syllabus (but excluding contents covered in Test I) is completed. Duration of each test shall be one hour. Addition of both test scores will be considered for passing.

End Semester Theory Examination will be of 60 Marks with Two Hours and 30 Minutes duration.

Course Code	Course Name	Credits (TH+P+TUT)
EXC602	**Electromagnetics & Antenna**	**3+0+0**
Prerequisite:	Applications of Mathematics in Engineering – I (Vector Calculus, Fundamentals concepts of electricity and magnetism, Two-Port Networks)	
Course Objectives:	1. To make student familiar with Maxwell's equation and its usefulness to describe different electromagnetic phenomena such as wave propagation, radiations from antenna etc. 2. To learn Electromagnetic radiation and propagation in space and within transmission lines 3. To learn different Antennas and its parameter. 4. To learn design of wired and patch Antenna.	
Course Outcomes:	1. Describe electromagnetic field including static and dynamic in terms of Maxwell's equations. 2. Apply Maxwell's equation to solve various electromagnetic fields. Determine the parameters of transmission line for various frequencies. 3. Explain the wave propagation and propagation in different media. 4. Determine basic antenna parameters like radiation pattern, input impedance directivity, gain and polarization. 5. Design of different types of the antenna structures such as Antenna arrays, Microstrip patch antennas and aperture antennas.	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisites and Course Outlines	Prerequisite Concepts and Course Introduction	-	02	02
1. 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	02	05
	1.2 Scalar Electric Potential, Potential gradient, Laplace's and Poison's equations.		02	
	1.3 Biot Savart Law, Ampere Circuit law, Gauss's law for magnetic field, Vector magnetic potential		01	
2. Electromagnetic Field and Maxwell's Equations	2.1 Faraday's Law, Displacement current density, Maxwell's equation for time varying filed, Boundary conditions.	2	02	05
	2.2 EM wave propagation through lossy, perfect dielectric and conducting medium.		02	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	2.3 Power in EM Wave: Poynting theorem and Poynting vector, Applications of EM waves(add 2-3 applications)		01	
3. Transmission Line	3.1 Transmission line parameters, Transmission line equations, Input impedance, Standing wave ratio, Power, Transients on transmission lines.	3	03	07
	3.2 Smith Chart, Applications of Smith Chart in finding VSWR, and reflection coefficient, admittance calculations, impedance calculations over length of line		04	
4. Basic of Antennas & Wave Propagation	4.1 Basic concepts: Radiation mechanism, near field and far field radiation, retarded potential.	4	02	07
	4.2 Antenna Parameters: Isotropic antenna, Radiation pattern, radiation intensity, Beam width, directivity, Gain, beam efficiency, bandwidth, polarization, Input impedance, Antenna efficiency, Radiation resistance, Loss resistance, aperture concept, FRII's transmission formula.		03	
	4.3 Ground Wave Propagation, Sky Wave Propagation and Space Wave Propagation.		02	
5. Wire Elements & Antenna Arrays	5.1 Infinitesimal dipole, Wire dipole, Monopole antennas: radiation field derivations and related parameters, Introduction to loop antenna.	5	03	09
	5.2 Yagi antenna, Broadband antenna like Helical and Log Periodic antenna (Design of Yagi & Log periodic).		03	
	5.3 Linear arrays of two isotropic point sources, linear arrays of N elements, Principle of pattern multiplication (Design)		02	
	5.4 Introduction and types to Planner arrays.		01	
6. Aperture & Patch antennas	6.1 Horn Antennas**:** E-Plane Sectoral Horn, H-Plane Sectoral Horn, Pyramidal Horn and Conical Horn (No Design).	6	02	06
	6.2 Reflector Antennas: Plane Reflectors, Corner Reflectors and Parabolic Reflector (No Design).		02	
	6.3 Patch Antenna: Microstrip antenna, Feeding Techniques, Introduction to design of Microstrip antenna (Rectangular and circular patch) (Design)		02	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
			Total:	**42**

Books:	
Text Books	1. Electromagnetic Waves and Radiating Systems- Jordan and Balmain, PHI, 2nd edition 2. Engineering Electromagnetics, William H Hayt and John A Buck - Tata McGraw-Hill Publishing Company Limited, Seventh Edition 3. "Electromagnetic Waves" written by Prof R K Shevgaonkar 4. Principles of Electromagnetics Engineering- Matthew N. O.Sadiku , S.V. Kulkarni, Oxford university press, 6th edition 5. Antenna Theory: Analysis and Design, Costantine A. Balanis, John Wiley Publication, 4th edition 6. Antenna and wave Propagation, John D Kraus, A S Khan, McGraw Hill, 4th edition 7. Antenna Theory and Design. Stutzman, Theile, John Wiley and Sons, 3rd edition
Reference Books	1. Antennas and Radio Wave Propagation, R. E. Collin, McGraw Hill, International Student Edition.
Useful Links:	
1. https://nptel.ac.in/courses/108/104/108104087/ 2. https://www.udemy.com/course/electromagnetic-theory/	

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1 (T-1)	20 marks
2.	Class Test 2 (T-2)	20 marks

Class Tests (20 Marks):

Two class tests of 20 marks each should be conducted in a semester. The first-class test is to be conducted when approx. 40% syllabus is completed and second-class test when additional 40% syllabus (but excluding contents covered in Test I) is completed. Duration of each test shall be one hour. Addition of both test scores will be considered for passing.

End Semester Theory Examination will be of 60 Marks with Two Hours and 30 Minutes duration.

Course Code	Major / Professional Elective – Department Level Course – II	Credits (TH+P+TUT)
EXDLC6031	**Machine Learning**	**3+0+0**
Prerequisite:	Skill lab Python Programming	
Course Objectives:	1. To appreciate machine learning approach to Artificial Intelligence, and understand fundamental issues and challenges of supervised and unsupervised learning techniques 2. To understand the underlying mathematical relationships within and across Machine Learning algorithms.	
Course Outcomes:	1. Explain the concepts related Machine Learning 2. Mathematically analyse various machine learning approaches and paradigms 3. Compare and contrast pros and cons of various machine learning techniques and to get an insight of when to apply a particular machine learning approach 4. Deploy machine learning algorithms using various evaluation techniques. 5. Implement supervised and unsupervised machine learning algorithms for real-world applications, while understanding the strengths and weaknesses. 6. Fine tune machine learning algorithms and evaluate models generated from data.	

Module No. & Name	Sub Topic	CO Mapped	Hrs./ Sub Topic	Total Hrs.
i. Prerequisites and Course Outlines	Prerequisite Concepts and Course Introduction	-	02	02
1. Introduction	1.1 Definition, Types of machine learning : Supervised/unsupervised/reinforcement	1	02	03
	1.2 Applications of machine learning		01	
2. Linear Regression	2.1 Univariate Linear Regression: Model representation, Cost Function, Gradient Descent, Gradient Descent for linear regression, Optimization, Overfitting, Regularization, Feature selection	2,6	06	10
	2.2 Multivariate Linear Regression: Multiple features: Model representation, Gradient Descent for multivariate linear regression, Feature scaling, Normal Equation		04	
3. Logistic Regression	3.1 Classification : Model representation, Decision boundary, Cost function, Gradient Descent, Optimization	3,6	02	12
	3.2 Feature selection, Multiclass Classification, Over fitting, ROC curve, Confusion Matrix		02	
	3.3 KNN		01	
	3.4 Decision Tree algorithms		02	
	3.5 Random forest		02	
	3.6 Support Vector Machine: Introduction, Kernel, Application, Difference between logistic regression and SVM		03	

Module No. & Name	Sub Topic	CO Mapped	Hrs./ Sub Topic	Total Hrs.
4. Deployment of Machine learning algorithm	4.1 Evaluation of hypothesis	4	1	05
	4.2 Cross validation		1	
	4.3 K-fold Cross validation		2	
	4.4 Learning Curve		1	
5. Unsupervised Learning	5.1 Introduction	3	2	05
	5.2 Clustering : K Mean Algorithm			
	5.3 Dimensionality reduction		1	
	5.4 Principal Component Analysis		2	
6. Advance Machine Learning topics	6.1 Anomaly Detection	5	1	04
	6.2 Recommender System		1	
	6.3 Gradient Descent with large dataset			
	6.4 Online learning		1	
	6.5 Map reduce and data parallelism		1	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
			Total	**42**

Books:	
Text Books	1. Introduction to statistical Learning 7th Edition Gareth James Daniela Witten Trevor Hastie Robert Tibshirani Springer 2017 2. Foundation of Machine Learning 2nd Edition Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar MIT Press 2018 Introduction to Machine Learning 2nd Edition Ethem Alpaydın The MIT Press 2010
Reference Books	1. Pattern Recognition and Machine Learning C. M. Bishop Springer 2010 2. Understanding Machine Learning: From Theory to Algorithms Shai Shalev-Shwartz and Shai Ben-David Cambridge University Press 2014
Useful Links:	
1. https://www.coursera.org/learn/machine-learning 2. https://paperswithcode.com/ 3. https://nptel.ac.in/courses/106/106/106106139/	

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1 (T-1)	20 marks
2.	Class Test 2 (T-2)	20 marks

Class Tests (20 Marks):

Two class tests of 20 marks each should be conducted in a semester. The first-class test is to be conducted when approx. 40% syllabus is completed and second-class test when additional 40% syllabus (but excluding contents covered in Test I) is completed. Duration of each test shall be one hour. Addition of both test scores will be considered for passing.

