Curriculum

Structure

for

B.Tech. in ECE / B.Tech. in ECE with Minor in Specialization / B.Tech. in ECE with Major in Specialization / B.Tech. (Hons.) in ECE

Applicable for Batch Admitted in 2021-22 and onwards

June 2021

Indian Institute of Information Technology Kota

(Mentored by MNIT Jaipur)

Curriculum Structure for B.Tech. in ECE / B.Tech. in ECE with Minor in Specialization / B.Tech. in ECE with Major in Specialization / B.Tech. (Hons.) in ECE
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1st Semester On-campus						
S. No.	**Course Code**	**Course Name**	**Scheme**			
			L	**T**	**P**	**Credits**
1	CST101	Computer Systems and Programming	3	0	0	3
2	ECT101	Digital Design	3	1	0	4
3	ECT103	Circuit Theory	3	1	0	4
4	HST101	Communication Skills	2	0	0	2
5	MAT101	Mathematics - I	3	1	0	4
		Practical				
6	CSP101	Computer Systems and Programming Lab	0	1	2	2
7	CSP111	IT Workshop - I	0	1	2	2
8	ECP101	Digital Design Lab	0	0	2	1
9	ECP111	System Simulation Techniques Lab	0	0	2	1
10	HSP101	Communication Skills Lab	0	0	2	1
11	OTP101	Upnayan - The Induction Programme	0	1	2	2
			14	**6**	**12**	**26**

2nd Semester On-campus						
S. No.	**Course Code**	**Course Name**	**Scheme**			
			L	**T**	**P**	**Credits**
1	CST102	Data Structures and Algorithms	3	0	0	3
2	ECT102	Electronic Devices and Circuits	3	1	0	4
3	ECT104	Fundamentals of Electrical Engineering	3	1	0	4
4	HST102	Technical Writing and Presentation Skills	2	0	0	2
5	MAT102	Mathematics - II	3	1	0	4
6	OTT102	Health, Safety and Environment	2	0	0	2
		Practical				
7	CSP102	Data Structures and Algorithms Lab	0	1	2	2
8	CSP112	IT Workshop - II	0	1	2	2
9	ECP102	Electronic Devices and Circuits Lab	0	0	2	1
10	ECP112	Circuit Design and Printing Lab	0	0	2	1
11	HSP102	Technical Writing and Presentation Skills Lab	0	0	2	1
			16	**5**	**10**	**26**

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3rd Semester On-campus						
S. No.	**Course Code**	**Course Name**	**Scheme**			
			L	**T**	**P**	**Credits**
1	CST201	Computer Architecture and Organization	3	0	0	3
2	ECT201	Microprocessors and Peripherals	3	0	0	3
3	ECT203	Analog Integrated Circuits	3	0	0	3
4	ECT205	Signals and Systems	3	0	0	3
5	HST201	Engineering for Social Empowerment	3	0	0	3
6	MAT203	Probability and Random Processes	3	1	0	4
		Practical				
7	CSP201	Computer Architecture and Organization Lab	0	0	2	1
8	CSP211	IT Workshop - III	0	1	2	2
9	ECP201	Microprocessors and Peripherals Lab	0	0	2	1
10	ECP203	Analog Integrated Circuits Lab	0	0	2	1
11	OTP201	Engineering Creativity, Innovation and Design	0	1	2	2
			18	**3**	**10**	**26**

4th Semester On-campus						
S. No.	**Course Code**	**Course Name**	**Scheme**			
			L	**T**	**P**	**Credits**
1	CST202	Object Oriented System Design	3	0	0	3
2	ECT202	Analog Communication	3	0	0	3
3	ECT204	Measurement and Instrumentation Technology	3	0	0	3
4	ECT206	Microcontrollers and Interfacing	3	0	0	3
5	ECT208	Electromagnetic Theory	3	1	0	4
6	ECT210	Control Systems	3	1	0	4
		Practical				
7	CSP202	Object Oriented System Design Lab	0	0	2	1
8	ECP202	Analog Communication Lab	0	0	2	1
9	ECP204	Measurement and Instrumentation Technology Lab	0	0	2	1
10	ECP206	Microcontrollers and Interfacing Lab	0	0	2	1
11	OTP202	Entrepreneurship and Business Incubation	0	1	2	2
			18	**3**	**10**	**26**

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5th Semester On-campus						
S. No.	Course Code	Course Name	Scheme			
			L	T	P	Credits
1	CST341	CSE Open Elective - I (Pool 3)	3	0	0	3
2	ECT301	Digital Signal Processing	3	0	0	3
3	ECT303	Digital Communication	3	0	0	3
4	ECT305	Digital MOS IC Design	3	0	0	3
5	ECT307	RF and Microwave Engineering	3	0	0	3
6	ECT321	ECE Departmental Elective - I (Pool 1)	3	0	0	3
	XXT3XX	Minor Specialization / Major Specialization / Honours Core Course (3 Credits)				
		Practical				
7	CSP341	CSE Open Elective - I Lab (Pool 3)	0	0	2	1
8	ECD301	Study of Technical Articles	0	2	2	3
9	ECP301	Digital Signal Processing Lab	0	0	2	1
10	ECP303	Digital Communication Lab	0	0	2	1
11	ECP305	Digital MOS IC Design Lab	0	0	2	1
			18	**2**	**10**	**25**

6th Semester On-campus						
S. No.	Course Code	Course Name	Scheme			
			L	T	P	Credits
1	CST342	CSE Open Elective - II (Pool 3)	3	0	0	3
2	ECT302	Wireless and Mobile Communication	3	0	0	3
3	ECT304	Optical Communication	3	0	0	3
4	ECT306	Digital System Design and FPGAs	3	0	0	3
5	ECT322	ECE Departmental Elective - II (Pool 1)	3	0	0	3
6	HST302	Professional Development	2	0	0	2
	XXT3XX	Minor Specialization / Major Specialization / Honours Core Course (3 Credits)				
		Practical				
7	CSP342	CSE Open Elective - II Lab (Pool 3)	0	0	2	1
8	ECD302	Skill Transformation based Engineering Project - I	0	2	6	5
9	ECP308	Microwave Engineering Lab	0	0	2	1
10	HSP302	Professional Development Lab	0	0	2	1
			17	**2**	**12**	**25**

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7th Semester On-campus (8th Semester On-campus or Off-campus) / 8th Semester On-campus (7th Semester Off-campus)						
S. No.	**Course Code**	**Course Name**	**Scheme**			
			L	**T**	**P**	**Credits**
1	ECT421 (7th Sem) / ECT422 (8th Sem)	ECE Departmental Elective - III (Pool 1)	3	0	0	3
2	ECT423 (7th Sem) / ECT424 (8th Sem)	ECE Departmental Elective - IV (Pool 1)	3	0	0	3
3	XXT441 (7th Sem) / XXT442 (8th Sem)	MAT / HSS Open Elective - I (Pool 4 / Pool 5)	3	0	0	3
4	OTT401 (7th Sem) / OTT402 (8th Sem)	Living Ethics	2	0	0	2
	XXT4XX, XXT4XX	Minor Specialization / Major Specialization / Honours Core Courses (6 Credits)				
		Practical				
5	ECD401 (7th Sem) / ECD402 (8th Sem)	Skill Transformation based Engineering Project - II	0	2	6	5
6	ECP421 (7th Sem) / ECP422 (8th Sem)	ECE Departmental Elective - III Lab (Pool 1)	0	0	2	1
7	ECP423 (7th Sem) / ECP424 (8th Sem)	ECE Departmental Elective - IV Lab (Pool 1)	0	0	2	1
			11	**2**	**10**	**18**

8th Semester On-campus (7th Semester On-campus)						
S. No.	**Course Code**	**Course Name**	**Scheme**			
			L	**T**	**P**	**Credits**
1	ECT432	ECE Departmental Fractal Elective - I (Pool 2)	1	0	0	1
2	ECT434	ECE Departmental Fractal Elective - II (Pool 2)	1	0	0	1
3	ECT436	ECE Departmental Fractal Elective - III (Pool 2)	1	0	0	1
4	ECT438	ECE Departmental Fractal Elective - IV (Pool 2)	1	0	0	1
5	HST442	HSS Open Elective - II (Pool 5)	3	0	0	3
6	MAT442	MAT Open Elective - II (Pool 4)	3	0	0	3
	XXT4XX, XXT4XX	Minor Specialization / Major Specialization / Honours Elective Courses (6 Credits)				
			10	**0**	**0**	**10**

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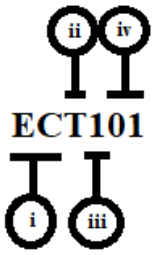
7th Semester On-campus (8th Semester On-campus or Off-campus) / 8th Semester On-campus (7th Semester Off-campus)						
S. No.	**Course Code**	**Course Name**	**Scheme**			
			L	**T**	**P**	**Credits**
1	ECT421 (7th Sem) / ECT422 (8th Sem)	ECE Departmental Elective - III (Pool 1)	3	0	0	3
2	ECT423 (7th Sem) / ECT424 (8th Sem)	ECE Departmental Elective - IV (Pool 1)	3	0	0	3
3	XXT441 (7th Sem) / XXT442 (8th Sem)	MAT / HSS Open Elective - I (Pool 4 / Pool 5)	3	0	0	3
4	OTT401 (7th Sem) / OTT402 (8th Sem)	Living Ethics	2	0	0	2
	XXT4XX, XXT4XX	Minor Specialization / Major Specialization / Honours Core Courses (6 Credits)				
		Practical				
5	ECD401 (7th Sem) / ECD402 (8th Sem)	Skill Transformation based Engineering Project - II	0	2	6	5
6	ECP421 (7th Sem) / ECP422 (8th Sem)	ECE Departmental Elective - III Lab (Pool 1)	0	0	2	1
7	ECP423 (7th Sem) / ECP424 (8th Sem)	ECE Departmental Elective - IV Lab (Pool 1)	0	0	2	1
			11	**2**	**10**	**18**

8th Semester Off-campus (7th Semester On-campus) / 7th Semester Off-campus (8th Semester On-campus)						
S. No.	**Course Code**	**Course Name**	**Scheme**			
			L	**T**	**P**	**Credits**
	XXT4XX, XXT4XX	Minor Specialization / Major Specialization / Honours Elective Courses (6 Credits)				
		Practical				
1	OTD402 (8th Sem) / OTD401 (7th Sem)	Internship and Training for Skilled Engineering Practice	0	0	20	10
			0	**0**	**20**	**10**

Note: Course Code nomenclature



i. First and Second characters together represents the specific department offering the course: EC for Electronics and Communication Engineering (ECE), CS for Computer Science and Engineering (CSE), MA for Mathematics (MAT), HS for Humanities and Social Sciences (HSS), OT for Other than those mentioned (OTH)

ii. Third character represents the mode of conduction of course: T for Theory Course, P for Practical Course, D for Project / Study / Training and Internship Course

iii. Fourth character represents the level of the course: 1 for 1st Year, 2 for 2nd Year, 3 for 3rd Year, 4 for 4th Year

iv. Fifth and Sixth characters together represent semester and nature of the course:
   a. Numbers are odd for Odd Semesters (1st / 3rd / 5th / 7th) and even for Even Semesters (2nd / 4th / 6th / 8th)
   b. For B.Tech. – Programme Core (01 to 19), Departmental Elective (21 to 29), Departmental Fractal Elective (31 to 39), Open Elective (41 to 49)
   c. For B.Tech. with Specialization – Programme Core (01 to 19), Departmental Elective (21 to 29), Departmental Fractal Elective (31 to 39), Open Elective (41 to 49), Specialization Core (51 to 59), Specialization Elective (61 to 69)
   d. For B.Tech. with Honours – Programme Core (01 to 19), Departmental Elective (21 to 29), Departmental Fractal Elective (31 to 39), Open Elective (41 to 49), Honours Core (71 to 79), Honours Elective (81 to 89)

ECE Departmental Electives and their groups (Pool 1)

- **Communication and Signal Processing Group**
  - Advanced Digital Communication
  - Advanced Digital Signal Processing
  - Advanced Microwave Engineering
  - Advanced Optical Communication
  - Advanced Wireless Communication
  - Antenna Theory and Design
  - Biomedical Measurement and Instrumentation
  - Computational Electromagnetics
  - Digital Image Processing
  - Electromagnetic Interference and Compatibility
  - Industrial Microwave
  - MIMO Wireless Communication
  - Pattern Recognition
  - Satellite Communication

- **Devices and Circuits Group**
  - Advanced CMOS and Beyond CMOS
  - Analog CMOS IC Design
  - MEMS and NEMS
  - Nanoelectronic Devices Modeling and Simulation
  - Power Electronics
  - Semiconductor Memory Design
  - Semiconductor Optoelectronic Devices
  - Simulation of Devices and Circuits
  - VLSI Signal Processing Architectures

- **Digital Systems Group**
  - Advanced Digital System Design and FPGAs
  - Advanced Microprocessors and Microcontrollers
  - CAD Algorithms for Synthesis of VLSI Systems
  - Computer Arithmetic and Micro-architecture Design
  - Digital System Synthesis
  - Embedded System Design
  - Internet of Things
  - Memory Design and Testing
  - Real Time Systems
  - VLSI Testing and Testability

- **Control, Automation and Intelligent Systems Group**
  - Control Theory
  - Digital Control
  - Evolutionary Computation Techniques
  - Fuzzy Logic and Applications
  - Industrial Automation and Control
  - Intelligent Control
  - Neural Networks and Applications
  - Optimization Techniques and Applications
  - Soft Computing
  - System Identification

ECE Departmental Fractal Electives (Pool 2)

Topics on ECE Departmental Electives

CSE Open Electives (Pool 3)

- Artificial Intelligence and Machine Learning
- Compiler Design
- Computer Networks
- Cryptography and Cyber Security
- Cyber Physical Systems
- Data Science
- Database Management Systems
- Design and Analysis of Algorithms
- Operating Systems
- Software Engineering

MAT Open Electives (Pool 4)