End Semester Theory Examination will be of 60 Marks with Two Hours and 30 Minutes duration.

Course Code	Major / Professional Elective – Department Level Course – II	Credits (TH+P+TUT)
EXDLC6032	**IoT and Industry 4.0**	**3+0+0**
Prerequisite:	Microcontrollers	
Course Objectives:	1. To offer introduction to Internet of Things and industry 4.0 standard 2. To understand the design features of Internet of Things (IoT) 3. To understand concepts of data management and data analytics in IoT 4. To understand the concept and framework of industry 4.0 standard 5. To understand the application of IoT and Industry 4.0 standard.	
Course Outcomes:	1. Describe the concepts of Internet of Things. 2. Illustrate various protocols of web connectivity. 3. Analyse and compare tools for data management and analytics in IoT. 4. Explain various frameworks for industry 4.0 standards. 5. Prepare case studies on applications of IIOT. 6. Explain advanced concepts and applications of industry 4.0	

Module No & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisites and Course Outlines	Prerequisite Concepts and Course Introduction	-	02	02
1. Introduction to IoT	1.1 Introduction - Defining IoT, Characteristics of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Sources of IoT, IoT and M2M - IoT/M2M System layers and Design standardization	1	02	06
	1.2 Defining Specifications About - Purpose & requirements, process, domain model, information model Operational view, Device and Component Integration, Application Development.		04	
2. Network & Communication aspects	2.1 Design Principles & Web Connectivity - Web Communication Protocols for connected devices, Web connectivity using Gateway, SOAP, REST, HTTP, RESTful and Web Sockets (Publish — Subscribe), MQTT.	2	04	08
	2.2 Internet Connectivity: - Internet connectivity, Internet based communication, IP addressing in IoT, Media Access Control, Application Layer Protocols. LPWAN Fundamentals: LORA, NBIoT		04	

Module No & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
3. Data Management and Analytics for IoT	3.1 Introduction, Apache Hadoop, Using Hadoop MapReduce for Batch Data Analysis, Apache Spark, Apache Cassandra	3	04	06
	3.2 Analysis, Case Study on Structural Health Monitoring, Crash detection system using IoT		02	
4. Introduction to Industry 4.0	4.1 Industry 4.0: Managing the Digital Transformation, Conceptual framework for Industry 4.0, Industrial IoT (IIoT) - Introduction, Business Model and Reference Architecture, Industrial IoT Layers, Sensing, Processing, Communication.	4	04	08
	4.2 Cyber Physical Systems and Next Generation Sensors, Collaborative Platform and Product Lifecycle Management, case study on Augmented Reality and IoT		04	
5. Introduction to Industrial IoT (IIoT)	5.1 Industrial IoT- Application Domains: Healthcare, Power Plants, Inventory Management & Quality Control	5	03	06
	5.2 Artificial Intelligence, Cybersecurity in Industry 4.0, Internet of Things for Industry 4.0 Design, Challenges and Solutions		03	
6. Industry 4.0 Technologies and Applications	6.1 Internet of Things and New Value Proposition.: Examples for IoTs Value Creation in Different Industries.	6	03	05
	6.2 Introduction to Industry 5.0, Human Machine Interaction, cognitive computing with human intelligence, Case study on AI based solution		02	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
			Total:	**42**

Books:	
Text Books	1. Arshdeep Bahga and Vijay Madisetti, "Internet of Things: A Hands-on Approach, Universities Press. 2. Raj Kamal, " Internet of Things: Architecture and Design Principles", McGraw Hill Education ,First edition 3. Radha Shankarmani, M Vijayalakshmi, "Big Data Analytics", Wiley Publications, 4. Andrew Minteer ,"Analytics for the Internet of Things(IoT)",Kindle Edition 5. Giacomo Veneri , Antonio Capasso," Hands-On Industrial Internet of Things: Create a powerful Industrial IoT infrastructure using Industry 4.0", Packt

Reference Books	1. Alp Ustundag Emre Cevikcan," Industry 4.0: Managing The Digital Transformation",Springer Series in Advanced Manufacturing 2. G. R. Kanagachidambaresan, R. Anand, E. Balasubramanian, V. Mahima, Internet of Things for Industry 4.0. EAI/Springer Innovations in Communication and Computing 3. The Internet of Things (Connecting objects to the web) by Hakima Chaouchi (Wiley Publications). 4. The Internet of Things (MIT Press) by Samuel Greengard 5. Adrian McEwen, Hakim Cassimally, : Designing the Internet of Things", Paperback,First Edition

Useful Links:

1. https://onlinecourses.nptel.ac.in

Suggested MOOCs:

1. 1.https://onlinecourses.nptel.ac.in/noc20_cs69 - Introduction to Industry 4.0 and Industrial Internet of Things, By Prof. Sudip Misra, IIT Kharagpur
2. https://www.edx.org/course/industry-40-how-to-revolutionize-your-business - Industry 4.0: How to Revolutionize your Business
3. https://onlinecourses.nptel.ac.in/noc21_cs17 - Introduction to internet of things, by Prof. Sudip Misra , IIT Kharagpur
4. 4 https://onlinecourses.nptel.ac.in/noc21_cs08 - Embedded Systems Design By Prof. Anupam Basu, IIT Kharagpur

Recommended list of tools:

1. Node Red - https://nodered.org/
2. M2MLabs Mainspring - http://www.m2mlabs.com/
3. Tensor Flow - https://www.tensorflow.org/
4. Things Speak - https://thingspeak.com

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1 (T-1)	20 marks
2.	Class Test 2 (T-2)	20 marks

Class Tests (20 Marks):

Two class tests of 20 marks each should be conducted in a semester. The first-class test is to be conducted when approx. 40% syllabus is completed and second-class test when additional 40% syllabus (but excluding contents covered in Test I) is completed. Duration of each test shall be one hour. Addition of both test scores will be considered for passing.

End Semester Theory Examination will be of 60 Marks with Two Hours and 30 Minutes duration.

Course Code	Major / Professional Elective – Department Level Course – II	Credits (TH+P+TUT)
EXDLC6033	**Robotics**	**3+0+0**
Prerequisite:	1. Microcontroller 2. Linear Algebra, matrix transformation Control system	
Course Objectives:	1. To introduce industrial Robotic ARM 2. To offer mathematical and engineering knowledge for sensor and actuators of Robotics 3. To offer understanding of control of Robot 4. To give exposure of intelligent Robotics	
Course Outcomes:	After taking this course student will be able to 1. Describe the steps involved in ARM manipulator design 2. Select a suitable drive System for robot application 3. Select a suitable sensor for robot application 4. Solve Direct Kinematics and inverse kinematics problem 5. Explain working of semi and autonomous Robot for structure and unstructured environment. 6. Describe Algorithm for Robot Navigation in structured and unstructured environment	

Module No & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Fundamentals of Robotics	1.1 Evolution of Robotics: Automation to AI Robotics, Robotic Paradigm: Sense, plan and act, Laws of Robotics, D-H Algorithm	5	03	04
	1.2 Specification of Robot, Classification of Robot, Robot Configuration	5	01	
2. Industrial Robotics	2.1 Simple manipulators: two / three ARM manipulators and their kinematics equation, Work space homogeneous	1, 4	02	06
	2.2 D-H Procedure, ROBOT Parameter, ARM matrix, DH matrix	1, 4	02	
	2.3 Inverse kinematics for manipulators	4	02	
3. Actuators, sensors and their control	3.1 DC motors, Brushless PM DC motor, AC/DC servomotor	2	01	06
	3.2 Sensors for Robots: camera, position encoders, tactile, hall, Force Sensors, Lidar	3, 5	02	
	3.3 Spring mass damper model, Combination of P,I and D control, PID control, Case study of Robocon Bots designed by KJSIEIT Robocon students team.	2, 5	03	
4. Introduction to Software for Robotics	4.1 ARM training, VAL	5, 6	01	08
	4.2 Matlab /octave for fast prototyping of Robots, Introduction to C++, C ++ for Robot Operating System (ROS)	5, 6	07	

Module No & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
5. Probabilistic Robotics for Navigation	5.1 Basics of Probability, Recursive state Estimation: Bayes filter	5, 6	03	07
	5.2 Mobile Robot Localization problem, path planning strategies: BFS; DFS; Dijsktra; A star ; D star; SLAM algorithm	5, 6	04	
6. AI Robotics and case study	6.1 State machine for Behavioural planning Machine Learning for Robotics, Supervised learning, Unsupervised Learning, Reinforcement Learning: State, action and award, RL for Robotics, Convolution Neural Networks for supervised Learning: Object detection, NLP for Robotics	5, 6	04	08
	6.2 Business Use Cases : Swaaytt Robotics, Boston Dynamics	5, 6	04	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
			Total	**42**

Books:	
Text Books	1. ROBOTICS, Appu Kuttan K.K., I.K. international Publishing house,1st Edition 2012 2. Introduction to Autonomous Mobile Robots, Roland Siegwart, Illah Reza Nourbakhsh and Davide Scaramuzza, Bradford Company Scituate, USA 2004
Reference Books	1. Fundamental of Robotics: Analysis and Control Robert J. Schilling 2. Introduction to AI Robotics, 2nd Edition, R. Murphy, MIT Press
Useful Links:	
1. http://www.swaayatt-robots.com/ 2. https://www.bostondynamics.com/ 3. http://www.iitg.ac.in/cse/robotics/?page_id=1349 4. https://modernrobotics.northwestern.edu/nu-gm-book-resource/2-2-degrees-of-freedom-of-a-robot/#department	

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1 (T-1)	20 marks
2.	Class Test 2 (T-2)	20 marks

Class Tests (20 Marks):

Two class tests of 20 marks each should be conducted in a semester. The first-class test is to be conducted when approx. 40% syllabus is completed and second-class test when additional 40% syllabus (but excluding contents covered in Test I) is completed. Duration of each test shall be one hour. Addition of both test scores will be considered for passing.

End Semester Theory Examination will be of 60 Marks with Two Hours and 30 Minutes duration.

Course Code	Major / Professional Elective – Department Level Course – II	Credits (TH+P+TUT)
EXDLC6034	**Database Management System**	**3+0+0**

Prerequisite:	1. Basic knowledge of programming
Course Objectives:	1. To learn and practice data modelling using the entity-relationship and developing database designs 2. To understand the use of Structured Query Language (SQL) and learn SQL syntax. 3. To understand the needs of database processing and learn techniques for controlling the consequences of concurrent data access
Course Outcomes:	1. Explain the fundamentals of database systems. 2. Design ER and EER diagram for real life problems. 3. Apply concepts of Normalization to relational database design 4. Explain the relational algebra queries 5. Solve database Query using SQL. 6. Explain the concept of transaction, concurrency and recovery.

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisites and Course Outlines	Prerequisite Concepts and Course Introduction	-	02	02
1. Introduction to Databases and Transactions	Introduction to databases, History of database system, Benefits of Database system over file system, relational databases, database architecture, transaction management	1	02	02
2. Data Models	The importance of data models, Basic building blocks, Business rules, Evolution of data models (hierarchical, Network, Relational, Entity relationship and object model), Degrees of data abstraction.	2	05	05
3. Database Design, ER-Diagram and Unified Modelling Language	Database design and ER Model: overview, ER-Model, Constraints, ER-Diagrams, ERD Issues, weak entity sets, Codd's rules, Relational Schemas, Introduction to UML Relational database model: Logical view of data, keys, and integrity rules. Relational Database design: features of good relational database design, atomic domain and Normalization (1NF, 2NF, 3NF, BCNF).	3	08	08

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
4. Relational Algebra and Calculus	Relational algebra: introduction, Selection and projection, set operations, renaming, Joins, Division, syntax, semantics. Operators, grouping and ungrouping, relational comparison. Calculus: Tuple relational calculus, Domain relational Calculus, Calculus Vs Algebra, computational capabilities.	4	08	08
5. Constraints, Views and SQL	What are constraints, types of constrains, Integrity constraints, Views: Introduction to views, data independence, security, updates on views, comparison between tables and views SQL: data definition, aggregate function, Null Values, nested sub queries, Joined relations. Triggers.	5	08	08
6. Transaction management and Concurrency control	Transaction management: ACID properties, serializability and concurrency control, Lock based concurrency control (2PL, Deadlocks), Time stamping methods, optimistic methods, database recovery management.	6	08	08
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
			Total:	**42**

Books:	
Text Books	1. A Silberschatz, H Korth, S Sudarshan, "Database System and Concepts", Fifth Edition McGraw-Hill 2. Rob, Coronel, "Database Systems", Seventh Edition, Cengage Learning 3. Ramez Elmasri, Shamkant B. Navathe, "Fundamentals of Database System", Seventh Edition, Person. 4. G. K. Gupta: "Database Management Systems", McGraw – Hill.
Reference Books	1. Peter Rob and Carlos Coronel, "Database Systems Design, Implementation and Management", Thomson Learning, 5th Edition 2. P.S. Deshpande, "SQL and PL/SQL for Oracle 11g, Black Book", Dreamtech Press 3. Mark L. Gillenson, Paulraj Ponniah, "Introduction to Database Management", Wiley 4. Raghu Ramkrishnan and Johannes Gehrke, "Database Management Systems", TMH 5. Debabrata Sahoo "Database Management Systems" Tata McGraw Hill, Schaum's Outline
Useful Links:	
1. https://www.tutorialspoint.com/dbms/index.htm 2. https://www.studytonight.com/dbms/ 3. https://beginnersbook.com/2015/04/dbms-tutorial/ 4. https://www.w3schools.in/dbms/ 5. https://www.tutorialcup.com/dbms	

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1 (T-1)	20 marks
2.	Class Test 2 (T-2)	20 marks

Class Tests (20 Marks):

Two class tests of 20 marks each should be conducted in a semester. The first-class test is to be conducted when approx. 40% syllabus is completed and second-class test when additional 40% syllabus (but excluding contents covered in Test I) is completed. Duration of each test shall be one hour. Addition of both test scores will be considered for passing.

End Semester Theory Examination will be of 60 Marks with Two Hours and 30 Minutes duration.

Course Code	Open Elective -Institute Level Course - I	Credits (TH+P+TUT)
ILC6051	Product Life Cycle Management	3+0+0
Course Objectives:	1. To familiarize the students with the needs, benefits and components of PLM. 2. To acquaint students with Product Data Management & PLM strategies. 3. To give insights into new product development programs and guidelines for designing and developing a product. 4. To familiarize the students with Virtual Product Development**.**	
Course Outcomes:	1. Apply the different phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation. 2. Analysis various approaches and techniques for designing and developing products. 3. Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc. 4. Applying virtual product development tools for components, machining and manufacturing plants. 5. Create an Integration of Environmental Aspects in Product Design 6. Analysis the Life Cycle Assessment and Life Cycle Cost Analysis	

Module No & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs /Module
i. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Introduction to Product Lifecycle Management (PLM)	Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications PLM Strategies: Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy ,Change management for PLM	1	10	10
2. Product Design:	Product Design: Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent	2	09	09

Module No & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs /Module
	Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process.			
3. Product Data Management (PDM)	Product Data Management (PDM):Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation.	3	05	05
4. Virtual Product Development Tools	Virtual Product Development Tools: For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies.	4	05	05
5. Integration of Environmental Aspects in Product Design	Integration of Environmental Aspects in Product Design: Sustainable Development, Design for Environment, Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design	5	05	05
6. Life Cycle Assessment and Life Cycle Cost Analysis	Life Cycle Assessment and Life Cycle Cost Analysis: Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis	6	05	05
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization	–	01	01
			Total	**42**

Books:	
Text Books	1. Product Lifecycle Management Authors: Saaksvuori, Antti, Immonen, Anselmi ISBN 978-3-540-26906-9 2. Product Lifecycle Management: 21st Century Paradigm for Product Realisation Decision engineering, ISSN 1619-5736,2005
Reference Books	1. John Stark, "Product Lifecycle Management: Paradigm for 21st Century Product Realisation", Springer-Verlag, 2004. ISBN: 1852338105 2. Fabio Giudice, Guido La Rosa, AntoninoRisitano, "Product Design for the environment-A life cycle approach", Taylor & Francis 2006, ISBN: 08493272293. Saaksvuori Antti, Immonen Anselmie, "Product Life Cycle Management", Springer, Dreamtech, ISBN: 3540257314 **3.** Michael Grieve, "Product Lifecycle Management: Driving the next generation of lean thinking", Tata McGraw Hill, 2006, ISBN:0070636265

Useful Links:

1. https://www.intechopen.com/books/product-lifecycle-management-terminology-and-applications/introductor y-chapter-product-lifecycle-management-terminology
2. https://www.spectechular.walkme.com/top-3-product-lifecycle-management-books/
3. https://dasme.co/wp-content/uploads/2016/07/plm.pdf
4. https://books.google.co.in/books/about/Product_Lifecycle_Management.html?id=PiVri4OyU7AC&redir_esc=y

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1 (T-1)	20 marks
2.	Class Test 2 (T-2)	20 marks

Class Tests (20 Marks):

Two class tests of 20 marks each should be conducted in a semester. The first-class test is to be conducted when approx. 40% syllabus is completed and second-class test when additional 40% syllabus (but excluding contents covered in Test I) is completed. Duration of each test shall be one hour. Addition of both test scores will be considered for passing.

End Semester Theory Examination will be of 60 Marks with Two Hours and 30 Minutes duration.

Course Code	Open Elective - Institute Level Course - I	Credits (TH+P+TUT)
ILC6052	**Reliability Engineering**	**3+0+0**
Course Objectives:	1. To familiarize the students with various aspects of probability theory 2. To acquaint the students with reliability and its concepts 3. To introduce the students to methods of estimating the system reliability of simple and complex systems 4. To understand the various aspects of Maintainability, Availability and FMEA procedure	
Course Outcomes:	1. Apply the concept of Probability to engineering problems 2. Apply various reliability concepts to calculate different reliability parameters 3. Estimate the system reliability of simple and complex systems 4. Apply the knowledge to improve reliability of complex system 5. Analysis the Maintainability and Availability of system 6. Identity a Failure Mode Effect and Criticality Analysis.	