- Applied Statistical Analysis
- Complex Analysis
- Discrete Mathematical Structures
- Graph Theory
- Information Theory and Coding
- Linear Algebra
- Mathematical Methods
- Mathematical Modelling
- Numerical Computation
- Operations Research

HSS Open Electives (Pool 5)

- Digital Innovation and Transformation
- Engineering Economics
- Human Resource Development
- Indian Economy - Contemporary Perspectives
- Intellectual Property Rights and Laws
- Introduction to International Relations and World Politics
- Mindfulness for Wellbeing
- Product Design - Planning and Management
- Quality Control and Reliability
- Supply Chain Management

Minor in Specialization / Major in Specialization / Honours Courses (Additional 18 Credits)

- Students with no backlog and CGPA greater than 7 at the end of 4^{th} / 5^{th} / 6^{th} / 7^{th} Sem are eligible to register Minor in Specialization / Major in Specialization / Honours courses in 5^{th} / 6^{th} / 7^{th} / 8^{th} Sem
- Students can reconvert from B.Tech. with Minor in Specialization / Major in Specialization / Honours to B.Tech. (B.Tech. with Minor in Specialization / Major in Specialization / Honours Course Credits earned will be accounted in terms of Audit Courses only)
- B.Tech. level Core Courses (12 Credits) and Elective Courses (6 Credits) from Minor Specialization / Major Specialization Pools from 5th Sem onwards for B.Tech. with Minor in Specialization / Major in Specialization
    - Minor specialization should be inter-departmental (one or more courses in the group can be inter-departmental) or non-departmental (all courses in the group must be non-departmental)
    - Major specialization should be departmental (all courses in the group must be departmental)
    - Probable Minor Specialization areas: AI and ML, Cyber Physical Systems, Big Data (those mentioned in the IIIT Kota logo may be explored in future)
    - Probable Major Specialization areas: Digital Communication, VLSI, Embedded Systems, Soft Computing (those mentioned in the IIIT Kota logo may be explored in future)
    - Minor / Major Specialization Core courses: Specified Four Core Courses from the Minor / Major Specialization group (12 Credits)
    - Minor / Major Specialization Elective courses: Any Two Elective Courses from the Minor / Major Specialization group (6 Credits)
- B.Tech. level Advanced / M.Tech. level Introductory Core Courses (12 Credits) and Elective Courses (6 Credits) from 5th Sem onwards for B.Tech. Honours
    - Honours should be within the Department (all courses must be departmental)
    - Honours Core courses: Advanced Digital Communication / Advanced Digital Signal Processing, Advanced CMOS and Beyond CMOS / Semiconductor Memory Design, Digital System Synthesis / Embedded System Design, Intelligent Control / Soft Computing (12 Credits)
    - Honours Elective courses: Any Two Elective Courses from any elective groups of the department (6 Credits)

Total = 182 Graded Credits for B.Tech. in ECE

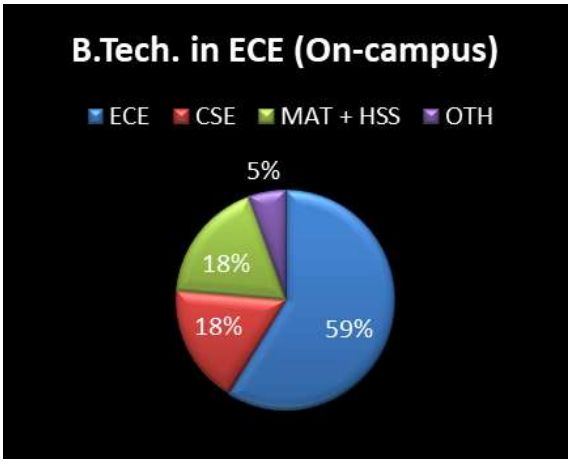
- **ECE:** 107 or 103 Graded Credits
  - 1st Year - 16 Credits for Theory and 4 Credits for Practical
  - 2nd Year - 26 Credits for Theory and 5 Credits for Practical
  - 3rd Year - 27 Credits for Theory and 4 Credits for Practical and 8 Credits for Project based Course
  - 4th Year - 10 or 6 Credits for Theory and 2 Credits for Practical and 5 Credits for Project based Course
- **CSE:** 32 Graded Credits
  - 1st Year - 8 Credits for Theory and 6 Credits for Practical
  - 2nd Year - 6 Credits for Theory and 4 Credits for Practical
  - 3rd Year - 6 Credits for Theory and 2 Credits for Practical
- **MAT+HSS:** 33 (15 for MAT + 15 for HSS + 3 for MAT or HSS) or 27 (12 for MAT + 12 for HSS + 3 for MAT or HSS) Graded Credits
  - 1st Year - 12 Credits for Theory and 2 Credits for Practical
  - 2nd Year - 7 Credits for Theory
  - 3rd Year - 2 Credits for Theory and 1 Credit for Practical
  - 4th Year - 9 or 3 Credits for Theory
- **OTH:** 10 or 20 Graded Credits
  - 1st Year – 2 Credits for Theory and 2 Credits for Practical
  - 2nd Year – 4 Credits for Practical
  - 4th Year - 2 Credits for Theory and 0 or 10 Credits for Project based Course

Total = 200 Graded Credits for B.Tech. in ECE with Minor in Specialization / B.Tech. in ECE with Major in Specialization / B.Tech. (Hons.) in ECE

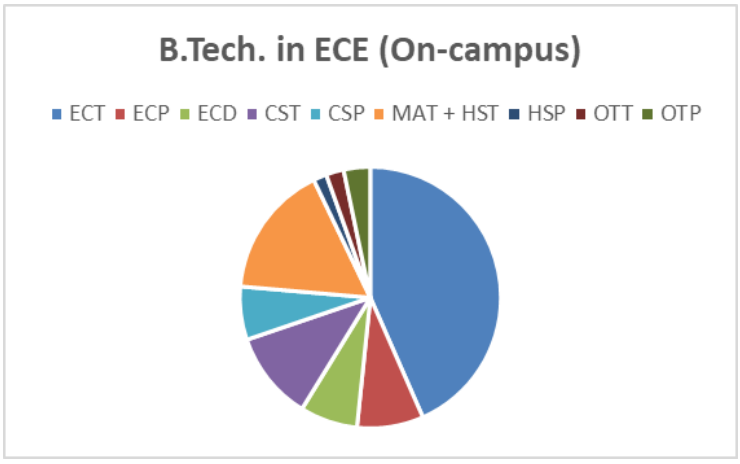
- **ECE:** 107 or 103 Graded Credits + 18 Graded Credits for Major in Specialization / Honours
  - 1st Year - 16 Credits for Theory and 4 Credits for Practical
  - 2nd Year - 26 Credits for Theory and 5 Credits for Practical
  - 3rd Year - 33 Credits for Theory and 4 Credits for Practical and 8 Credits for Project based Course
  - 4th Year - 22 or 18 Credits for Theory and 2 Credits for Practical and 5 Credits for Project based Course
- **CSE:** 32 Graded Credits + 18 Graded Credits for Minor in Specialization
  - 1st Year - 8 Credits for Theory and 6 Credits for Practical
  - 2nd Year - 6 Credits for Theory and 4 Credits for Practical
  - 3rd Year - 12 Credits for Theory and 2 Credits for Practical
  - 4th Year - 12 Credits for Theory
- **MAT+HSS:** 33 (15 for MAT + 15 for HSS + 3 for MAT or HSS) or 27 (12 for MAT + 12 for HSS + 3 for MAT or HSS) Graded Credits
  - 1st Year - 12 Credits for Theory and 2 Credits for Practical
  - 2nd Year - 7 Credits for Theory
  - 3rd Year - 2 Credits for Theory and 1 Credit for Practical
  - 4th Year - 9 or 3 Credits for Theory
- **OTH:** 10 or 20 Graded Credits
  - 1st Year – 2 Credits for Theory and 2 Credits for Practical
  - 2nd Year – 4 Credits for Practical
  - 4th Year - 2 Credits for Theory and 0 or 10 Credits for Project based Course

Case 1: B.Tech. in ECE (On-campus)

On-campus	
ECE	107
CSE	32
MAT + HSS	33
OTH	10

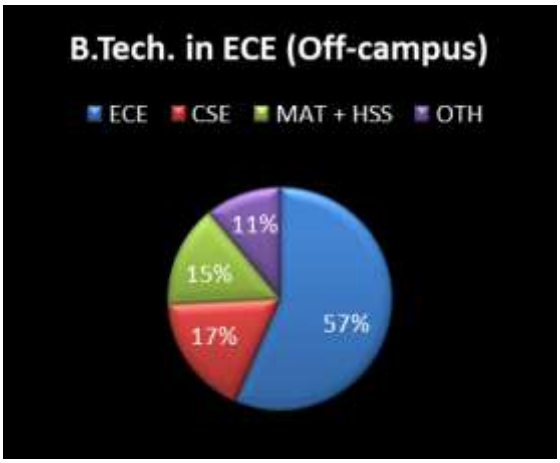


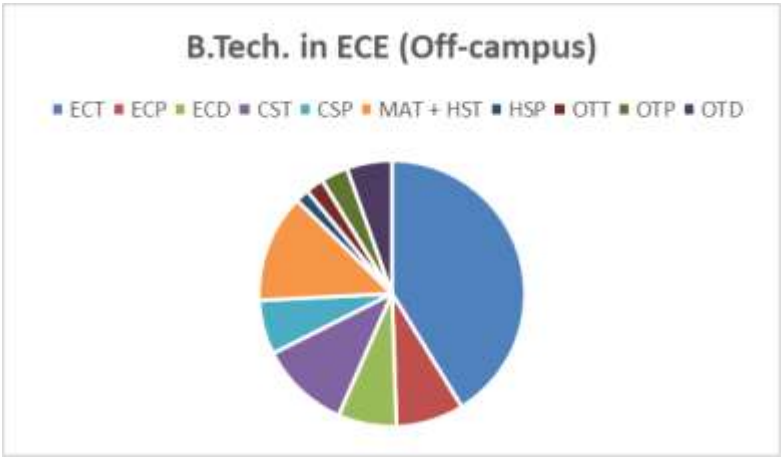
On-campus	
ECT	79
ECP	15
ECD	13
CST	20
CSP	12
MAT + HST	30
HSP	3
OTT	4
OTP	6



Case 1: B.Tech. in ECE (Off-campus)

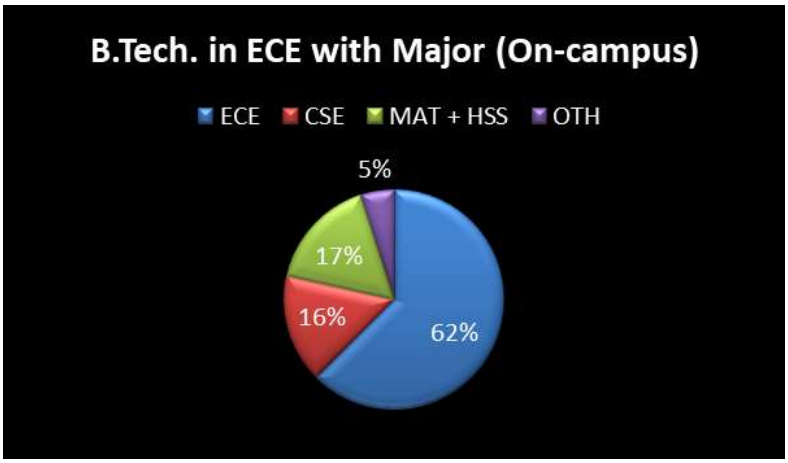
Off-campus	
ECE	103
CSE	32
MAT + HSS	27
OTH	20

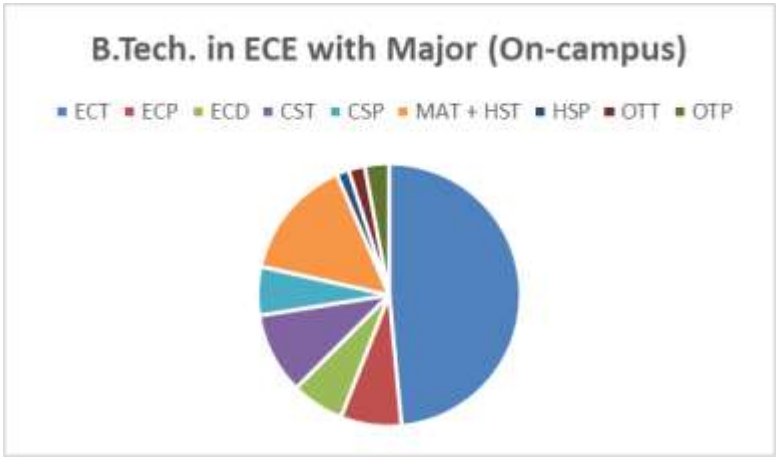


Off-campus		
ECT	75	
ECP	15	
ECD	13	
CST	20	
CSP	12	
MAT + HST	24	
HSP	3	
OTT	4	
OTP	6	
OTD	10	

Case 2: B.Tech. in ECE with Major in Specialization (On-campus)

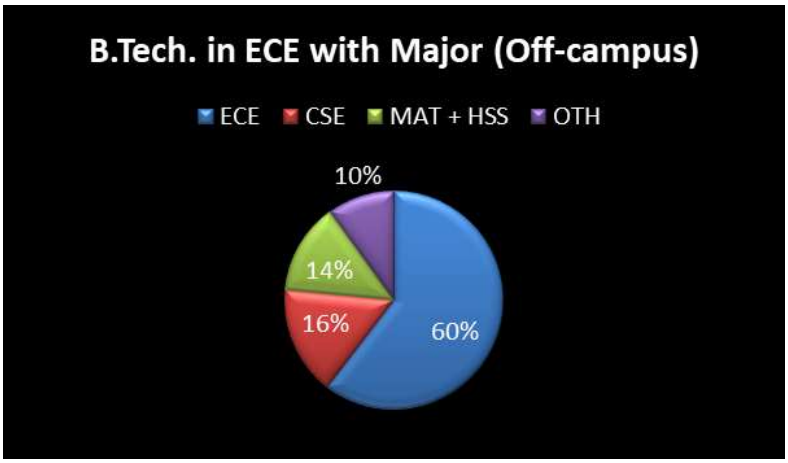
On-campus	
ECE	125
CSE	32
MAT + HSS	33
OTH	10