Module No & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Hrs/ Module
i. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Probability	1.1 Probability theory: Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem.	1	03	08
	1.2 Probability Distributions: Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance.		03	
	1.3 Measures of Dispersion: Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.		02	
2. Reliability Concept	2.1 Reliability Concepts: Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve	2	03	08
	2.2 Failure Data Analysis: Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions.		03	

Module No & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Hrs/ Module
	2.3 Reliability Hazard Models: Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.		02	
3. System Reliability	System Reliability: System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.	3	05	05
4. Reliability Improvement	4.1 Reliability Improvement: Redundancy Techniques: Element redundancy, Unit Redundancy, Standby redundancies. Markov analysis.		04	08
	4.2 System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method.	4	04	
5. Maintainability and Availability	Maintainability and Availability: System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. Availability – qualitative aspects.	5	05	05
6. Failure Mode, Effects and Criticality Analysis	Failure Mode, Effects and Criticality Analysis: Failure mode effects analysis, Severity/ criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fau1t tree analysis and Event tree Analysis	6	05	05
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization	-	01	01
			Total	**42**

Books:	
Text Books	1. Introduction To Reliability Engineering 2Nd Edition by Lewis, Wiley India 2. Reliability Engineering Theory And Practice 8Ed (Hb 2017) by BIROLINI A., SPRINGER 3. The Certified Reliability Engineer Handbook by Donald W. Benbow, Hugh W. Broome, New Age International (P) Ltd., Publishers
Reference Books	1. L.S. Srinath, "Reliability Engineering", Affiliated East-Wast Press (P) Ltd., 1985. 2. Charles E. Ebeling, "Reliability and Maintainability Engineering", Tata McGraw Hill. 3. B.S. Dhillion, C. Singh, "Engineering Reliability", John Wiley & Sons, 1980. 4. P.D.T. Conor, "Practical Reliability Engg.", John Wiley & Sons, 1985. 5. K.C. Kapur, L.R. Lamberson, "Reliability in Engineering Design", John Wiley & Sons. 6. Murray R. Spiegel, "Probability and Statistics", Tata McGraw-Hill Publishing Co. Ltd.

Useful Links:

1. https://victorops.com/blog/the-comprehensive-site-reliability-engineering-sre-pdf
2. https://nptel.ac.in/courses/105/108/105108128/
3.https://nptel.ac.in/content/storage2/courses/112101005/downloads/Module_5_Lecture_3_final.pdf
4. https://documents.in/document/curso-nptel-reliability-engineering.html
5. https://www.coursera.org/learn/site-reliability-engineering-slos

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1 (T-1)	20 marks
2.	Class Test 2 (T-2)	20 marks

Class Tests (20 Marks):

Two class tests of 20 marks each should be conducted in a semester. The first-class test is to be conducted when approx. 40% syllabus is completed and second-class test when additional 40% syllabus (but excluding contents covered in Test I) is completed. Duration of each test shall be one hour. Addition of both test scores will be considered for passing.

End Semester Theory Examination will be of 60 Marks with Two Hours and 30 Minutes duration.

Course Code	Open Elective - Institute Level Course - I	Credit (TH+P+TUT)
ILC6053	**Management Information System**	**3+0+0**
Course Objectives:	1. To discuss the roles played by information technology in business and define various technology architectures on which information systems are built. 2. To define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage. 3. To identify the basic steps in systems development.	
Course Outcomes:	1. Describe how information systems transform business. 2. Identify the impact information systems have on an organization. 3. Describe IT infrastructures and its components and its current trends. 4. Explain the principal tools and technologies for accessing information from databases. 5. Apply to improve business performance and decision making. 6. Identify the types of systems used for enterprise wide knowledge management.	

Module No & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Hrs/ Module
i. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Introduction to Information System	1.1 Computer Based Information Systems, Impact of IT on organizations.	1	02	04
	1.2 Importance of IS to Society. Organizational Strategy, Competitive Advantages and IS.	1	02	
2. Data and Knowledge Management	2.1 Data and Knowledge Management: Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management.	2,3	04	07
	2.2 Business intelligence (BI): Managers and Decision Making, BI for Data analysis and Presenting Results.	2,3	03	
3. Ethical Issues and Privacy	3.1 Ethical issues and Privacy: Information Security.	3	03	07
	3.2 Threat to IS and Security Controls.	3	04	
4. Social Computing (SC)	4.1 Social Computing (SC): Web 2.0 and 3.0, SC in business-shopping, Marketing.	4	03	07
	4.2 Operational and Analytical CRM, E-business and E-commerce – B2B B2C.	4	04	

	Mobile commerce.			
5.Computer Networks	5.1 Computer Networks Wired and Wireless technology.	5	03	06
	5.2 Pervasive computing, Cloud computing model.	5	03	
6.Project leadership and Ethics and Closing the projects	6.1 Information System within Organization: 6.2 Transaction Processing Systems, Functional Area Information System.	6	04	08
	6.3 ERP and ERP support of Business Process. Acquiring Information Systems and Applications: Various System development life cycle models. Managing without authority; Areas of further study.	6	04	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization	–	01	01
			Total	**42**

Books:	
Text Books:	1. K. Rainer, Brad Prince,Management Information Systems, Wiley . 2. K.C. Laudon and J.P. Laudon, Management Information Systems: Managing the Digital Firm 10th Ed., Prentice Hall.
Reference Books:	1. S. Jawadekar's Management Information Systems: published by McGraw-Hill Education. 2. D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization, Prentice Hall.

Useful Links:

1. https://www.nptel.ac.in/
2. https://www.coursera.org/

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1 (T-1)	20 marks
2.	Class Test 2 (T-2)	20 marks

Class Tests (20 Marks):

Two class tests of 20 marks each should be conducted in a semester. The first-class test is to be conducted when approx. 40% syllabus is completed and second-class test when additional 40% syllabus (but excluding contents covered in Test I) is completed. Duration of each test shall be one hour. Addition of both test scores will be considered for passing.

End Semester Theory Examination will be of 60 Marks with Two Hours and 30 Minutes duration.

Course Code	Open Elective - Institute Level Course - I	Credits (TH+P+TUT)
ILC654	**Design of Experiments**	**3+0+0**
Prerequisites:	---	
Course Objectives (COBs):	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 designs for robustness and optimization	
Course Outcomes(COs):	1. Plan data collection, to turn data into information and to make decisions that lead to appropriate action. 2. Analyze the different fitting regression models. 3. Apply the different two level factorial designs. 4. Distinguish the different fractional factorial methods. 5. Apply the methods taught to real life situations. 6. Plan, analyze, and interpret the results of experiments.	

Module No & Name	Sub Topics	CO Mapped	Hrs/Sub Topic	Total Hours
i. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Introduction	1.1 Strategy of Experimentation, Typical Applications of Experimental Design.	1	01	03
	1.2 Guidelines for Designing Experiments, Response Surface Methodology.	1	02	
2. Fitting Regression Models	2.1 Linear Regression Models, Estimation of the Parameters in Linear Regression Models, Hypothesis Testing in Multiple Regression.	2	04	08
	2.2 Confidence Intervals in Multiple Regression, Prediction of new response observation, Regression model diagnostics, Testing for lack of fit.	2	04	
3. Two Levels Factorial Designs	3.1 The 2^2 Design, The 2^3 Design, The General2k Design.	3	04	08
	3.2 A Single Replicate of the 2^k Design, The Addition of Center Points to the 2^k Design, Blocking in the 2^k Factorial Design, Split-Plot Designs.	3	04	
4. Two Levels Fractional Factorial Methods	4.1 The One-Half Fraction of the 2^k Design, The One-Quarter Fraction of the 2^k Design, The General 2^{k-p} Fractional Factorial Design.	4	04	08
	4.2 Resolution III Designs, Resolution IV and V Designs, Fractional Factorial Split-Plot Designs.	4	04	
5. Response Surface	5.1 Introduction to Response Surface Methodology, The Method of Steepest Ascent.	5	04	08

Module No & Name	Sub Topics	CO Mapped	Hrs/Sub Topic	Total Hours
Methods and Designs	5.2 Analysis of a Second-Order Response Surface, Experimental Designs for Fitting Response Surfaces.	5	04	
6. Taguch Approach	6.11 Crossed Array Designs and Signal-to-Noise Ratios.	6	02	04
	6.2 Analysis Methods, Robust design examples.	6	02	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization	-	02	01
		Total		**42**

Books:	
Text Books	1. R. Mayers, D. Montgomery and C. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, John Wiley & Sons, New York. 2. D. Montgomery, Design and Analysis of Experiments, John Wiley & Sons, New York. 3. W. Dimond, Peactical Experiment Designs for Engineers and Scientists, John Wiley and Sons.
Reference Books	1. G. Box, J Hunter and W. Hunter, Statics for Experimenters: Design, Innovation and Discovery, Wiley. 2. A. Dean, and D. Voss, Design and Analysis of Experiments, Springer. 3. P. Ross, Taguchi Technique for Quality Engineering, McGraw Hill. 4. M. Phadake, Quality Engineering using Robust Design, Prentice Hall.
Useful Links:	
1. https://nptel.ac.in/courses/110/105/110105087/ 2. https://www.udemy.com/course/design-of-experiments-i/	

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1 (T-1)	20 marks
2.	Class Test 2 (T-2)	20 marks

Class Tests (20 Marks):

Two class tests of 20 marks each should be conducted in a semester. The first-class test is to be conducted when approx. 40% syllabus is completed and second-class test when additional 40% syllabus (but excluding contents covered in Test I) is completed. Duration of each test shall be one hour. Addition of both test scores will be considered for passing.

End Semester Theory Examination will be of 60 Marks with Two Hours and 30 Minutes duration.

Course Code	Open Elective - Institute Level Course - I	Credits (TH+P+TUT)
ILC6055	Operation Research	3+0+0
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:	1. Define and formulate linear programming problems and solve them by applying appropriate techniques. 2. Determining the optimum solution for transportation and Assignment models. 3. Choose the appropriate queuing model for a given practical application and propose the best strategy and value of the given game model. 4. Use CPM and PERT techniques, to plan, schedule and control project activities. Determining the optimum sequence to process jobs. 5. Judge classical & probabilistic inventory models and simulate different real life probabilistic situation using Monte Carlo simulation technique. 6. Selecting the best strategy from various alternatives by applying various tools and methodology for decision-making.	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisite and Course outline	Prerequisite concepts, Introduction, Structure of the Mathematical Model, Limitations of operational research.	-	01	01
1. Linear Programming	1.1 Linear Programming: Problem formulation, Graphical Method and simplex method.	1	04	10
	1.2 Artificial Variable Simplex Techniques: Big-M Method and Two-Phase Method.	1	03	
	1.3 Advanced Topics in Linear Programming: Duality in Linear Programming and the Dual Simplex Method.	1	03	
2. Transportation models and Assignment mo dels	2.1 Transportation Model: North-west corner method, Row Minima method, Column Minima method, Least – cost method, Vogel's Approximation method, Optimality by MODI method and Unbalanced Transportation Problem.	2	03	06
	2.2 Assignment Model: The Hungarian method for solution of Assignment problems,	2		

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	Unbalanced assignment problem and maximization problem.		03	
3. Queuing Model and Game Theory	3.1 Queuing Models: Introduction, Single-channel, Finite population model with Poisson Arrivals and Exponential Service Times (Limited Source Model).	3	03	06
	3.2 Game Theory, Saddle Point, Minimax (Maximin) Method of Optimal strategies, Value of The Game. Solution of Games with Saddle Points, Dominance Principle. Rectangular Games Without Saddle Point – Mixed Strategy for 2 x 2 Games.	3	03	
4. Network analysis in project planning and Sequencing models	4.1 Project Management: Phases of project management, Network construction, Critical Path Method (CPM) and Process Evaluation & Review Techniques (PERT). (Exclude Cost analysis, crashing, resource scheduling and updating)	4	04	07
	4.2 Sequencing Models: Processing n jobs through one machine, two machines and three machines, Processing n jobs through m machines.	4	03	
5.Inventory Control and Simulation	5.1 Inventory Models: Introduction, Inventory models with Deterministic demand (with and without shortages) and Inventory models with price breaks.	5	04	07
	5.2 Simulation: Definition, Types of Simulation Models, Monte Carlo Technique, Practical Problems, Applications in Queuing and Inventory problems.	5	03	
6. Decision Theory	Steps in Decision theory approach, Decision – Making Environments, Decision making under conditions of certainty and uncertainty, Decision making under conditions of Risk and Decision Trees.	6	04	04
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization	–	01	01
		Total		**42**

Reference Books:	1. Taha, H.A. "Operations Research - An Introduction", Prentice Hall, (7th Edition), 2002. 2. Ravindran, A, Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", John Willey and Sons, 2nd Edition, 2009 3. Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", Tata McGraw Hill, 2002. 4. Operations Research, S. D. Sharma, KedarNath Ram Nath-Meerut 5. Operations Research, KantiSwarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons

Useful Links:

1. https://onlinecourses.nptel.ac.in/noc19_ma29/preview
2. https://www.coursera.org/courses?query=operations%20research

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1 (T-1)	20 marks
2.	Class Test 2 (T-2)	20 marks

Class Tests (20 Marks):

Two class tests of 20 marks each should be conducted in a semester. The first-class test is to be conducted when approx. 40% syllabus is completed and second-class test when additional 40% syllabus (but excluding contents covered in Test I) is completed. Duration of each test shall be one hour. Addition of both test scores will be considered for passing.

End Semester Theory Examination will be of 60 Marks with Two Hours and 30 Minutes duration.

Course Code	Open Elective - Institute Level Course - I	Credits (TH+P+TUT)
ILC6056	**Cyber Security and Laws**	**3+0+0**
Course Objectives:	1. To understand and identify different types cybercrime and cyber law 2. To recognized Indian IT Act 2008 and its latest amendments 3. To learn various types of security standards compliance	
Course Outcomes:	1. Explain the concept of cybercrime and its effect on outside world 2. Classify and Examine the Cyber Offences and security implications. 3. Illustrate and identify the modus operandi followed in cyber-crimes. 4. Explain the aspects in Indian Cyber Laws 5. Explain the penalties in cyber law. 6. Apply Information Security Standards compliance during software design and development	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Introduction to Cybercrime	Cybercrime definition and origins of the world, Cybercrime and information security, Classifications of cybercrime, Cybercrime and the	1	04	04
2. Cyber Offenses & Cybercrime	How criminal plan the attacks, Social Engg, Cyber stalking, Cyber café and Cybercrimes, Botnets, Attack vector, Cloud computing, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Devices-Related Security Issues, Organizational Security Policies and Measures in Mobile Computing Era, Laptops	2	09	09
3. Tools and Methods Used in Cyber line	Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer OverFlow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	4	04	06
4. The Concept of Cyberspace	E-Commerce , The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law ,The Intellectual Property Aspect in Cyber Law, The Evidence Aspect in Cyber Law , The Criminal Aspect in Cyber Law, Global Trends in Cyber	3	08	08

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	Law , Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking , The Need for an Indian Cyber Law			
5. Indian IT Act	Cyber Crime and Criminal Justice: Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	5	06	06
6. Information Security Standard compliance	SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	6	06	06
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization	–	01	01
			Total	**42**

Books:	
Text Books:	1. William Stallings, *Cryptography and Network Security*, Pearson Publication The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi 2. Nina Godbole, Sunit Belapure, *Cyber Security*, Wiley India, New Delhi 3. Cyber Law & Cyber Crimes By Advocate Prashant Mali; Snow White Publications, Mumbai
Reference Books:	1. Nina Godbole, Sunit Belapure, *Cyber Security*, Wiley India, New Delhi 2. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi 3. The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi. 4. Cyber Law & Cyber Crimes By Advocate Prashant Mali; Snow White Publications, Mumbai 5. Nina Godbole, *Information Systems Security*, Wiley India, New Delhi 6. Kennetch J. Knapp, *Cyber Security* & *Global Information Assurance* Information Science Publishing. 7. William Stallings, *Cryptography and Network Security*, Pearson Publication
Useful Links:	
1. Websites for more information is available on : The Information Technology ACT, 2008- TIFR : https://www.tifrh.res.in 2. Website for more information , A Compliance Primer for IT professional https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer-professionals- 33538	

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1 (T-1)	20 marks
2.	Class Test 2 (T-2)	20 marks

Class Tests (20 Marks):

Two class tests of 20 marks each should be conducted in a semester. The first-class test is to be conducted when approx. 40% syllabus is completed and second-class test when additional 40% syllabus (but excluding contents covered in Test I) is completed. Duration of each test shall be one hour. Addition of both test scores will be considered for passing.

End Semester Theory Examination will be of 60 Marks with Two Hours and 30 Minutes duration.

Course Code	Open Elective - Institute Level Course - I	Credits (TH+P+TUT)
ILC6057	**Disaster Management and Mitigation Measures**	**3+0+0**

Prerequisites:	Basics of Physics
Course Objectives:	1. To Understand Physics and Various Types of Disaster Occurring Around the World. 2. To Identify Extent and Damaging Capacity of a Disaster. 3. To Study and Understand the Means of Losses and Methods to Overcome Minimize it. 4. To Understand Application of GIS in the Field of Disaster Management. 5. To Understand the Emergency Government Response Structures Before, During and after Disaster.
Course Outcomes:	1. Illustrate the importance of Disaster Management 2. Discuss natural as well as man made disaster and their extent and possible effects on the economy. 3. Use government policies, acts and various organizational structures associated with an emergency. 4. Devise various Framework for Disaster Management in India. 5. Reviewing various approaches of disaster relief measures. 6. Generalize the simple do‘s and don‘ts in such extreme events and act accordingly

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Introduction	1.1 Definition of Disaster, Hazard, Global and Indian Scenario, General Perspective, Importance of Study in Human Life.	1	02	04
	1.2 Direct and Indirect Effects of Disasters, Long Term Effects of Disasters.		02	
2. Natural Disaster and Manmade disasters	2.1 Natural Disaster: Meaning and Nature of Natural Disaster, Flood, Flash Flood, Drought, Cloud Burst.	2	01	07
	2.2 Earthquake, Landslides, Avalanches, Volcanic Eruptions, Mudflow, Cyclone, Storm, Storm Surge.		01	
	2.3 Climate Change, Global Warming, Sea Level Rise, Ozone Depletion.		02	
	2.4 Man Made Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of Growing Population and Subsequent Industrialization.		02	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	2.5 Urbanization and Changing Lifestyle of Human Beings in Frequent Occurrences of Manmade Disasters.		01	
3. Disaster Management, Policy and Administration	3.1 Disaster Management: Meaning, Concept, Importance.	3	02	06
	3.2 Objective of Disaster Management Policy, Disaster Risks in India, Paradigm Shift in Disaster Management.		02	
	3.3 Policy and Administration Importance and Principles of Disaster Management Policies, Command and Coordination of Disaster Management.		01	
	3.4 Rescue Operations: How to Start With And How to Proceed in Due Course of Time, Study of Flowchart Showing the Entire Process.		01	
4. Institutional Framework for Disaster Management in India	4.1 Importance of Public Awareness, Preparation and Execution of Emergency Management Programme. Scope and Responsibilities of National Institute of Disaster Management (NIDM) and National Disaster Management Authority (NDMA) in India.	4	02	06
	4.2 Methods and Measures to Avoid Disasters, Management of Casualties, Set Up of Emergency Facilities, Importance of Effective Communication Amongst Different Agencies in Such Situations.		02	
	4.5 Use of Internet and Software for Effective Disaster Management. Applications of GIS, Remote Sensing and GPS.		02	
5. Financing Relief Measures	5.1 Ways to Raise Finance for Relief Expenditure, Role of Government Agencies and NGO's in this Process.	5	02	08
	5.2 Legal Aspects Related to Finance Raising as well as Overall Management of Disasters.		02	
	5.3 Various NGO's and the Works they have Carried Out in the Past on the Occurrence of Various Disasters, Ways to Approach these Teams.		02	
	5.4 International Relief Aid Agencies and Their Role in Extreme Events.		02	
6. Preventive and Mitigation Measures	6.1 Pre-Disaster, During Disaster and Post-Disaster Measures in Some Events in General.	6	02	08
	6.2 Structural Mapping: Risk Mapping, Assessment and Analysis, Sea Walls and Embankments, Bio Shield, Shelters, Early Warning and Communication.		02	
	6.3 Non-Structural Mitigation: Community Based Disaster Preparedness, Risk Transfer and Risk Financing, Capacity Development and Training, Awareness And Education, Contingency Plans.		02	
	6.4 Do's And Don'ts in Case of Disasters and		02	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	Effective Implementation of Relief Aids.			
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization	–	01	01
			Total	**42**