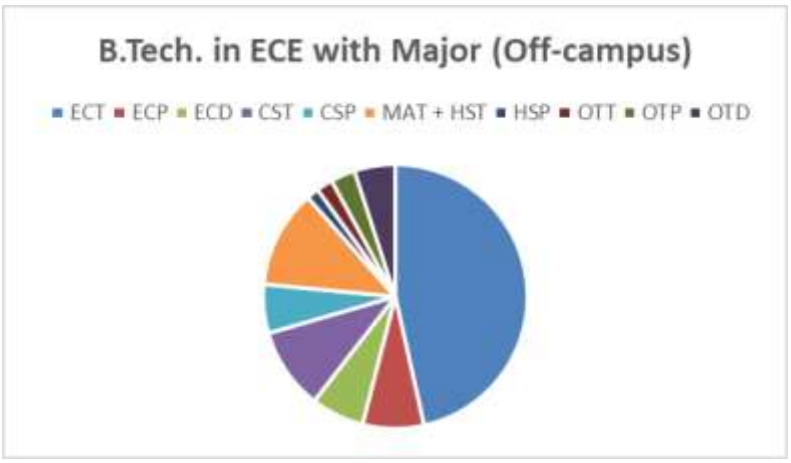


On-campus		
ECT	97	
ECP	15	
ECD	13	
CST	20	
CSP	12	
MAT + HST	30	
HSP	3	
OTT	4	
OTP	6	

Case 2: B.Tech. in ECE with Major in Specialization (Off-campus)

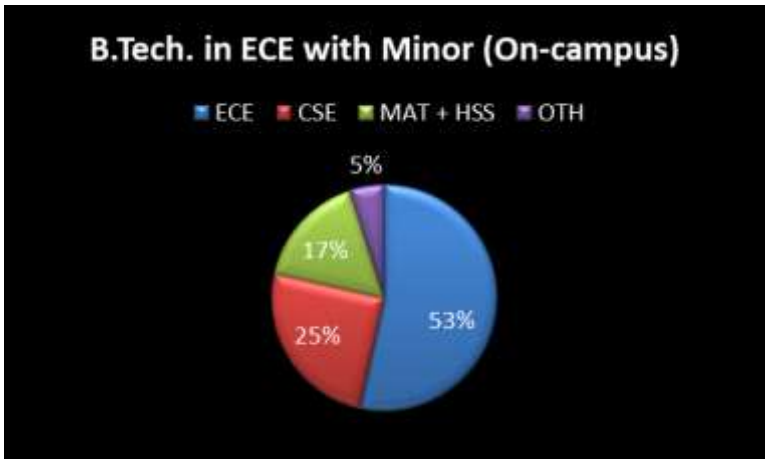
Off-campus	
ECE	121
CSE	32
MAT + HSS	27
OTH	20



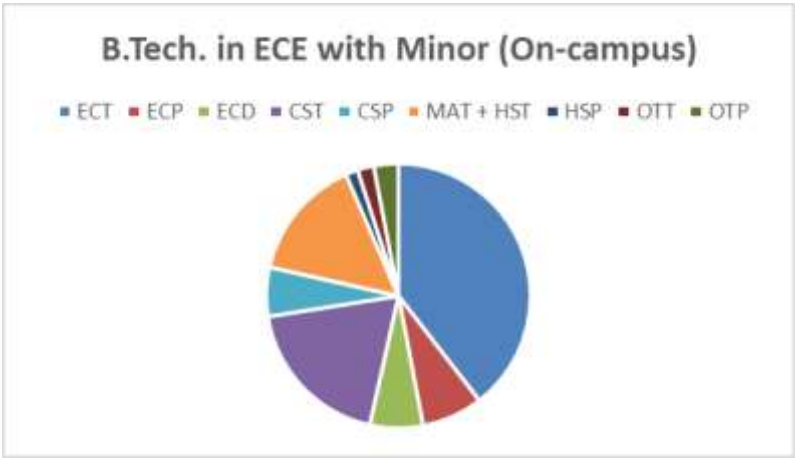
Off-campus		
ECT	93	
ECP	15	
ECD	13	
CST	20	
CSP	12	
MAT + HST	24	
HSP	3	
OTT	4	
OTP	6	
OTD	10	

Case 3: B.Tech. in ECE with Minor in Specialization (On-campus)

On-campus	
ECE	107
CSE	50
MAT + HSS	33
OTH	10

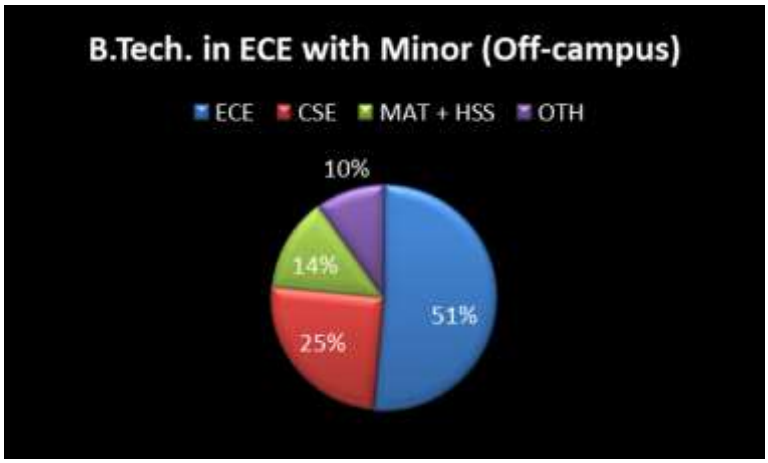


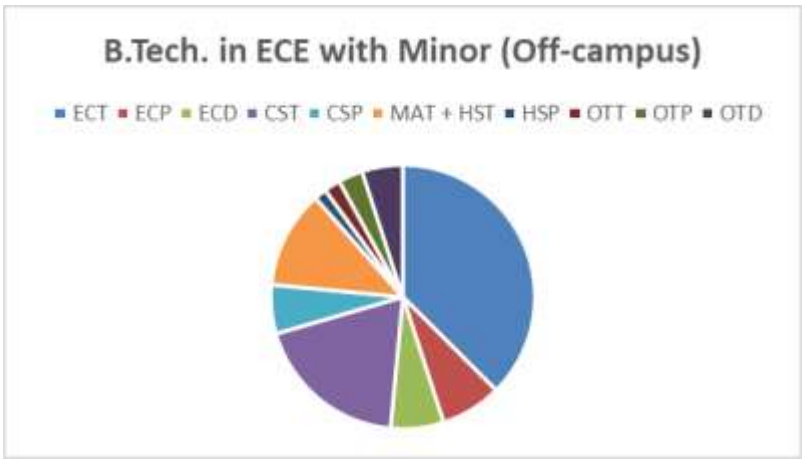
On-campus	
ECT	79
ECP	15
ECD	13
CST	38
CSP	12
MAT + HST	30
HSP	3
OTT	4
OTP	6



Case 3: B.Tech. in ECE with Minor in Specialization (Off-campus)

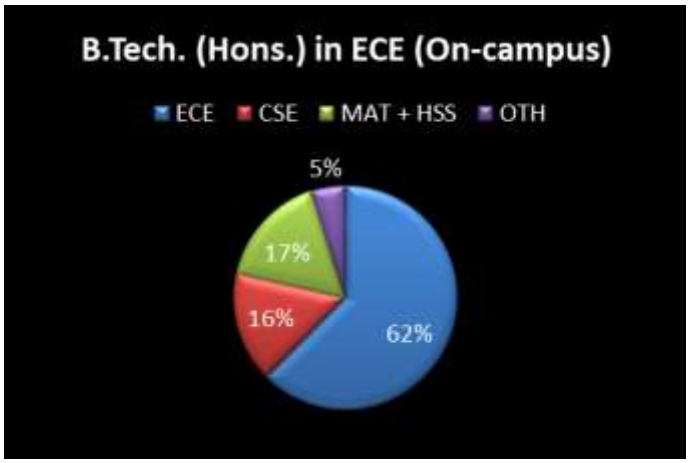
Off-campus	
ECE	103
CSE	50
MAT + HSS	27
OTH	20

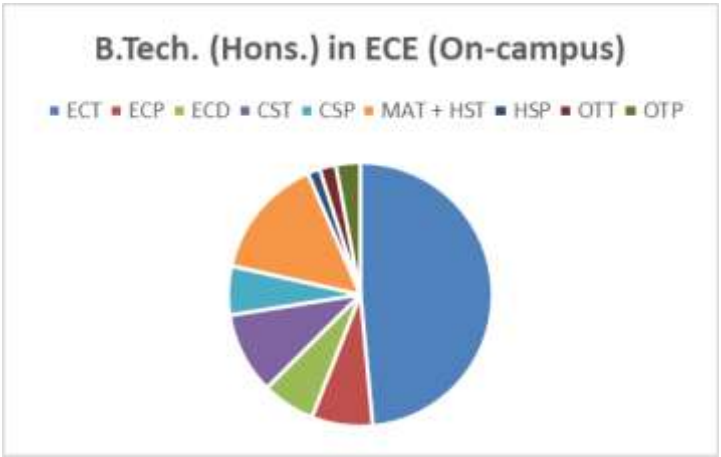


Off-campus		
ECT	75	
ECP	15	
ECD	13	
CST	38	
CSP	12	
MAT + HST	24	
HSP	3	
OTT	4	
OTP	6	
OTD	10	

Case 4: B.Tech. (Hons.) in ECE (On-campus)

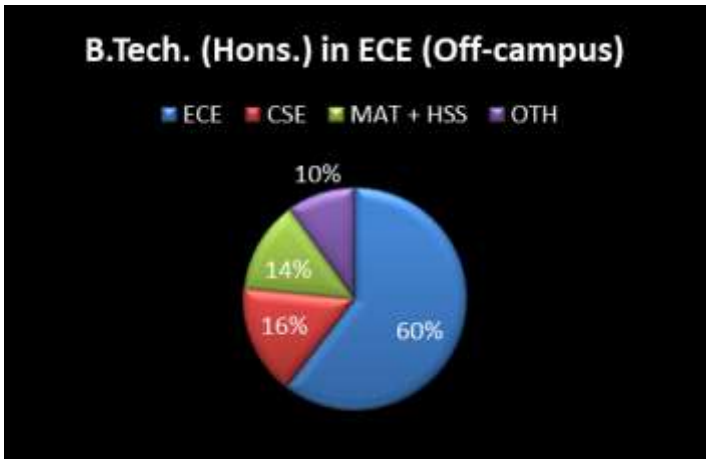
On-campus	
ECE	125
CSE	32
MAT + HSS	33
OTH	10



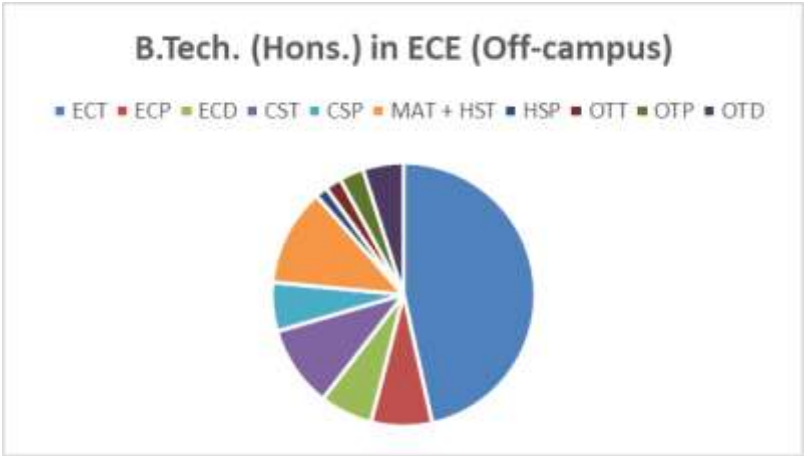
On-campus		
ECT	97	
ECP	15	
ECD	13	
CST	20	
CSP	12	
MAT + HST	30	
HSP	3	
OTT	4	
OTP	6	

Case 4: B.Tech. (Hons.) in ECE (Off-campus)

Off-campus	
ECE	121
CSE	32
MAT + HSS	27
OTH	20



Off-campus		
ECT	93	
ECP	15	
ECD	13	
CST	20	
CSP	12	
MAT + HST	24	
HSP	3	
OTT	4	
OTP	6	
OTD	10	



Note:

- Student is eligible for Diploma in Electronics and Communication Engineering after 3rd Year, and B.Tech. in ECE / B.Tech. in ECE with Minor in Specialization / B.Tech. in ECE with Major in Specialization / B.Tech. (Hons.) in ECE after 4th Year
- Student can register maximum 28 Credits in a particular Semester, except in the final year
- Students can register for Specialization / Honours Courses from 5th Sem onwards if they meet maximum Registration Credits requirements
- Students should register for minimum 3 Credit and maximum 6 Credits from each ECE Elective group under Departmental Elective and Departmental Fractal Elective category for B.Tech. in ECE or B.Tech. in ECE with Minor in Specialization
- Students should register for minimum 3 Credit and maximum 12 Credits from each ECE group under Departmental Elective / Departmental Fractal Elective / Major Specialization Elective category for B.Tech. in ECE with Major in Specialization
- Students should register for minimum 3 Credit and maximum 12 Credits from each ECE Elective group under Departmental and Honours Elective category for B.Tech. (Hons.) in ECE
- The guidelines for off-campus 'Internship and Training for Skilled Engineering Practice' course (22 Week duration) is given in **Annexure – I**.
- Students are allowed to register for Specialization / Honours Core and Elective Courses through reputed Online MOOC Courses under NPTEL or SWAYAM platforms with due approval of DUGC of the Department. Refer to **Point no. 2 of Annexure – I** for more details.
- Students can register for 10 Credits under Summer Term (8 Week duration) for Grade Improvements where students will have to complete the course in accelerated mode and they can earn Regular Grades (Grade cut-offs must be same as that of regular semester course, Supplementary Examination can give only DD grades)