Books:	
Text Books:	1. H Gupta Disaster Management, Universities Press Publications. 2. O Dagur, Disaster Management: An Appraisal of Institutional Mechanisms in India, Centre for Land Warfare Studies. 3. C Damon and Butterworth, Introduction to International Disaster Management, Elseveir Publications.
Reference Books:	1. K. Yonng, Concepts and Techniques of GIS –C.P.Lo, Prentice Hall (India) Publications. 2. R Singh, Natural Hazards and Disaster Management, Vulnerability and Mitigation, Rawat Publications.
Useful Links:	
1 www.msme.gov.in/ 2. www.dcmesme.gov.in/ 3. www.msmetraining.gov.in/	

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1 (T-1)	20 marks
2.	Class Test 2 (T-2)	20 marks

Class Tests (20 Marks):

Two class tests of 20 marks each should be conducted in a semester. The first-class test is to be conducted when approx. 40% syllabus is completed and second-class test when additional 40% syllabus (but excluding contents covered in Test I) is completed. Duration of each test shall be one hour. Addition of both test scores will be considered for passing.

End Semester Theory Examination will be of 60 Marks with Two Hours and 30 Minutes duration.

Course Code	Open Elective - Institute Level Course - I	Credits (TH+P+TUT)
ILC6058	**Energy Audit and Management**	**3+0+0**
Prerequisite:	——	
Course Objectives:	1. To understand the importance of energy security for sustainable development and the fundamentals of energy conservation. 2. To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management 3. To relate the data collected during performance evaluation of systems for identification of energy saving opportunities.	
Course Outcomes:	1. Identify and describe the present state of energy security and its importance. 2. Identify and describe the basic principles and methodologies adopted in energy audit of an utility. 3. Describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities. 4. Describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities 5. Analyze the data collected during performance evaluation and recommend energy saving measures. 6. Reviewing the concepts of Energy Conservation in buildings	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-		02
1. Energy Scenario	Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance	1	04	04
2. Energy Audit Principles	Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Benchmarking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring & targeting; Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)	2	08	08

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
3. Energy Management and Energy Conservation in Electrical System	Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipments and appliances, star ratings. Energy efficiency measures in lighting systems, 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	3		10
4. Energy Management and Energy Conservation in Thermal Systems	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.	4	10	10
5. Energy Performance Assessment	On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.	5	04	04
6. Energy conservation in Buildings	Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources	6	03	03
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization	-	01	01
			Total	**42**

Books:	
Text Books	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
Reference Books	1. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press 2. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press

Useful Link

1. www.energymanagertraining.com
2. www.bee-india.nic.in

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1 (T-1)	20 marks
2.	Class Test 2 (T-2)	20 marks

Class Tests (20 Marks):

Two class tests of 20 marks each should be conducted in a semester. The first-class test is to be conducted when approx. 40% syllabus is completed and second-class test when additional 40% syllabus (but excluding contents covered in Test I) is completed. Duration of each test shall be one hour. Addition of both test scores will be considered for passing.

End Semester Theory Examination will be of 60 Marks with Two Hours and 30 Minutes duration.

Course Code	Open Elective - Institute Level Course - I	Credits (TH+P+TUT)
ILC6059	**Development Engineering**	**3+0 +0**
Prerequisite:	**-**	
Course Objectives:	1. To understand the characteristics of rural Society and the Scope, Nature and Constraints of rural Development 2. To study Implications of 73rd CAA on Planning, Development and Governance of Rural Areas 3. To explain exploration of human values, which go into making a 'good' human being, a 'good' professional, a 'good' society and a 'good life' in the context of work life and the personal life of modern Indian professionals 4. To understand the Nature and Type of Human Values relevant to Planning Institutions	
Course Outcomes:	1. Apply knowledge for Rural Development. 2. Demonstrate post-independence rural development. 3. Apply knowledge for Initiatives and Strategies 4. Develop acumen for higher education and research. 5. Master the art of working in groups of different nature. 6. Develop confidence to take up rural project activities independently	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1.Introduction to Rural Development	Introduction to Rural Development Meaning, nature and scope of development; Nature of rural society in India; Hierarchy of settlements; Social, economic and ecological constraints for rural development Roots of Rural Development in India Rural reconstruction and Sarvodaya programme before independence; Impact of voluntary effort and Sarvodaya Movement on rural development; Constitutional direction, directive principles; Panchayati Raj - beginning of planning and community development; National extension services	1	08	08
2. Post-Independence rural Development	Post-Independence rural Development Balwant Rai Mehta Committee – three tier system of rural local Government; Need and scope for people's participation and	2	05	05

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	Panchayati Raj; Ashok Mehta Committee - linkage between Panchayati Raj, participation and rural development			
3. Rural Development Initiatives in Five Year Plans	Rural Development Initiatives in Five Year Plans Five Year Plans and Rural Development; Planning process at National, State, Regional and District levels; Planning, development, implementing and monitoring organizations and agencies; Urban and rural interface - integrated approach and local plans; Development initiatives and their convergence; Special component plan and sub-plan for the weaker section; Micro-eco zones; Database for local planning; Need for decentralized planning; Sustainable rural development.	3	06	06
4. Post 73rd Amendment Scenario	Post 73rd Amendment Scenario 73rd Constitution Amendment Act, including - XI schedule, devolution of powers, functions and finance; Panchayati Raj institutions - organizational linkages; Recent changes in rural local planning; Gram Sabha - revitalized Panchayati Raj; Institutionalization; resource mapping, resource mobilization including social mobilization; Information Technology and rural planning; Need for further amendments	4	05	05
5. Values and Science and Technology Material development	Values and Science and Technology Material development and its values; the challenge of science and technology; Values in planning profession, research and education. Types of Values Psychological values — integrated personality; mental health; Societal values — the modern search for a good society; justice, democracy, rule of law, values in the Indian constitution; Aesthetic values — perception and enjoyment of beauty; Moral and ethical values; nature of moral judgment; Spiritual values; different concepts; secular spirituality; Relative and absolute values; Human values— humanism and human values; human rights; human values as freedom, creativity, love and wisdom.	5	10	10
6. Ethics Canons	Ethics Canons of ethics; ethics of virtue; ethics	6	05	05

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
of ethics	of duty; ethics of responsibility; Work ethics; Professional ethics; Ethics in planning profession, research and education			
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
			Total	**42**

Books:	
Text Books	1. ITPI, "Village Planning and Rural Development", ITPI, New Delhi 2. Thooyavan, K.R, " Human Settlements: A 2005", MA Publication, Chennai 3. GoI, "Constitution (73rd GoI, New Delhi Amendment) Act", GoI, New Delhi 4. Planning Commission, Five Year Plans, Planning Commission 5. Planning Commission, Manual of Integrated District Planning, 2006, Planning Commission New Delhi
Reference Books	1. Planning Guide to Beginners 2. Weaver, R.C., The Urban Complex, Doubleday. 3. Farmer, W.P. et al, Ethics in Planning, American Planning Association, Washington. 4. How, E., Normative Ethics in Planning, Journal of Planning Literature, Vol.5, No.2, pp. 123-150. 5. Watson, V. , Conflicting Rationalities: -- Implications for Planning Theory and Ethics, Planning Theory and Practice, Vol. 4, No.4, pp.395– 407

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1 (T-1)	20 marks
2.	Class Test 2 (T-2)	20 marks

Class Tests (20 Marks):

Two class tests of 20 marks each should be conducted in a semester. The first-class test is to be conducted when approx. 40% syllabus is completed and second-class test when additional 40% syllabus (but excluding contents covered in Test I) is completed. Duration of each test shall be one hour. Addition of both test scores will be considered for passing.

End Semester Theory Examination will be of 60 Marks with Two Hours and 30 Minutes duration.