Annexure – I

Off-campus 'Internship and Training for Skilled Engineering Practice' Course - Guidelines

Following guidelines to be applicable to the IIIT Kota students admitted in the year 2021 and onwards:

1. Students having no active backlog courses will be permitted to proceed on 22-week long off-campus internship and training during 7^{th} / 8^{th} semester only at following organizations: Industry Partners of IIIT Kota, Any Company which has hired IIIT Kota students and not blacklisted by IIIT Kota, Any other relevant Company with approval of DUGC, QS ranked institutions (ranked at least once in top 1000 in last three years), National and International Research Labs like CSIR or equivalent
2. Student will do the classes on MOOCs basis for courses other than 'Internship and Training for Skilled Engineering Practice' course during off-campus. The MOOCs courses has to be identified by the concerned DUGC and approved by the Chairperson, Senate. Students have to register to the identified MOOCs courses themselves and have to submit the detailed Course File (details of course and assessment conducted as well as marks obtained in all the evaluation components) from the respective MOOCs platform to the designated Course Coordinator of IIIT Kota. Student should be in constant touch with the designated Course Coordinator of IIIT Kota and brief the progress in the registered MOOCs.
   The grade earned after successful completion of the MOOCs shall be accepted as it is. In case student performance is graded in terms of percentage of marks obtained, the **Table 1** mentioned in the **Annexure – II** shall be used for Grade Assignment for MOOCs based on Percentage Marks Obtained.
   Student shall meet the attendance criteria of the course and evaluation (minimum 75% of total duration). In case the student is not meeting attendance criteria of the course / absent in the End Term Examination / obtained failed grade in the course by the MOOC evaluator, the student shall mandatorily repeat the course in On-campus mode only.
3. Student shall submit the details of Project Mentor (employee of the organization where student is pursuing off-campus internship and training) to the Course Coordinator as well as DUGC Convener and Training & Placement Cell Convener.
   Student shall submit the monthly attendance report and project progress report duly signed by the Project Mentor to the Course Coordinators. Student shall meet the attendance criteria of the organization (minimum 75% of total duration).
   Student shall be available for End Term Examination (Offline mode, after 22-week duration) under the 'Internship and Training for Skilled Engineering Practice' course. Project mentor shall also be invited to attend and evaluate all such presentation in Online mode. Method of evaluation to be same as Project – I / Project – II course.
4. Students going for internship should not be under Non-disclosure agreement (NDA) during project evaluation.
5. Student shall abide by all the rules of the Organization, where student is undergoing off-campus internship and training, and the IIIT Kota Honor Code.

Annexure – II

Grade Assignment for MOOCs based on Percentage Marks Obtained

Percentage Marks Obtained (X)	Grade To Be Assigned
$92 \leq X < 100$	AA
$84 \leq X < 92$	AB
$75 \leq X < 84$	BB
$66 \leq X < 75$	BC
$57 \leq X < 66$	CC
$48 \leq X < 57$	CD
$40 \leq X < 48$	DD
$0 \leq X < 40$	FP

End of the Document

Courses

Syllabus

for

B.Tech. in ECE / B.Tech. in ECE with Minor in Specialization / B.Tech. in ECE with Major in Specialization / B.Tech. (Hons.) in ECE

Applicable for Batch Admitted in 2021-22 and onwards

June 2021

Indian Institute of Information Technology Kota

(Mentored by MNIT Jaipur)

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Curriculum Structure for B.Tech. in ECE / B.Tech. in ECE with Minor in Specialization / B.Tech. in ECE with Major in Specialization / B.Tech. (Hons.) in ECE
Applicable for Batch Admitted in 2021-22 and onwards

1st Semester On-campus						
S. No.	**Course Code**	**Course Name**	**Scheme**			
			L	**T**	**P**	**Credits**
1	CST101	Computer Systems and Programming	3	0	0	3
2	ECT101	Digital Design	3	1	0	4
3	ECT103	Circuit Theory	3	1	0	4
4	HST101	Communication Skills	2	0	0	2
5	MAT101	Mathematics - I	3	1	0	4
		Practical				
6	CSP101	Computer Systems and Programming Lab	0	1	2	2
7	CSP111	IT Workshop - I	0	1	2	2
8	ECP101	Digital Design Lab	0	0	2	1
9	ECP111	System Simulation Techniques Lab	0	0	2	1
10	HSP101	Communication Skills Lab	0	0	2	1
11	OTP101	Upnayan - The Induction Programme	0	1	2	2
			14	**6**	**12**	**26**

2nd Semester On-campus						
S. No.	**Course Code**	**Course Name**	**Scheme**			
			L	**T**	**P**	**Credits**
1	CST102	Data Structures and Algorithms	3	0	0	3
2	ECT102	Electronic Devices and Circuits	3	1	0	4
3	ECT104	Fundamentals of Electrical Engineering	3	1	0	4
4	HST102	Technical Writing and Presentation Skills	2	0	0	2
5	MAT102	Mathematics - II	3	1	0	4
6	OTT102	Health, Safety and Environment	2	0	0	2
		Practical				
7	CSP102	Data Structures and Algorithms Lab	0	1	2	2
8	CSP112	IT Workshop - II	0	1	2	2
9	ECP102	Electronic Devices and Circuits Lab	0	0	2	1
10	ECP112	Circuit Design and Printing Lab	0	0	2	1
11	HSP102	Technical Writing and Presentation Skills Lab	0	0	2	1
			16	**5**	**10**	**26**

Curriculum Structure for B.Tech. in ECE / B.Tech. in ECE with Minor in Specialization / B.Tech. in ECE with Major in Specialization / B.Tech. (Hons.) in ECE
Applicable for Batch Admitted in 2021-22 and onwards

3rd Semester On-campus						
S. No.	**Course Code**	**Course Name**	**Scheme**			
			L	**T**	**P**	**Credits**
1	CST201	Computer Architecture and Organization	3	0	0	3
2	ECT201	Microprocessors and Peripherals	3	0	0	3
3	ECT203	Analog Integrated Circuits	3	0	0	3
4	ECT205	Signals and Systems	3	0	0	3
5	HST201	Engineering for Social Empowerment	3	0	0	3
6	MAT203	Probability and Random Processes	3	1	0	4
		Practical				
7	CSP201	Computer Architecture and Organization Lab	0	0	2	1
8	CSP211	IT Workshop - III	0	1	2	2
9	ECP201	Microprocessors and Peripherals Lab	0	0	2	1
10	ECP203	Analog Integrated Circuits Lab	0	0	2	1
11	OTP201	Engineering Creativity, Innovation and Design	0	1	2	2
			18	**3**	**10**	**26**

4th Semester On-campus						
S. No.	**Course Code**	**Course Name**	**Scheme**			
			L	**T**	**P**	**Credits**
1	CST202	Object Oriented System Design	3	0	0	3
2	ECT202	Analog Communication	3	0	0	3
3	ECT204	Measurement and Instrumentation Technology	3	0	0	3
4	ECT206	Microcontrollers and Interfacing	3	0	0	3
5	ECT208	Electromagnetic Theory	3	1	0	4
6	ECT210	Control Systems	3	1	0	4
		Practical				
7	CSP202	Object Oriented System Design Lab	0	0	2	1
8	ECP202	Analog Communication Lab	0	0	2	1
9	ECP204	Measurement and Instrumentation Technology Lab	0	0	2	1
10	ECP206	Microcontrollers and Interfacing Lab	0	0	2	1
11	OTP202	Entrepreneurship and Business Incubation	0	1	2	2
			18	**3**	**10**	**26**

Curriculum Structure for B.Tech. in ECE / B.Tech. in ECE with Minor in Specialization / B.Tech. in ECE with Major in Specialization / B.Tech. (Hons.) in ECE
Applicable for Batch Admitted in 2021-22 and onwards

5th Semester On-campus						
S. No.	Course Code	Course Name	Scheme			
			L	T	P	Credits
1	CST341	CSE Open Elective - I (Pool 3)	3	0	0	3
2	ECT301	Digital Signal Processing	3	0	0	3
3	ECT303	Digital Communication	3	0	0	3
4	ECT305	Digital MOS IC Design	3	0	0	3
5	ECT307	RF and Microwave Engineering	3	0	0	3
6	ECT321	ECE Departmental Elective - I (Pool 1)	3	0	0	3
	XXT3XX	Minor Specialization / Major Specialization / Honours Core Course (3 Credits)				
		Practical				
7	CSP341	CSE Open Elective - I Lab (Pool 3)	0	0	2	1
8	ECD301	Study of Technical Articles	0	2	2	3
9	ECP301	Digital Signal Processing Lab	0	0	2	1
10	ECP303	Digital Communication Lab	0	0	2	1
11	ECP305	Digital MOS IC Design Lab	0	0	2	1
			18	**2**	**10**	**25**

6th Semester On-campus						
S. No.	Course Code	Course Name	Scheme			
			L	T	P	Credits
1	CST342	CSE Open Elective - II (Pool 3)	3	0	0	3
2	ECT302	Wireless and Mobile Communication	3	0	0	3
3	ECT304	Optical Communication	3	0	0	3
4	ECT306	Digital System Design and FPGAs	3	0	0	3
5	ECT322	ECE Departmental Elective - II (Pool 1)	3	0	0	3
6	HST302	Professional Development	2	0	0	2
	XXT3XX	Minor Specialization / Major Specialization / Honours Core Course (3 Credits)				
		Practical				
7	CSP342	CSE Open Elective - II Lab (Pool 3)	0	0	2	1
8	ECD302	Skill Transformation based Engineering Project - I	0	2	6	5
9	ECP308	Microwave Engineering Lab	0	0	2	1
10	HSP302	Professional Development Lab	0	0	2	1
			17	**2**	**12**	**25**

Curriculum Structure for B.Tech. in ECE / B.Tech. in ECE with Minor in Specialization / B.Tech. in ECE with Major in Specialization / B.Tech. (Hons.) in ECE
Applicable for Batch Admitted in 2021-22 and onwards

7th Semester On-campus (8th Semester On-campus or Off-campus) / 8th Semester On-campus (7th Semester Off-campus)						
S. No.	**Course Code**	**Course Name**	**Scheme**			
			L	**T**	**P**	**Credits**
1	ECT421 (7th Sem) / ECT422 (8th Sem)	ECE Departmental Elective - III (Pool 1)	3	0	0	3
2	ECT423 (7th Sem) / ECT424 (8th Sem)	ECE Departmental Elective - IV (Pool 1)	3	0	0	3
3	XXT441 (7th Sem) / XXT442 (8th Sem)	MAT / HSS Open Elective - I (Pool 4 / Pool 5)	3	0	0	3
4	OTT401 (7th Sem) / OTT402 (8th Sem)	Living Ethics	2	0	0	2
	XXT4XX, XXT4XX	Minor Specialization / Major Specialization / Honours Core Courses (6 Credits)				
		Practical				
5	ECD401 (7th Sem) / ECD402 (8th Sem)	Skill Transformation based Engineering Project - II	0	2	6	5
6	ECP421 (7th Sem) / ECP422 (8th Sem)	ECE Departmental Elective - III Lab (Pool 1)	0	0	2	1
7	ECP423 (7th Sem) / ECP424 (8th Sem)	ECE Departmental Elective - IV Lab (Pool 1)	0	0	2	1
			11	**2**	**10**	**18**

8th Semester On-campus (7th Semester On-campus)						
S. No.	**Course Code**	**Course Name**	**Scheme**			
			L	**T**	**P**	**Credits**
1	ECT432	ECE Departmental Fractal Elective - I (Pool 2)	1	0	0	1
2	ECT434	ECE Departmental Fractal Elective - II (Pool 2)	1	0	0	1
3	ECT436	ECE Departmental Fractal Elective - III (Pool 2)	1	0	0	1
4	ECT438	ECE Departmental Fractal Elective - IV (Pool 2)	1	0	0	1
5	HST442	HSS Open Elective - II (Pool 5)	3	0	0	3
6	MAT442	MAT Open Elective - II (Pool 4)	3	0	0	3
	XXT4XX, XXT4XX	Minor Specialization / Major Specialization / Honours Elective Courses (6 Credits)				
			10	**0**	**0**	**10**

7th Semester On-campus (8th Semester On-campus or Off-campus) / 8th Semester On-campus (7th Semester Off-campus)						
S. No.	**Course Code**	**Course Name**	**Scheme**			
			L	**T**	**P**	**Credits**
1	ECT421 (7th Sem) / ECT422 (8th Sem)	ECE Departmental Elective - III (Pool 1)	3	0	0	3
2	ECT423 (7th Sem) / ECT424 (8th Sem)	ECE Departmental Elective - IV (Pool 1)	3	0	0	3
3	XXT441 (7th Sem) / XXT442 (8th Sem)	MAT / HSS Open Elective - I (Pool 4 / Pool 5)	3	0	0	3
4	OTT401 (7th Sem) / OTT402 (8th Sem)	Living Ethics	2	0	0	2
	XXT4XX, XXT4XX	Minor Specialization / Major Specialization / Honours Core Courses (6 Credits)				
		Practical				
5	ECD401 (7th Sem) / ECD402 (8th Sem)	Skill Transformation based Engineering Project - II	0	2	6	5
6	ECP421 (7th Sem) / ECP422 (8th Sem)	ECE Departmental Elective - III Lab (Pool 1)	0	0	2	1
7	ECP423 (7th Sem) / ECP424 (8th Sem)	ECE Departmental Elective - IV Lab (Pool 1)	0	0	2	1
			11	**2**	**10**	**18**

8th Semester Off-campus (7th Semester On-campus) / 7th Semester Off-campus (8th Semester On-campus)						
S. No.	**Course Code**	**Course Name**	**Scheme**			
			L	**T**	**P**	**Credits**
	XXT4XX, XXT4XX	Minor Specialization / Major Specialization / Honours Elective Courses (6 Credits)				
		Practical				
1	OTD402 (8th Sem) / OTD401 (7th Sem)	Internship and Training for Skilled Engineering Practice	0	0	20	10
			0	**0**	**20**	**10**

Note: For details, please refer to the document Curriculum Structure for B.Tech. in ECE / B.Tech. in ECE with Minor in Specialization / B.Tech. in ECE with Major in Specialization / B.Tech. (Hons.) in ECE Applicable for Batch Admitted in 2021-22 and onwards.