Lab Code	Lab Name	Credits (P+TUT)
EXL601	**Image Processing and Machine Vision Laboratory**	**1+0**
Lab Prerequisite:	Knowledge of Programming languages, Python / any other suitable tool available	
Lab Objectives:	1. To implement the basic of Image Processing and Machine Vision on Image Enhancement, Image transforms, Morphology and Segmentation. 2. To hands on Practice to students to object recognition/ classification techniques in Machine Vision. 3. To facilitate students for understanding practical aspects of Image Processing and Machine Vision through an application.	
Lab Outcomes:	1. Perform enhancement of digital images in spatial and frequency domain 2. Perform edge detection and morphological operations on digital images 3. Classify patterns using standard Machine vision classification techniques like SVM 4. Apply theoretical knowledge in image processing and machine vision to practical case studies 5. Adhere to the Ethical Practices in the lab while building codes. 6. Work in teams to solve any problem based on Activity, Skill or Technology based Methods.	

Lab No.	Experiment Title	LO Mapped	Hrs./ Lab
0	Lab Prerequisites	-	02
1	Point Processing Methods – Negative, Log, Power law, Contrast stretching, Bit plane slicing	1,5,6	02
2	Form Histogram of an image and its histogram equalization	1,5,6	02
3	Spatial Domain Filtering: 1. Smoothening filters 2. Sharpening with Laplacian 3. Unsharp masking & high boost filtering Edge detection using 1^{st} and 2^{nd} order derivatives	1,5,6	02
4	Frequency Domain Filtering : Ideal, Butterworth and Gaussian filters	1,5,6	02
5	Morphological operation – Erosion, dilation, opening, closing, hit-miss transform, Boundary extraction	2,5,6	02
6	Image segmentation using global Thresholding Algorithm	2,5,6	02
7	Shape representation using chain code	3,5,6	02
8	Canny edge detection	3,5,6	02
9	Feature extraction using co-occurrence matrix	4,5,6	02
10	Classification using k-means algorithm	4,5,6	02
11	Classification using Bayesian classifier	4,5,6	02
12	Basic binary classification of any data or pattern using Support Vector Machine	4,5,6	02
13	Case Studies	1 to 6	02
		Total	**28**

Virtual Lab Links:
https://ssp-iiith.vlabs.ac.in/
Term work: 1. Term work should consist of a minimum of 8 experiments. 2. Journal must include assignments on content of theory and practical of the course. 3. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. 4. Total 25 Marks (Experiments: 15-marks, Assignments/Case study/Project/demo/presentation: 10-marks)
Oral/Practical/P&O : **P&O** examination will be based on the experiment list and content of the entire theory syllabus and carries 25-Marks

Lab Code	Lab Name	Credits (P+TUT)
EXL602	**Electromagnetics and Antenna Laboratory**	**1+0**
Lab Prerequisite:	Applications of Mathematics in Engineering-I (Vector Calculus, Fundamental concepts of electricity and magnetism, Two Port Network)	
Lab Objectives:	1. To learn the fundamentals of Electromagnetics 2. To learn the basic parameters and design of Transmission Line 3. To learn the applications of Electromagnetics 4. To learn about Antenna measurements and radio wave propagation. 5. To learn about linear wire antenna elements and Antenna arrays. 6. To learn Aperture Antenna, Patch antenna and its designing.	
Lab Outcomes:	1. Design of Electromagnetic application using Simulation. 2. Design of Transmission Line using Simulation. 3. Define Basic Antenna parameters like radiation pattern, directivity and gain. 4. Design of uniform linear, basic radiating elements like wire antenna, loop antenna, planar antenna, arrays using isotropic and directional Sources, Micro strip and aperture antennas and reflectors. 5. Write accurate documentation for experiments performed. 6. Apply ethical principles like timeliness and adhere to the rules of the laboratory	

Lab No.	Experiment Title	LO Mapped	Hrs/Lab
0	Lab Prerequisites	-	02
1	Electromagnetics Simulation using HFSS	1,5,6	02
2	Transmission line design using HFSS	2,5,6	02
3	Plot Radiation pattern of i. Dipole Antenna ii. Monopole iii. Folded Dipole Antenna through measurement setups iv. Broadside Array Antenna v. End Fire Array Antenna vi. Helical through measurement setups	2,5,6	02
4	Analyse and design: Monopole Antenna for a frequency 2.4 GHz using HFSS software Dipole Antenna for a frequency 2.4 GHz using HFSS software	3,5,6	02
5	Design Yagi-Uda Antenna for a frequency of 2.4 GHz using HFSS software.	3,5,6	02
6	Design Rectangular Microstrip Antenna (RMSA) for a frequency of 2.4 GHz using HFSS software.	4, 5, 6	02
7	Design Circular Micro strip Antenna (CMSA) for a frequency of 2.4GHz using HFSS software.	4, 5, 6	02

Lab No.	Experiment Title	LO Mapped	Hrs/Lab
8	Design Horn Antenna for a frequency of 2.4 GHz using HFSS software.	4, 5, 6	02
9	Case Study of Recent reported variations of Antenna types	1 to 6	10
		Total	**28**
Virtual Lab Links:			
1. https://www.labster.com/simulations/electromagnetic-spectrum/ 2. https://www.ee.iitb.ac.in/course/~vel/			

Term work:

1. Term work should consist of a minimum of 8 experiments.
2. Journal must include assignments on content of theory and practical of the course.
3. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4. Total 25 Marks (Experiments: 15-marks, Assignments/Case study/Project/demo/presentation: 10-marks)

Oral/Practical/P&O :

Practical examination will be based on the experiment list and content of the entire theory syllabus and carries 25-Marks

Lab Code	Major / Professional Elective - Department-level Lab – II	Credits (P+TUT)
EXDLL6031	Speech and Audio Processing Laboratory	1+0

Lab Prerequisite:	1. Knowledge of open source simulator
Lab Objectives:	1. To learn properties of Speech signal 2. To learn time domain and frequency domain analysis of speech 3. To learn speech coding, recognition and enhancement techniques 4. To learn application of Speech and Audio signal
Lab Outcomes:	1. Distinguish properties of Speech signal 2. Demonstrate time domain and frequency domain approach 3. Demonstrate speech coding, recognition and enhancement techniques 4. Applications of Speech and Audio signal 5. Write accurate documentation for experiments performed 6. Apply ethical principles like timeliness and adhere to the rules of the laboratory

Lab No.	Experiment Title	LO Mapped	Hrs/ Lab
0	Lab Prerequisites	-	02
1	To simulate / demonstrate properties of speech signal	1,5,6	02
2	To simulate / demonstrate limitations of Fourier transform in speech signal	1,5,6	02
3	To simulate / demonstrate zero crossing rate and pitch period estimation	2,5,6	02
4	To simulate / demonstrate speech enhancement techniques	3,5,6	02
5	To simulate / demonstrate short term auto correlation method	2,5,6	02
6	To simulate / demonstrate voice/unvoice/salience classification of speech using short term time domain parameter	2,5,6	02
7	To simulate / demonstrate LPC of speech signal	3,5,6	02
8	To simulate / demonstrate Automatic speech recognition, Dynamic time warping and Hidden Markov model	3,5,6	02
9	To simulate / demonstrate Audio processing for music	4,5,6	02
10	Case Study/ Mini Project	1to 6	08
		Total	**28**

Virtual Lab Links:

1. https://ssp-iiith.vlabs.ac.in/
2. https://vlab.amrita.edu/index.php?sub=59&brch=164

Term work:

1. Term work should consist of a minimum of 8 experiments.
2. Journal must include assignments on content of theory and practical of the course.
3. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4. Total 25 Marks (Experiments: 15-marks, Assignments/Case study/Project/demo/presentation: 10-marks)

Lab Code	Major / Professional Elective - Department-level Lab – II	Credits (P+TUT)
EXDLL6032	**IoT and Industry 4.0 Laboratory**	**1+0**
Lab Prerequisite:	1. Project Based Learning - Mini Project Lab-II 2. Skill Based Learning - IV 3. Project Based Learning - Minor Project Lab-I	
Lab Objectives:	1. To understand Internet of Things and its hardware and software components 2. To interface I/O devices, sensors & communication modules 3. To remotely monitor data and control devices 4. To understand the concepts of Industry 4.0 and basics of Industrial IoT.	
Lab Outcomes:	1. Demonstrate the concept of IoT, Arduino/Raspberry Pi, and also able to install software setup of Arduino/ Raspberry Pi 2. Retrieve data from sensors and display the data, status of devices and sensors from web cloud 3. Identify the use of Communication and Networking in Industrial IoT Application 4. Implementation of analytics in Industrial IoT. 5. Write accurate documentation for experiments performed. 6. Apply ethical principles like timeliness and adhere to the rules of the laboratory.	