Course Code: CST101	**Course Credit: 3**
Course Name: Computer Systems and Programming	**L-T-P: 3-0-0**
Course Prerequisite: None	

Course Syllabus:

Basics: C language introduction, C language Standards, System Software, Application Software. Compiler - Compilation process - Compiler and interpreter. **[6 Lectures]**

Data Types and Storage Classes: Different data types, Storage Classes – auto, static, extern, register. Macro & Preprocessor in C. Operator Precedence and Associativity. Control Statements: If-else condition, If-else if Ladder, Switch case, Loop – for, while, do while. Nested loop, break, continue, exit, goto and problem with goto. **[10 Lectures]**

Functions: Passing arguments in main() function, Call by value, Call by reference. Array & Strings: Introduction to Array, Number type array, Character type array (String), Multi-dimensional array, Operations on strings (User defined functions for strlen, strcpy, strcmp, strrev, etc.), gets(), puts(), getc(), getch(), getchar(), putc(), putch(), putchar() functions. **[10 Lectures]**

Pointers: Introduction to pointer, Double pointer. Pointer to int, Pointer to char, Pointer to function, Function to pointer, Pointer to array, Pointer to structure, Array of pointers.Static & Dynamic Memory Allocation: malloc(), calloc(), realloc() and free() functions. **[8 Lectures]**

Structure and Union: Structure in C, Union in C, Enum operator. File Handling: Basics of working with text files, File read, write, append and other similar operations, EOF and feof() functions, File pointer, fopen(), fgetc() and fgets() functions, fputc and fprintf() functions. **[6 Lectures]**

Course Outcome (CO):

CO1: To be able to understand and operate Linux the operating system.
CO2: Basic understanding of the compiler, interpreter, assembler, and library functions.
CO3: Develop the ability to implement the fundamental knowledge of mathematics and science in computer programming.
CO4: Design the flowchart of the solution and develop the computer program to solve real-life problems.
CO5: Develop the ability to analyze the problem, develop an algorithm and finally implement using the C programming language.

References:

1. The C Programming Language, Brian W. Kernighan and Dennis Ritchie, Latest Edition, Prentice Hall.
2. Programming in ANSI C, E. Balagurusamy, Latest Edition, McGraw Hill
3. Let us C, Yashavant Kanetkar, Latest Edition, BPB Publication

Course Code: ECT101	**Course Credit: 4**
Course Name: Digital Design	**L-T-P: 3-1-0**
Course Prerequisite: None	

Course Syllabus:

Number base conversion (binary, octal, decimal, hexadecimal), Binary codes (weighted, unweighted, self-complementary), Signed and unsigned binary numbers, complements (1's, 2's, 9's, 10's), Binary arithmetic (addition, subtraction, multiplication, division), Binary logic (positive and negative logic). **[8 Lectures]**

Boolean algebra (basic theorems and properties, truth tables, DeMorgan's theorem, duality, operator precedence), Boolean function (canonical and standard forms), Digital logic gates, Boolean function simplification (2 to 4 variable Karnaugh maps, don't care conditions, Quine-McCluskey method), NAND and NOR implementation. **[9 Lectures]**

Analysis and design of combinational logic circuits (code conversion, error detector, binary adder and subtractor, look-ahead carry and BCD adders, binary magnitude comparator, decoder, encoder, priority encoder, multiplexer, demultiplexer), Programmable logic devices (design using read only memory, and programmable logic arrays). **[9 Lectures]**

Level and edge-triggered flip-flops (RS flip-flop, D flip-flop, JK flip-flop, T flip-flop, timing specifications of flip-flops, characteristic table and equation of flip-flops, excitation table of flip-flops). **[7 Lectures]**

Analysis of clocked sequential circuits (state table, state diagram, state reduction and assignment), Design of synchronous and asynchronous counters, Shift registers and its timing considerations. **[7 Lectures]**

Course Outcome (CO):

CO1: Represent and convert decimal numbers in various other number systems.
CO2: Use Boolean algebra to construct, minimize and implement real time problems in digital system design.
CO3: Implement, analyze, optimize and debug design based on various logic gates.
CO4: Design and analyze circuits for digital arithmetic. To describe the operation and timing constraints for latches, Flip-flops and registers etc.

References:

1. M. Morris Mano, Michael D. Ciletti, "Digital Design", Prentice Hall, 4th Edition
2. R.P. Jain, "Modern Digital Electronics", Tata McGraw Hill, 3rd Edition
3. Albert Paul Malvino, Donald P. Leach, "Digital Principles and Applications", Tata McGraw Hill, 6th Edition
4. John F. Wakerly, "Digital Design: Principles and Practices", Pearson Education, 4th Edition Wiley, 1st Edition

Course Code: ECT103	**Course Credit: 4**
Course Name: Circuit Theory	**L-T-P: 3-1-0**
Course Prerequisite: None	

Course Syllabus:

Introduction to electric circuits and networks, Circuit variables (charge, current, voltage, electric field, power), Circuit elements (independent and dependent voltage and current sources, resistors, capacitors, inductors), Kirchhoff's laws (KCL and KVL), Ohm's law, Series and parallel circuits, Linear circuit analysis techniques (nodal analysis, mesh analysis). **[8 Lectures]**

Network topology and graphs, Network theorems (Superposition, Thevenin's, Norton's, Maximum Power Transfer, Millman's, Tellegen's, Reciprocity, Compensation), Circuit transformation (Wye - Delta), Source transformations, Duality principle. **[10 Lectures]**

Time-domain transient analysis (natural and forced) of first-order and second-order circuits. **[8 Lectures]**

Phasor-domain or frequency-domain steady-state analysis, AC power, Polyphase circuits, Three-phase loads, Frequency response, Basic filters, Resonance, Quality factor and bandwidth. **[8 Lectures]**

Two Port Parameters (Impedance, Admittance, Transmission, Hybrid), Relationships between parameters, Interconnection of two port networks, Symmetrical two port network. **[6 Lectures]**

Course Outcome (CO):

CO1: Learn the essentials of electrical circuits and networks.
CO2: Learn the linear circuit analysis techniques and network theorems.
CO3: Learn the time-domain response for RLC circuits.
CO4: Learn the frequency-domain response of RLC circuits.
CO5: Learn the two port networks and its parameters.

References:

1. Charles K. Alexander, Mathew N.O. Sadiku, "Fundamentals of Electric Circuits", McGraw Hill, 3rd Edition
2. William H. Hayt, Jack Kemmerley and Steven M. Durbin, "Engineering Circuit Analysis", 8th Ed., Tata McGraw-Hill, 2012
3. M. E. Van Valkenburg, "Network Analysis", 3rd Ed., Prentice Hall of India, 2003
4. Leonard S. Bobrow, Navneet Gupta, "Foundations of Electrical Engineering", Oxford University Press, Asian Edition
5. Allan R. Hambley, "Electrical Engineering Principles and Applications", Prentice Hall, 5th Edition

Course Code: HST101	Course Credits: 2
Course Name: Communication Skills	**L-T-P: 2-0-0**
Course Prerequisite: None	

Course Syllabus:

Basic Grammar: Sentence Construction and Types; Simple, Complex and Compound sentences; Tenses; Agreement of Subject and Verb; Conditional Sentences; Direct and Indirect Narration; Active and Passive Voice; Error Spotting; Question tags and short responses. **[9 Lectures]**

Vocabulary and Usage: Word Formation (by adding suffixes and prefixes), Confusing Word Pairs; Homophones, and Homonyms; One Word Substitution; Phrasal Verbs; Punctuation. **[4 Lectures]**

Writing Skills: Precis writing; Note-making; Expressing ideas within a restricted word limit; Email writing; Reading Comprehension. **[5 Lectures]**

Texts for Appreciation and Analysis:

1. *Animal Farm* (1945) by George Orwell. Penguin India, 2011. (ISBN: 9781502492791) **and**
2. Selected chapters from the prescribed textbook: *Insights: A Course in English Literature and Language* (2009) by K. Elango, Orient Blackswan Publishers:

- 'The Diary of a Young Girl'
- 'Wings of Fire'
- 'Our Urgent Need for Self-esteem **[9 Lectures]**

Course Outcome (CO):

CO1: Understand the essential rules of syntax in the English language.
CO2: Learn the techniques to expand the knowledge of vocabulary.
CO3: Learn to use appropriate idiomatic expressions in speech and writing.
CO4: Learn the techniques for effective written communication.
CO5: Learn to develop the skills of comprehending and analyzing a written work.

References:

1. Murphy, Raymond. *English Grammar in Use*, Cambridge UP. 2012.
2. Stuart Redman, *English Vocabulary in Use: Pre-Intermediate and Intermediate*, Cambridge UP, 2012.
3. Barker, Alan. *Improve Your Communication Skills: How to Build Trust, Be Heard and Communicate with Confidence.* Kogan Page, 2019.
4. Swan, Michael. *Practical English Usage*, Oxford UP, 2017.
5. Barnet, Sylvan, & William E. Cain. *A Short Guide to Writing about Literature*. Longman, 2005.
6. O'Brien, Terry. *Modern Writing Skills*, Rupa, 2011.

Course Code: MAT101	**Course Credit: 4**
Course Name: Mathematics - I	**L-T-P: 3-1-0**
Course Prerequisite: None	

Course Syllabus:

Differential Calculus: Asymptotes, curve tracing (Cartesian, parametric and five polar curves-Folium of Descartes, Limacon, Cardioids, Lemniscuses of Bernoulli and Equiangular spiral and other simple polar curves). Partial differentiation, Euler's theorem on homogeneous functions, total differentiation, approximate calculation. **[8 Lectures]**

Integral Calculus – Improper integrals, Area and length of curves, Surface area and volume of solid of revolution. Multiple integrals, Change of order of integration. **[6 Lectures]**

Differential Equations – Differential equations of first order and first degree - linear form, reducible to linear form, exact form, reducible to exact form. Linear differential equations of higher order with constant coefficients. Second order ordinary differential equations with variables coefficients – Homogeneous, exact form, reducible to exact form, change of dependent variable (normal form), change of independent variable, method of variation of parameters. **[9 Lectures]**

Matrices – Rank and inverse of matrix by elementary transformations, Consistency of linear system of equations and their solution. Eigenvalues and eigenvectors. Cayley-Hamilton theorem (statement only) & its applications. **[8 Lectures]**

Numerical Analysis- Finite differences, interpolations and numerical differentiations – Forward, Backward, Central differences and relations between them, Newton's forward, backward interpolation formulas and Stirling's central difference interpolation formulas. Lagrange's interpolation formula, Numerical differentiations using Newton's forward, backward, Stirling's central difference interpolation formulas. Numerical integrations - Trapezoidal rule, Simpson's one-third rule, Simpson's 3/8 rule. **[9 Lectures]**

Course Outcome (CO):

CO1: Understand Differential equations and its applicability in different engineering fields.
CO2: Incorporate the knowledge of calculus to support their concurrent and subsequent engineering studies.
CO3: Have the idea of matrices, its physical interpretation and applications in real life examples.
CO4: To develop mathematical skills so that students are able to apply mathematical methods & principles in solving problems from Engineering fields.
CO5: To make aware students about the importance and symbiosis between Mathematics and Engineering.

References:

1. R.K. Jain, S.R.K. Iyengar, "Advanced Engineering Mathematics", Narosa
2. Srimanta Pal and Subodh C. Bhunia, "Engineering Mathematics", Oxford
3. Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley India
4. D. W. Jordan, P. Smith, "Mathematical Techniques", Oxford
5. Peter V. O'Neil, "Advanced Engineering Mathematics", Cengage Learning, New Delhi
6. B.V. Ramana, "Higher Engineering Mathematics", McGraw–Hill

Course Code: CSP101	**Course Credit: 2**
Course Name: Computer Systems and Programming Lab	**L-T-P: 0-1-2**
Course Prerequisite: None	

Course Syllabus:

First program in C, Variable Declaration and Initialization, Scope of a variable, Use of Constant, Use of Escape sequences, Use of printf() and scanf() functions, Different data types, Use of static, extern, Use of Macro, Use of Logical and Relational operators, Operator Precedence and Associativity, Evaluation order, Post-increment and Pre-increment, sizeof operator, If-else condition, If-else if Ladder, Switch case, Loop – for, while, do while. Nested loop, break, continue, exit. **[3 Labs]**

User defined functions, Function prototype, Argument passing, return type, Passing arguments in main() function, Evaluation order of arguments, Return multiple values from a function, Number type array, Character type array (String), Multi-dimensional array. **[3 Labs]**

Operations on strings (User defined functions for strlen, strcpy, strcmp, strrev, etc.), gets(), puts(), getc(), getch(), getchar(), putc(), putch(), putchar() functions, Call by value, Call by reference. **[2 Labs]**

Null, void pointers, Double pointer, Pointer to int, Pointer to char, Pointer to function, Function to pointer, Pointer to array, Pointer to structure, Array of pointers. **[2 Labs]**

Structure in C, Different operations on struct variables, Enum operator, malloc(), calloc(), realloc() and free() functions, Basics of working with text files, File read, write, append and other similar operations, EOF and feof() functions, File pointer, fopen(), fgetc() and fgets() functions, fputc and fprintf() functions. **[2 Labs]**

Course Outcome (CO):

CO1: To understand and use variables, data types and functions to implement various algorithms.
CO2: To handle loop execution, if-else conditions, array and pre-processing directives.
CO3: To understand the use and implementation of arrays, structures and unions as user defined datatypes.
CO4: To handle pointer variables, static and dynamic memory allocation, array of pointers and other uses of pointers.

References:

1. The C Programming Language, Brian W. Kernighan and Dennis Ritchie, Latest Edition, Prentice Hall.
2. Programming in ANSI C, E. Balagurusamy, Latest Edition, McGraw Hill.
3. Let us C, Yashavant Kanetkar, Latest Edition, BPB Publication.

Course Code: CSP111	Course Credit: 2
Course Name: IT Workshop - I	**L-T-P: 0-1-2**
Course Prerequisite: None	

Course Syllabus:

Part 1: COMPUTER ANIMATION [6 Labs]
Software Used: Blender
Animation Basics – Timeline, Frame rate, Shots and Scenes, Keyframes, In-between frames, Timing, Spacing, etc
Animation Principles – Squash and Stretch, Anticipation, Overlapping actions, etc
Type of Animation – Difference among 3D animation, Stop Motion Animation, Character Animation.
Animation Process – Story and Script, Concept Art, Animatic, Creating Assets, Animation, Texturing and Rendering, Editing, Add Music and Sound.
Project: Making an animated movie / video game / any other project

Part 2: ROBOTICS [6 Labs]
Introduction to Robots and Autonomous Systems
Getting started with Arduino Uno
Installation of Arduino IDE for coding and sample socket programming
Write the first LED on-off program and transfer it to the Arduino Uno
Connecting Ultrasonic sensor and other sensors
Practice with L298N motor controller and DC motors
Embedding and data transfer using Bluetooth module
Lecture and small demonstration on advanced applications of IoT

Course Outcome (CO):

CO1: To understand the importance and industrial scope of computer animation and gaming
CO2: To understand the principles of animation and its vocabulary
CO3: To design and develop an animated film step-by-step
CO4: To understand the microcontrollers, analog and digital sensors and motors.
CO5: To connect sensors and actuators with the microcontroller and power supply system.
CO6: Mathematical simple dynamic modelling and programming to make a working robotic prototype to develop a simple robot control system, environment perception, planning and action.

References:

1. Oliver Villar, “Learning Blender: A Hands-On Guide to Creating 3D Animated Characters”, Addison-Wesley
2. Gordon Fisher, “Blender 3D Basics”, Packt Publishing Limited
3. Mark Geddes, Arduino Project Handbook, No Starch Press
4. Simon Monk, Programming Arduino: Getting Started with Sketches, McGraw-Hill Education, Latest Edition
5. Andy Beane, “3D Animation Essentials”, John Wiley
6. Isaac Kerlow, “The Art of 3D Computer Animation and Effects”, Latest Edition, Wiley
7. Simon Monk, 30 Arduino Projects for Evil Genius, McGraw-Hill Education, Latest Edition

Course Code: ECP101	Course Credit: 1
Course Name: Digital Design Lab	**L-T-P: 0-0-2**
Course Prerequisite: None	

Course Syllabus: 1 Lab per experiment

1. Verification of truth table for various logic gates using TTL ICs and implementation of basic gates universal NAND and NOR gates.
2. Design of four bit Binary to Gray and Gray to Binary code Converter.
3. Design of Half and Full Adder and Subtractor circuits.
4. Design of Two-bit multiplier.
5. Design of One- and Two-bit Comparators.
6. Design of Even and Odd parity generator and checker.
7. Design of 2:1 and 4:1 MUX using basic gates, and design of 4:1 MUX using 2:1 MUX.
8. Design a binary to decimal and octal to decimal decoder.
9. Design and verification truth table of flip-flops (SR latch with NOR and NAND Gates, SR flip-flop with control input using NOR and NAND Gates).
10. Design and verification truth table of flip-flops (D, JK and T).
11. Design and implement binary ripple and synchronous up/down counters using flip-flops.
12. Design and implement shift registers using flip-flops.

Course Outcome (CO):

CO1: Design and verify the truth table of various logic gates.
CO2: Design and analyze the universal gates using basic gates.
CO3: Design and analyses of different combinational circuits.
CO4: Design and analyses of different sequential circuits.

References:

1. M. Morris Mano, Michael D. Ciletti, "Digital Design", Prentice Hall, 4th Edition.
2. R.P. Jain, "Modern Digital Electronics", Tata McGraw Hill, 3rd Edition.
3. Albert Paul Malvino, Donald P. Leach, "Digital Principles and Applications", Tata McGraw Hill, 6th Edition.
4. John F. Wakerly, "Digital Design: Principles and Practices", Pearson Education, 4th Edition.
5. Frederick J. Hill, Gerald R. Peterson, "Introduction to Switching Theory and Logic Design", John Wiley, 1st Edition.
6. Frederick J. Hill, Gerald R. Peterson, "Computer Aided Logical Design with Emphasis on VLSI", John Wiley, 4th Edition.

Course Code: ECP111	Course Credit: 1
Course Name: System Simulation Techniques Lab	**L-T-P: 0-0-2**
Course Prerequisite: None	
Course Syllabus: Total 12 Labs Matlab Programming - Introduction to Programming (Components of a computer, Working with numbers, Machine code, Software hierarchy, Matrix theory). Programming Environment (MATLAB Windows, A First Program, Expressions, Constants, Variables and assignment statement, Arrays). Graph Plots (Basic plotting, Built-in functions, Generating waveforms). Procedures and Functions, Arguments and return values, M-files, Formatted console input-output, String handling. Conditional statements (If, Else, Elseif, Repetition statements: While, For). 1D and 2D signals. Audio and Image processing, load save etc.	
Course Outcome (CO): CO1: Understand the concept of Matlab programming on Linux. CO2: Understand the concept of MATLAB programming. CO3: Understand the concept of graph plotting. CO4: Understand the concept of functions, constitutional statements etc. CO5: Understand the concept of 1D and 2D signals, image processing etc.	
References: 1. Rudra Pratap. Getting started with MATLAB: a quick introduction for scientists and engineers. New York: Oxford University Press, 2010. 2. S. J. Chapman. MATLAB programming for engineers. Nelson Education, 2015. 3. Raj Kumar Bansal, Ashok Kumar Goel and Manoj Kumar Sharma. MATLAB and its applications in engineering. Pearson Education India, 2009.	

Course Code: HSP101	**Course Credit: 1**
Course Name: Communication Skills Lab	**L-T-P: 0-0-2**
Course Prerequisite: None	

Course Syllabus:

Active Listening, Interactive Vocabulary building, Grammar Practice. **[3 Labs]**

Extempore Speaking, Group discussions, Interaction on Topics Of Social & General awareness, Turncoat Debates, Grammar practice. **[3 Labs]**

Story Telling, Screening Select episodes/Clips from Movies/Series, Viewing Skills (Writing Activities using silent videos), Grammar Practice. **[3 Labs]**

Jigsaw reading, Drills & training on the combined skills of Vocal, Written, Visual, & Non-verbal Communication, Grammar practice. **[3 Labs]**

Course Outcome (CO):

CO1: Effective Communication as a Must-have skill
CO2: Receiving Information Successfully.
CO3: Transmitting Information Successfully, Effectively, & Constructively.

References:

1. Murphy, Raymond. *English Grammar in Use*, Cambridge UP. 2012.
2. Stuart Redman, *English Vocabulary in Use: Pre-Intermediate and Intermediate*, Cambridge UP, 2012.
3. Barker, Alan. *Improve Your Communication Skills: How to Build Trust, Be Heard and Communicate with Confidence.* Kogan Page, 2019.
4. Swan, Michael. *Practical English Usage*, Oxford UP, 2017.
5. Barnet, Sylvan, & William E. Cain. *A Short Guide to Writing about Literature*. Longman, 2005.
6. O'Brien, Terry. *Modern Writing Skills*, Rupa, 2011.

Course Code: OTP101	Course Credit: 2
Course Name: Upnayan – The Induction Programme	**L-T-P: 0-1-2**
Course Prerequisite: None	

Course Syllabus:

Day 1:

- Inaugural Session: Welcome Note, Introduction to the institute, Introduction to Leadership
- Session: Role of Effective studentship for a better life ahead
- Introduction to the curriculum, evaluation metrics, time-table and annual calendar

Day 2:

- Understanding and Managing Change, and Transition -1 and Transition -2
- Introduction to the functioning of institution:
- Committees, Clubs, Events, Activities, Student Support Services Ragging, Regulations (class rules, discipline, ragging etc
- Campus tour

Day 3:

- Expand your learning styles
- Study Skills -1(Introduction, Self -evaluation, Attention Management), Study Skills -2 (Reading, Note Making, Comprehension), Study Skills-3 (Memory, Time Management, Test Taking Skills)

Day 4:

- Enhancing 21st Century Skills-1(Introduction and Relevance), Enhancing 21st Century Skills-2: Imagination and Creativity, Enhancing 21st Century Skills-3: Digital Literacy Skills, Enhancing 21st Century Skills-4: Leadership and Team Culture

Day 5:

- Getting ready for career -1
- Getting ready for career -2
- Evaluation and Feedback: Directions for improvement
- Wrap up session
- Sharing of Experience
- An inspirational connect with an influencer
- Vote of Thanks

Course Outcome (CO):

CO1: To establish values and ethics.
CO2: To explore the creative side of students.
CO3: To promote social awareness in the students.
CO4: To promote physical activity and sports culture.

References:

Course Code: CST102	**Course Credit: 3**
Course Name: Data Structure and Algorithms	**L-T-P: 3-0-0**
Course Prerequisite: Basic programming in C language	

Course Syllabus:

Introduction: Concept of Data Structures, Algorithms and ADT (Abstract Data Type), Program v/s algorithms, Execution time and storage space, Complexity -time and space, Asymptotic notations: O(n), Ω(n) Q(n). **[6 lectures]**

Array: Array as storage element, computing address in n-dimensional array. Insertion and Deletion, Searching (Sequential and binary), Sorting (Bubble sort, Insertion, Selection, Merge sort, Quick sort, radix sort), Representation of polynomial and its applications, Representation of Sparse matrix and its applications.

Linked lists: Single and double linked lists, Insertion/deletion/searching in linked lists, Comparison of arrays and linked lists, Implementation of circular lists. **[9 Lectures]**

Stack and Queue: Stack, Queue, Circular queue, Concept of overflow and underflow, Concept of precedence and associativity in expressions, Resolving precedence of operators and association of operands, Evaluation of Expression: Infix, Prefix & Postfix notations, conversion of expression from one form to other form, Recursion: concepts, use and implementation. Strings, Hash tables (open and close), Dictionary, Sets. **[10 Lectures]**

Trees: Concept of Trees, Binary and Multiway tree, Representing multiway tree as Binary tree, Tree Traversal, constructing Binary tree from Traversal, BST (Binary Search Tree), threaded and unthreaded BST as data structure, Insertion/Deletion/Search in BST, Heap Tree and Heap sort, Introduction to height balanced tree. **[9 Lectures]**

Graphs: Introduction to graphs (directed and undirected), representation of graphs using adjacency matrix and list, Graph Traversals: DFS and BFS, Topological sorting. **[6 Lectures]**

Course Outcome (CO):

CO1: To understand the basic data structures and analyze them to use in different problems.
CO2: To understand the linear and nonlinear search data structures and their implementation.
CO3: Select the appropriate data structures and analyze time and space complexities.
CO4: To derive the mathematical details to compute the complexity asymptotically.
CO5: Identify different parameters to analyze and implement various types of data structures and design algorithms for solving real world problems.

References:

1. Ellis Horowitz, SartajSahni, Fundamentals of Data Structures, Computer Science Press, Latest Edition.
2. Robert Kruse, et al. Data Structures and Program Design in C, Pearson, Latest Edition.
3. Alfred V. Aho, John E. Hopcroft, and Jeffrey D. Ullman, Data Structures and Algorithms, Addison Wesley, Latest Edition.
4. Aaron M. Tenenbaum, Y. Langsam, Moshe J. Augenstein, Data Structures Using C, PHI.

Course Code: ECT102	**Course Credit: 4**
Course Name: Electronic Devices and Circuits	**L-T-P: 3-1-0**
Course Prerequisite: None	

Course Syllabus:

Types of materials, Characteristics of intrinsic and extrinsic semiconductors, Junction diode and its characteristics, Ideal diode and its applications (half-wave and full-wave rectifiers in voltage regulators, positive and negative clippers, positive and negative clampers), Non-ideal diode models, Zener diodes and its applications (clipper, voltage regulator), Diode capacitance and switching times, Types of diodes (LED, Varactor diode, Schottky diode, Photodiode). **[8 Lectures]**

Bipolar Junction Transistor (BJT types, operation, configurations, characteristics), Cutoff and saturation operations, BJT switching times. **[8 Lectures]**

Field Effect Transistor (FET types, operation, configurations, characteristics), Metal-Oxide Semiconductor FET (MOSFET types, operation, configurations, characteristics), Complimentary MOSFET (CMOS). **[8 Lectures]**

BJT biasing and small-signal analysis of BJT amplifiers, FET biasing and small-signal analysis of FET amplifiers, Frequency response (low-frequency and high-frequency responses of amplifiers), Large-signal power amplifiers (class A, class B, class AB). **[8 Lectures]**

Feedback (concept of negative and positive feedback, characteristics of negative feedback amplifiers, negative feedback amplifiers topologies, sinusoidal oscillators). **[8 Lectures]**

Course Outcome (CO):

CO1: Learn the essentials of semiconductor materials and devices.
CO2: Learn the operation of BJT and FET.
CO3: Learn the design and frequency-domain analysis of amplifiers using BJT and FET.
CO4: Learn the basic power amplifiers.
CO5: Learn the concept of feedback and their circuit applications.