Lab No.	Experiment Title	LO Mapped	Hrs/ Lab
0	Lab Prerequisites	-	02
1	Familiarization with the concept of IoT, Arduino/Raspberry Pi and perform necessary software installation.	1, 5, 6	02
2	LED and IR sensor interfacing with Nodemcu.	1, 5, 6	02
3	Ultrasonic sensor interfacing with Nodemcu for distance measurement.	2, 5, 6	02
4	Temperature/Humidity monitoring using Blynk App.	2, 5, 6	02
5	DHT sensor interfacing with Nodemcu and communication of data using MQTT protocol	2, 5, 6	02
6	To study the MQTT and ThingSpeak and upload the DHT sensor data on ThingSpeak	2, 5, 6	02
7	Identify the use of Communication and Networking in Industrial IoT Application	3, 5, 6	02
8	Study of IoT based industrial process monitoring and control system	3, 5, 6	02
9	Implementation of analytics in Industrial IoT Application	4, 5, 6	02
10	Design prototype of IoT based smart system	4, 5, 6	02
11	Case Study / Mini Project	1 to 6	06
		Total	**28**
Note: Suggested 8 lab exercises based on six modules of IoT and Industry 4.0 Syllabus			

Virtual Lab Links:
https://www.vlab.co.in/
Useful Links:
1. Node Red - https://nodered.org/ 2. M2MLabs Mainspring - http://www.m2mlabs.com/ 3. Tensor Flow - https://www.tensorflow.org/ 4. Things Speak - https://thingspeak.com
Term work: 1. Term work should consist of a minimum of 8 experiments 2. Journal must include assignments on content of theory and practical of the course 3. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. 4. Total 25 Marks (Experiments: 15-marks, Assignments/Case study/Project/demo/presentation: 10-marks)

Lab Code	Major / Professional Elective - Department-level Lab – II	Credits (P+TUT)
EXDLL6033	**Mixed Signal VLSI Laboratory**	**1+0**
Lab Prerequisite:	1. Microelectronics Devices & Circuits 2. Electronics Devices & Circuits	
Lab Objectives:	1. To understand analysis and design of building blocks of CMOS Analog VLSI Circuits. 2. To highlight the issues associated with the CMOS analog VLSI circuit design. 3. To emphasize upon the issues related to mixed signal layout design.	
Lab Outcomes:	1. Simulate electrical characteristics of biasing techniques 2. Design and simulate analog circuits 3. Analyze the performance of the analog circuits 4. Design and simulate ADC and DAC circuits 5. Write accurate documentation for experiments performed. 6. Apply ethical principles like timeliness and adhere to the rules of the laboratory.	

Lab No.	Experiment Title	LO Mapped	Hrs/ Lab
0	Lab Prerequisites	-	02
1	Analysis of MOSFETs for analog performance	1,3,5,6	02
2	Transconductance plots (voltage bias, current bias and technology bias).	1,3,5,6	02
3	Design of regulated current sink.	2,5,6	02
4	Design and simulate various types of oscillators	2,5,6	02
5	Design and simulate ideal Opamp	2,5,6	02
6	10 bit ADC	4,5,6	02
7	Design of basic current sink.	4,5,6	02
8	Design of cascode current sink	4,5,6	02
9	Simulate noise in CMOS amplifier	3,5,6	02
10	Design and simulate differential amplifier	2,5,6	02
11	Design and simulate operational transconductance amplifier	2,5,6	02
12	Case Study / Mini Project	1 to 6	04
		Total	**28**

Term work:

1. Term work should consist of a minimum of 8 experiments.
2. Journal must include assignments on content of theory and practical of the course.
   The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
3. Total 25 Marks (Experiments: 15-marks, Assignments/Case study/Project/demo/presentation: 10-marks)

Lab Code	Major / Professional Elective - Department-level Lab – II	Credits (P+TUT)
EXDLL6034	**Database Management System Laboratory**	**1+0**

Lab Prerequisite:	Any programming skills
Lab Objectives:	1. To study and design modelling in database 2. To learn and apply SQL commands in queries. 3. To create database and apply transaction management command. 4. To use databases and solve real world problems.
Lab Outcomes:	1. Demonstrate how to retrieve data from more than one table or views using the key 2. Apply the select information from the tables and manipulate it. 3. Apply create, alter and drop on tables and apply insert, update and delete statements. 4. Build a Database using all the concepts of DBMS 5. Write accurate documentation for experiments performed. 6. Apply ethical principles like timeliness and adhere to the rules of the laboratory.

Lab No.	Experiment Title	LO Mapped	Hrs/ Lab
0	Lab Prerequisites	-	02
1	Identify the case study & detail statement of problem. Design an ER/ ERR model	4,5,6	02
2	Mapping ER/ERR to relational Schema Model	4,5,6	02
3	Create and populate database using DDL and DML commands for your specified system	3,5,6	02
4	To study and apply Integrity Constraint for the specified system	1,5,6	02
5	To study various select commands in SQL	2,5,6	02
6	To study Nested and Complex queries	2,5,6	02
7	To study and Perform Join operation	2,5,6	02
8	To study Views and Triggers in SQL	1,5,6	02
9	To study functions, cursor and Procedure	4,5,6	02
10	To study Transaction and concurrency	4,5,6	02
11	Write SQL queries for Sorting of the data in database.	4,5,6	02
12	Case Study/ Mini Project	1 to 6	04
		Total	**28**

Virtual Lab Links:

1. https://www.tutorialspoint.com/dbms/index.htm
2. https://www.studytonight.com/dbms/
3. https://beginnersbook.com/2015/04/dbms-tutorial/
4. https://www.w3schools.in/dbms/

Term work:

1. Term work should consist of a minimum of 8 experiments.
2. Journal must include assignments on content of theory and practical of the course.
3. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4. Total 25 Marks (Experiments: 15-marks, Assignments/Case study/Project/demo/presentation: 10-marks)

Course Code	Community Engagement PBL	Credits (TH+P+TUT)
EXPR64	Innovation-Based Major Project - A	0+3+0

Prerequisite:	1. Mini Project 2. Minor Project
Lab Objectives:	The Project work enables the students, 1. To develop the required skills and knowledge about research. 2. To analyse a specific problem or issue by using the latest technologies with a multidisciplinary approach. 3. To demonstrate proficiency in the design of a research project, application with appropriate research methods. 4. To present and adopt various research ideas with appropriate solution
Lab Outcomes:	1. Identify, formulate, review research literature, and analyse complex engineering problems 2. Design solutions, components or processes for complex engineering problems. 3. Select appropriate modern engineering tools and analyse and interpret data to meet the problem statement. 4. Apply ethical principles and commit to professional ethics, responsibilities norms of the engineering practice, and engage in independent and life-long learning. 5. Comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions. 6. Interact efficiently and effectively as an individual with the team members or leader for timely and professional management of projects.

Syllabus:

Project Topic:

- To proceed with the project work it is especially important to select the right topic. Project can be undertaken on any domain of Electronics and Telecommunication programme. 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 three 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/project coordinator in the department will take decisions regarding selection of projects.
- Students have to submit a weekly progress report to the internal guide whereas the internal guide has to keep track of the progress of the project and also has to maintain attendance reports. This progress report can be used for awarding the term work marks. In case of industry projects, visits by internal guides will be preferred.
- Students shall be motivated to publish a paper based on the work in Conferences/Technical paper presentations/project competitions/Poster presentations.

Project Report Format

At the end of semester, a project report should preferably contain at least following Details: -

1. Abstract
2. CO-PO mapping
3. Introduction
4. Literature Survey
   a) Comparative Survey of Existing system
   b) Limitation of the Existing system or research gap
5. Proposed System
   a) Problem Statement and Objective
   b) Methodology (your approach to solve the problem)
   c) Analysis/Framework/ Algorithm
   d) Details of Hardware & Software
   e) Design details
   f) Budget details
   g) Implementation Plan for next semester
6. Conclusion and future scope
7. References
8. 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)
9. The final certification and acceptance of Term Work will carry 25 Marls ensuring satisfactory performance on the above aspects.
10. Oral & Practical:
    Oral &Practical examination of Major Project-A should be conducted by Internal and External will carry 50 Marks based on satisfactory presentation, demonstration of implementation of the project

Useful Links:

1. https://ieeexplore.ieee.org/
2 https://www.electronicsforu.com/

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 an internal guide will be preferred to get the status of the project.

Students shall be motivated to publish a paper based on the work in Conferences/Technical paper presentations/project competitions/Poster presentations.

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 (soft Bound)
d) Term End Presentation (Internal)

The final certification and acceptance of Term Work ensures the satisfactory performance on the above aspects which carries 25 Marks.

Oral Practical P&O:

P&O examination of Major Project-A shall be conducted by Internal and External examiners. Students must give a presentation and demonstration on the Major Project-A. Practical will carry 50 Marks.

SAT Code	Vocational Skill - SAT XII:	Credits (TH+P+TUT)
EXXT612	Technology Based Learning	0+2+0

Prerequisite:	Knowledge of SY subjects
TBL Objectives:	1. Identify, describe, and apply emerging technologies in teaching and learning environments 2. Plan, design, and assess effective learning environments and experiences 3. Compare and contrast social, ethical, and legal issues surrounding technology 4. Facilitate instruction in the new literacies that emerge within digital / interactive learning environment
TBL Outcomes:	1. Identify, describe, and apply emerging technologies in teaching and learning environments 2. Demonstrate knowledge, attitudes, and skills of digital age work and learning 3. Plan, design, and assess effective learning environments and experiences 4. Implement curriculum methods and strategies that use technology to maximize student learning 5. Develop technology-enabled assessment and evaluation strategies 6. Compare and contrast social, ethical, and legal issues surrounding technology

Guidelines for Technology Based Learning:

1. Selection of course with 4 weeks/8 weeks Duration (Subject related to Emerging Technology and approval from department)
2. Faculty supervisor is allotted at department level.
3. The faculty supervisor will monitor the activities and documentation of the students assigned to them.
    1. Whether students are going through the four lectures, weekly
       (One lecture will be of duration 25 to 30 minutes.)
    2. Weekly submission of Assignments.
    3. Registration for the Exam.
    4. Appearing for the Exam on schedule date and time.
    5. Submission of Certificate

Term Work (50 Marks):

1. Marks will be awarded based on Assessment Rubrics designed
2. Use of Technology for Minor Project development
3. Technical Competition Participation
4. Course Completion Certificate
5. Certification Grades/performance