References:

1. Robert Boylestad, Louis Nashelsky, “Electronic Devices and Circuit Theory”, Prentice Hall, 7th Edition
2. Jacob Millman, Christos C. Halkias, “Integrated Electronics: Analog and Digital Circuits and Systems”, Tata McGraw Hill
3. Adel S. Sedra, Kenneth C. Smith, “Microelectronic Circuits”, Oxford University Press, 5th Edition
4. Leonard S. Bobrow, Navneet Gupta, “Foundations of Electrical Engineering”, Oxford University Press, Asian Edition
5. Donald A. Neamen, “Microelectronics: Circuit Analysis and Design”, McGraw Hill, 4th Edition

Course Code: ECT104	**Course Credit: 4**
Course Name: Fundamentals of Electrical Engineering	**L-T-P: 3-1-0**
Course Prerequisite: None	

Course Syllabus:

Brief history of electrical engineering, Sources of Electrical Energy, Generation and Transmission of Electrical Energy. **[6 Lectures]**

Measurement of electrical quantities (current, voltage, power, energy, resistance, inductance, capacitance, frequency). **[8 Lectures]**

Magnetic circuits, Ideal transformer, Non-ideal transformer parameters determination. **[6 Lectures]**

DC machines (DC generator and motor), AC machines (synchronous and induction generators and motors). **[10 Lectures]**

Realization of Digital Logic Gates (AND, OR, NOT, NAND, NOR, Latch, Flip-flops) using Semiconductor Devices (Diode / BJT / FET), Operation of Digital Logic Families (RTL, DTL, TTL, ECL, MOS, CMOS), Parameters of Digital Logic Families (Fan-out, Power dissipation, Propagation delay, Noise margin). **[10 Lectures]**

Course Outcome (CO):

CO1: Learn the essentials of electrical energy.
CO2: Learn the measurement of electrical quantities.
CO3: Learn the principle of operation of transformer.
CO4: Learn the principle of operation of DC and AC motors and generators.
CO5: Learn the realization of digital logic gates and families.

References:

1. Charles A. Gross, Thaddeus A. Roppel, “Fundamentals of Electrical Engineering”, CRC Press
2. A.K. Sawhney, “Electrical & Electronics Measurement and Instrumentation”, Dhanpat Rai & Co
3. M. Morris Mano, Michael D. Ciletti, “Digital Design”, Prentice Hall, 4th Edition
4. Edward Hughes, “Electrical & Electronic Technology”, Pearson Education, 10th Edition
5. Vincent Del Toro, “Electrical Engineering Fundamentals”, Prentice Hall India, 2nd Edition

Course Code: HST102	**Course Credit: 2**
Course Name: Technical Writing and Presentation Skills	**L-T-P: 2-0-0**
Course Prerequisite: None	

Course Syllabus:

Communication Strategy, Data Visualization and Delivery, Communication Across Cultures. **[6 lectures]**

Communication to Build Brands/Values/Promise (Slogan Writing, Demos, Sales Pitch etc.), Communication in Crisis (Negotiation, Brainstorming for Deadlines, Precision in Extreme Situations). [**5 lectures]**

Communication in different conversations (Emails, Meetings, Interviews, Presentations, Networking), Style, Tone & Voice. **[5 lectures]**

Types of Presentations (Formal, Informal, Speeches, Demos, etc.), Preparation, Writing, Method, and delivery, Tailoring Information to Suit the Audience). **[5 lectures]**

Writing to Create Quality Documents: 7Cs of Communication; Structured Writing: Paragraph Expansion, Essay, Presentation; Style, Coherence, Emphasis. [**6 lectures]**

Course Outcome (CO):

CO1: Confidence Building.
CO2: Effective Participation
CO3: Developing Skills for Digital Communication
CO4: Developing Critical, Independent, and Creative Thinking

References:

1. Handbook of Technical Writing: Charles T Brusaw, Gerald J Alred & Walter E Oliu, St. Martin's Press, New York.
2. Technical Writing 101: Alan S Pringle & Sarah S O'Keefe, Scriptorium Publishing Services Inc
3. Every Page is Page One: Mark Baker XLM Press
4. How to Talk to Anyone: Leil Lowndes, McGraw Hill
5. Talk Like Ted : Carmine Gallo, Pan Macmillan

Course Code: MAT102	**Course Credit: 4**
Course Name: Mathematics-II	**L-T-P: 3-1-0**
Course Prerequisite: None	

Course Syllabus:

Vector Calculus – Differentiation and integration of vector functions of scalar variables, Scalar and vector fields, Gradient, Directional derivative, Divergence, Curl. Line integral, Surface integral and Volume integral. Green's, Gauss's and Stokes's theorems (statement only) and their simple applications. **[8 lectures]**

Fourier series- full range and half range series, change of intervals, Harmonic analysis **[6 lectures]**

Partial Differential Equation – Formulation and classification of PDE; Linear partial differential equation of the first order (Lagrange's method) Non-linear PDE of the first order. Four standard forms, Charpit's method. **[8 lectures]**

Integral Transforms – Laplace Transform and Convergence, Properties of Laplace Transform, Inverse Laplace Transform, Fourier Transform, Inverse Fourier Transform, Laplace Transform and Fourier Transform. **[6 lectures]**

Complex Variable – Limit, Continuity and Differentiability of complex function, Analytic functions, Cauchy-Riemann Equations, Necessary and Sufficient condition for analyticity, Properties of Analytic functions and their Engineering Applications. Complex Integration: Line Integral (contour integral) and its properties, Cauchy's integral theorem, Cauchy Integral Formula, Taylor's series and Laurent's series, Applications of Contour Integration –Residue theorem, calculation of residues, Evaluation of various types of definite real integrals using contour. **[12 lectures]**

Course Outcome (CO):

CO1: Understand Integral transforms and its applicability in different engineering fields.
CO2: Incorporate the knowledge of calculus to support their concurrent and subsequent engineering studies.
CO3: To develop mathematical skills so that students are able to apply mathematical methods & principles in solving problems from Engineering fields.
CO4: To make aware students about the importance and symbiosis between Mathematics and Engineering.
CO5: To integrate a continuous function of two or three variables over a bounded region. Understand Curl, divergence and gradient with their applications.
CO6: Calculate line integral, surface integral and volume integral and correlate them with the application of Stokes, Green and Divergence theorem.

References:

1. R.K. Jain, S.R.K. Iyengar, "Advanced Engineering Mathematics", Narosa
2. Srimanta Pal and Subodh C. Bhunia, "Engineering Mathematics", Oxford
3. Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley India
4. R.V. Hogg, J.W. McKean, A. Craig, "Introduction to Mathematical Statistics", Pearson Education India, 6th Edition
5. N.P. Bali, Manish Goyal, "A text Book of Engineering Mathematics", Laxmi Publications
6. J. Ravichandran, "Probability and Statistics for Engineers", Wiley India, 2010

Course Code: OTT102	Course Credit: 2
Course Name: Health, Safety and Environment	**L-T-P: 2-0-0**
Course Prerequisite: None	

Course Syllabus:

Health and Safety:
Health and Safety Foundations, Key Elements of Health and Safety Policy, History of Occupational Safety and Health, Organizing and Promoting a Positive Health and Safety Culture, Risk Assessment and Principles of Control, Monitoring as well as Review and Audit, Hazards Control and Personal Protective Equipment at work places (Hazards related to Food, Body Posture, Fire, Electrical, Office, Construction, Chemical, Mining, Oil and Gas), International and National Aspects of Health and Safety, Mental Health and Physical Wellbeing **[14 Lectures]**

Environment:
Introduction to Water, Air and Land Pollution, Environmental Legislation and Standards in India **[4 Lectures]**

Parameters of Water Pollution, Biochemical Oxygen Demand, Five day BOD Test, Modeling BOD (First order reaction), Effect of Oxygen demanding wastes on rivers, Oxygen sag curve, Streeter-Phelps Equation, Overview of air pollution, Global warming and climate change **[6 Lectures]**

Introduction to Solid Waste Management, Municipal Solid Waste (MSW) Management Practices, Introduction to Hazardous Waste and its Management, E-waste, Waste Electrical & Electronic Equipment (WEEE) Directives, Water Conservation, Role of IT in Environment Protection & Human Health **[3 Lectures]**

Course Outcome (CO):

CO1: Understanding the fundamentals of Health and Safety.
CO2: Understanding the common Hazards and methods to control them.
CO3: Understanding the issues and challenges related to environment and pollution.
CO4: Understanding the methods to estimate and quantify environmental parameters.

References:

1. Phil Hughes, Ed Ferrett, “Introduction to Health and Safety at Work”, Elsevier, 2009
2. S. Z. Mansdorf, “Handbook of Occupational Safety and Health”, Wiley, 2019
3. G. M. Masters and W. P. Ela, Introduction to Environmental Engineering and Science, 3rd edition, Pearson
4. Benny Joseph, Environmental Studies, 2nd edition, Tata McGraw Hill
5. S. K. Dhameja, Environmental Engineering & Management, 2nd edition, S. K. Kataria & Sons

Course Code: CSP102	**Course Credit: 2**
Course Name: Data Structures and Algorithms Lab	**L-T-P: 0-1-2**
Course Prerequisite: Basic Programming in C Language	

List of Experiments:

1. Concepts revision of C Programming Language, Data Types Revisited, Variable and Constant, Static and Dynamic Memory Allocation, Array, Pointer, Structure, Strings. **[2 Labs]**
2. Sorting (Bubble sort, Selection sort, Insertion sort, Quick sort, Merge sort), Searching (Linear search and binary search) **[2 Labs]**
3. Linked List (Creation, Insertion, Deletion and Search operations in Singly Linked List, Circular Linked List, Doubly Linked List and Circular Doubly Linked List) **[2 Labs]**
4. Stack, Queue, Circular Queue, Priority Queue, Double Ended Queue, Infix Prefix and Postfix expression conversion. **[3 Labs]**
5. Tree (Creation of Binary and Multiway tree, Insertion, Deletion and Search in Binary Tree, Creation, Insertion, Deletion in Binary Search Tree, Inorder, Preorder and Postorder Traversal, Creation of Heap Tree, Heap sort), Graph (Creation of Directed and Undirected Graph, Depth First Traversal and Breadth First Traversal) **[3 Labs]**

Course Outcome (CO):

CO1: To implement all basic data structures in C programming language.
CO2: To implement dynamic array, stack, queue, linked list and priority queue.
CO3: To implement various sorting and searching algorithms using linear data structures.
CO4: To analyze and implement binary search trees, graphs, heaps, B-Tree, B+-Tree and other non-linear data structures to solve various computing problems.
CO5: Design algorithms and implement using the combination of linear and nonlinear data structures.

References:

1. Ellis Horowitz, SartajSahni, Fundamentals of Data Structures, Computer Science Press, Latest Edition.
2. Robert Kruse, et al. Data Structures and Program Design in C, Pearson, Latest Edition.
3. Alfred V. Aho, John E. Hopcroft, and Jeffrey D. Ullman, Data Structures and Algorithms, Addison Wesley, Latest Edition.
4. Aaron M. Tenenbaum, Y. Langsam, Moshe J. Augenstein, Data Structures Using C, PHI.

Course Code: CSP112	Course Credit: 2
Course Name: IT Workshop - II	**L-T-P: 0-1-2**
Course Prerequisite: None	

List of Experiments: 1 Lab per experiment unless otherwise mentioned

1. Web Development, Beginning HTML and CSS, Creating HTML Content.
2. Photoshop Basics, CSS, Customizing Colors and Fonts, Styling Web Pages and Navigation **[2 Labs]**
3. Java Script, Adding Pages to a Website, Responsive design, testing
4. Debugging HTML/CSS
5. PHP Basics and Functions, Error Handling, SQL Basics
6. Integrating PHP with Database
7. Building Dynamic Website with PHP
8. Build website with Django, Angular
9. Integrate React in dynamic website
10. Use AJAX in dynamic website
11. Project: Building Dynamic Website with PHP, CSS, JavaScript, Ajax, SQL

Course Outcome (CO):

CO1: To provide the students an exposure to develop dynamic and static websites using state-of-the-art technologies.
CO2: Hands-on the latest web development practices in Industry and provide practical exposure to develop effective and efficient websites using the latest open source technologies.

References:

1. Craig Knuckles, David Yuen, “Web Applications Technologies Concepts and Real World Design”, John Wiley, 1st Edition
2. Robert W. Sebesta, “Programming with World Wide Web”, Pearson, 6th Edition
3. Internet & Intranet Engineering, Daniel Minoli, TMH.
4. W. Jason Gilmore, “Beginning PHP and MySQL: From Novice to Professional”, Apress, 2008

Course Code: ECP102	**Course Credit: 1**
Course Name: Electronic Devices and Circuits Lab	**L-T-P: 0-0-2**
Course Prerequisite: None	

List of Experiments: 1 Lab per experiment

1. To study following: Basic circuit elements (resistor, capacitor, diode, transistor) and Basic measurements using lab equipment's (DMM, DSO, function generator, power supply).
2. To study I-V characteristics of pn junction and Zener diodes.
3. To study Positive and negative level clippers using diode.
4. To study Positive and negative clamper circuits using diode.
5. To study Voltage regulator using diode.
6. To study BJT input and output characteristics in CB configurations.
7. To study BJT input and output characteristics in CE configurations.
8. To study FET input and output characteristics.
9. To study FET transfer characteristics.
10. To study frequency response of BJT amplifier in CE configurations.
11. To study frequency response of FET amplifier.
12. To design an oscillator circuit.

Course Outcome (CO):

CO1: Understand the fundamental concepts of various electronic equipment's/components.
CO2: Utilize the various concepts of diodes for various diode circuits such as rectifiers, clippers, clampers, voltage regulators etc.
CO3: Learn and implement the various concepts of transistors.
CO4: To design oscillators.

References:

1. Robert Boylestad, Louis Nashelsky, "Electronic Devices and Circuit Theory", Prentice Hall, 7th Edition
2. Jacob Millman, Christos C. Halkias, "Integrated Electronics: Analog and Digital Circuits and Systems", Tata McGraw Hill
3. Adel S. Sedra, Kenneth C. Smith, "Microelectronic Circuits", Oxford University Press, 5th Edition
4. Donald A. Neamen, "Microelectronics: Circuit Analysis and Design", McGraw Hill, 4th Edition
5. Leonard S. Bobrow, Navneet Gupta, "Foundations of Electrical Engineering", Oxford University Press, Asian Edition

Course Code: ECP112	**Course Credit: 1**
Course Name: Circuit Design and Printing Lab	**L-T-P: 0-0-2**
Course Prerequisite: None	

Course Syllabus:

Circuit Design and Printing fundamentals: [6 Labs]

1. PCB Design overview, Prototyping and the PCB Design Flow.
2. Customizing the board outline and handling board outline errors.
3. Configure the Board Outline, Layer selection, Placing the parts at desired location.
4. Selection and application of routing method, optimal routing methods.
5. Finalizing a design for fabrication and exporting Gerbers.

Mini Project on circuit design and printing. **[2 Labs]**

Introduction to 2D and 3D design using EDA tools. **[4 Labs]**

Course Outcome (CO):

CO1. Understand the need for PCB Design and steps involved in PCB Design and Fabrication process. CO2. Familiarize Schematic and layout design flow using Electronic Design Automation (EDA) Tools
CO3. Understand the steps involved in schematic, layout, fabrication, and assembly process of PCB design.
CO4. Design PCB for analog and digital circuits.
CO5: Learn the 2D and 3D design fundamentals.

References:

1. https://www.ni.com/tutorial/12242/en/
2. Printed Circuit Board by RS Khandpur, Tata McGraw Hill Education Pvt Ltd., New Delhi
3. Electronic Product Design Volume-I by S D Mehta, S Chand Publications
4. Open source EDA Tool KiCad Tutorial: http://kicad-pcb.org/help/tutorials/
5. Bernd S. Palm, Introduction to AutoCAD 2020, CRC Press, 2020.
6. https://www.tinkercad.com/dashboard.

Course Code: HSP102	Course Credit: 1
Course Name: Technical Writing and Presentation Skills Laboratory	**L-T-P: 0-0-2**
Course Prerequisite: None	
Course Syllabus: Exercise to Lower Anxiety, Build Confidence. **(2 Labs)** Exercise in Clarity of Messaging. **(2 Labs)** Exercise in Effective Speaking. **(3 Labs)** Exercise In Structured Writing. **(2 Labs)** Exercise in Organizing, & delivering a Memorable Presentation. **(3 Labs)**	
Course Outcome (CO): CO1: Clear Communication CO2: Communicating Complex Ideas & Projects effectively. CO3: Practical application of the Lecture Content. CO4: Building Confidence and effectiveness.	
References:	

Course Code: CST201	Course Credit: 3
Course Name: Computer Architecture and Organization	**L-T-P: 3-0-0**
Course Prerequisite: Digital Design	

Course Syllabus:

Fundamentals: History of Computers, System layers and levels- device to application, Architecture vs Organization, Y-chart, Synthesis and Design Metrics (performance, power, thermal and reliability), Instruction Set Architecture, Von Neumann and Harvard Architecture, Flynn's Classification. Basic CPU Organization – General purpose Registers Organization; Stack Organization; Bit-sliced CPU; Accumulator-based CPU Data Representation - Basic Data-type formats; Storage order: Big-endian and Little-endian Instruction Formats - RISC and CISC type; Instruction Types; Instruction Cycle and Machine Cycle. Addressing Modes. **[8 Lectures]**

Computer Arithmetic – Fixed-Point Arithmetic - Addition and Subtraction of Signed Numbers, Addition architecture and algorithms, Design and implementation of different algorithms for multiplication and division using design metrics, Floating Point Arithmetic - Addition, Subtraction and Multiplication for IEEE 754 standard, Arithmetic-Logic Units - Combinational ALUs and Sequential ALUs (basic concepts). **[8 Lectures]**

Processor Design – Logic Design Conventions, Data Path Construction, Hardwired Control versus microprogrammed control, single cycle implementation, multi-cycle implementation, performance enhancement using pipelining. Performance enhancement using pipelining, arithmetic and instruction pipelining, pipeline hazards. Pipelining - Instruction & Arithmetic Pipeline, Concept, Structure and Space-time diagram. **[8 Lectures]**

Memory Characteristics - Types of memories, hierarchy, caches policies, organization and design, and cache protocols for many-core architectures. Performance, power and thermal aware caches design. **[8 Lectures]**

Communication Architectures: Intrasystem versus Intersystem; Architecture and implementation of different buses and Data Transfers (Synchronous versus Asynchronous) schemes, and control methods. RISC-V: Introduction. **[8 Lectures]**

Course Outcome (CO):

CO1: Describe the interconnection between various functional units of a computer system.
CO2: Describe the importance of the design matrices like performance, power and thermal based on organization and architecture.
CO3: Describe various parts of a system memory hierarchy and caching techniques.

References:

1. D.A. Patterson, J.L. Hennessy, “Computer Organization and Design”, Elsevier, 5th Edition
2. John P. Hayes, “Computer Architecture and Organization”, McGraw Hill, 5th Edition
3. C. Hamacher, Z. Vranesic, S. Zaky, “Computer Organization”, McGraw Hill, 5th Edition.

Course Code: ECT201	Course Credit: 3
Course Name: Microprocessors and Peripherals	**L-T-P: 3-0-0**
Course Prerequisite: None	

Course Syllabus:

Introduction: 8085 Microprocessor Architecture, Pin Description, Bus organization, Multiplexing and Demultiplexing of Buses; RAM, ROM, Memory map; Signals and Timings, Classification of Instructions, Instruction Format, Instruction Set, Addressing Modes. **[8 Lectures]**

Assembly Language Programming and Debugging – Simple Assembly Programming and testing, Counter and Time delay, Stack organization and implementation, Stack, Subroutine, Restart, Conditional Call, and Return Instructions, Subroutine, Code Conversion, BCD Arithmetic, and 16-Bit Data Operations, Interrupts - Types, Applications and Handling, RST, SIM and RIM Instructions and their uses. **[8 Lectures]**

Interfacing with 8085 Microprocessor – Interfacing of Simple input/output devices (Switches, LEDs); 8255 Programmable Peripheral Interface; 8254 Programmable Interval Timer; 8279 Keyboard/Display Controller; 8251 USART; 8257 DMA Controller; Memory Interfacing. Serial Interface - RS232C and RS422A; Parallel Interface, 8259 Programmable Interrupt Controller. **[8 Lectures]**

INTEL 8086 - 16-Bit Microprocessor - Architecture of 8086, Accessing Memory Locations, Pin Details of 8086 Addressing Modes in 8086, Segment Override Prefix, Instruction Set of 8086(Data Transfer, Arithmetic, Logical, Flag Manipulation, Control Transfer, Shift/Rotate, String, Machine or Processor Control), 8086 Assembly Language Programming, Program Development Process, Physical Memory Organization in 8086, Formation of System Bus, Interfacing RAM and EPROM Chips, I/O Interfacing, Interfacing 8-bit Input device with 8086 (8-bit address using logic gates, 8-bit address using 74LS318, 16-bit address using logic gates), Interfacing 8-bit Output Device with 8086, Interfacing 8-bit and 16-bit I/O devices or ports with 8086, Design of 8086 in Minimum Mode and Maximum Mode configuration, 8086 System Bus timings, Introduction to next generation Microprocessors. **[16 Lectures]**

Course Outcome (CO):

CO1: To introduce processor architectures and programming microprocessor such as 8085 and 8086
CO2: To illustrate interfacing of different peripherals (8255, 8253, 8257 etc.) with 8085.

References:

1. Ramesh S. Gaonkar, “Microprocessor Architecture, Programming and Applications with the 8085”, Penram Publishers.
2. Douglas V. Hall, “Microprocessors and Interfacing”, Tata McGraw Hill.
3. Barry B. Brey, “The INTEL Microprocessors,” Architecture, Programming, and Interfacing”, PHI, 8th Edition
4. John Uffenbeck, “Microcomputers and Microprocessors – The 8080, 8085 and Z80 Programming, Interfacing and Troubleshooting”, Tata McGraw Hill, 3rd Edition
5. Triebel, Walter A., Singh, Avtar, The 8088 and 8086 Microprocessors: Programming, Interfacing, Software, Hardware, and Applications, 4e: Programming, Interfacing, Software, Hardware and Applications, Prentice Hall

Course Code: ECT203	**Course Credit: 3**
Course Name: Analog Integrated Circuits	**L-T-P: 3-0-0**
Course Prerequisite: None	

Course Syllabus:

Op-amp (symbol, equivalent circuit and its analysis, open loop transfer characteristics), Ideal op-amp based basic configurations (inverting amplifier, non-inverting amplifier, voltage follower, summing amplifier using inverting and non-inverting configurations, differential input-differential output amplifier, difference amplifier, bridge amplifier, instrumentation amplifier, I to V converter, V to I converter, integrator, differentiator, inductance simulation), Practical op-amp IC741 based amplifiers (input impedance, output impedance and gain), Practical op-amp IC741 characteristics. **[8 Lectures]**

Log and anti-log amplifiers, analog multipliers, precision circuits (half-wave and full wave rectifiers, positive and negative clipper circuits, positive and negative clamper circuits, peak detector circuits), comparator and Schmitt trigger circuits, sample-and-hold circuits. **[8 Lectures]**

Basic theory of filters, designing of active filters: Low pass, high pass, bandpass and bandstop, (transfer function synthesis, Sallen-Key filters, multiple feedback filters, switched capacitor filter etc.). **[8 Lectures]**

Sinusoidal oscillators: Basic concepts, Barkhausen criterion, RC oscillators (phase shift, Wien bridge), LC oscillators (Hartley, Collpit, Crystal), Non-sinusoidal oscillators (square and triangular waveform generators), IC555 timer circuit and its application as Multivibrators (bistable, astable, monostable). **[8 Lectures]**

OP-AMP based ADC and DAC Circuits: Digital-to-analog converters (DAC): Weighted resistor, R-2R ladder etc. Analog-to-digital converters (ADC): Single slope, dual slope, successive approximation, flash etc., Voltage regulator circuits, voltage regulator ICs (IC723, ICs 78XX and 79XX etc.) **[8 Lectures]**

Course Outcome (CO):

CO1: Understand the fundamental concepts of Op-amp.
CO2: Design and Implement the precision diode circuits.
CO3: Utilise the basic Kirchhoff's circuit laws (KVL & KCL) for realization of mathematical operations and solving electrical circuits.
CO4: Learn the working of different type of Analog Circuits such as adder substractor, integrators, filters, and oscillators etc.
CO5: Use of Active components for implementation of analog to digital converters and vice versa.

References:

1. Ramakant Gayakwad, “Op-Amps and Linear Integrated Circuits”, Pearson Education, 4th Edition.
2. Sergio Franco, “Design with Operational Amplifiers & Analog Integrated Circuits”, McGraw Hill, 2nd Edition.
3. Adel S. Sedra, Kenneth C. Smith, “Microelectronic Circuits”, Oxford University Press, 5th Edition.
4. L.K. Maheshwari, M.M.S. Anand, “Analog Electronics”, Prentice Hall India, 1st Edition.

Course Code: ECT205	**Course Credit: 3**
Course Name: Signals and Systems	**L-T-P: 3-0-0**
Course Prerequisite: None	

Course Syllabus:

Classification of signals: signal properties, signal operations, elementary signals, Continuous-time and discrete-time signals, Signal energy and power, Periodic signals, even-odd signals, exponential and sinusoidal signals, Unit impulse and step functions. **[10 Lectures]**

Classification of System: system properties (linearity, time/shift-invariance, causality, stability), continuous-time linear time invariant (LTI) and discrete-time linear shift invariant (LSI) systems, impulse response and step response, response to an arbitrary input, convolution and LTI system representation using differential equations. **[10 Lectures]**

Fourier series representation of continuous-time and discrete-time signals, continuous-time Fourier transform and its properties, Relationship between Fourier transform and Fourier series and Parseval's relation. **[8 Lectures]**

The Laplace Transform, ROC, properties of Laplace-transform, analysis and characterization of LTI systems using Laplace Transform, Relationship of Laplace and Fourier transforms, Transfer function and its block diagram representation. **[6 Lectures]**

The z-transform, ROC, pole-zero plot, properties of z-transform, analysis and characterization of LTI systems using z-transform and Stability criterion. **[6 Lectures]**

Course Outcome (CO):

CO1: Understand the concept of the signals and systems and its classifications.
CO2: Understand the concept of LTI systems
CO3: Able to transform the time domain signals into the Fourier domain.
CO4: Understand the concept and mathematical representation of Fourier transform, L-Transform and Z-transform.

References:

1. Alan V. Oppenheim, Alan S. Willsky, S. Hamid Nawab, “Signals and Systems”, Prentice Hall India, 2nd Edition, 2006.
2. B.P. Lathi, “Signal Processing and Linear Systems”, Oxford University Press, 1998
3. Simon Haykin, Barry Van Veen, “Signal & Systems”, John Willey and Sons, 2nd Edition, 2003.
4. A.V. Oppenheim, A.S. Willsky and I.T. Young, Signals and Systems, Prentice Hall, 1983
5. Roberts, M.J., “Fundamentals of Signals & Systems”, Tata McGraw Hill, 2007.
6. Lathi, B. P., “Linear Systems and Signals”, 2nd Ed., Oxford University Press, 2006.

Course Code: ECT211	**Course Credit: 3**
Course Name: Microprocessors and Microcontrollers	**L-T-P: 3-0-0**
Course Prerequisite: Digital Design	

Course Syllabus:

Introduction: Motivation, history, growth curves and issues that microprocessors face till now. Basic system stack – hardware and software. ARM- motivation and objectives. Microprocessor trends and development, Processor design trade-offs, Components of the Microprocessor, Motivation to design CISC and RISC, Level of abstractions and View (Y-Chart), Design Matrices (Performance, power, thermal and reliability). ISA design concepts and needs. **[4 Lectures]**

The ARM Architecture and Assembly Language Programming: The Acorn RISC Machine, Architectural inheritance, The ARM programmer's model, ARM development tools. Data processing instructions, Data transfer instructions, Control flow instructions. **[4 Lectures]**

ARM Organization and Implementation: Comparison Case study of ARM 7, 9, microarchitectures with 8085. ARM organization- 3-stage and 5-stage pipeline. ARM instruction execution, ARM implementation, The ARM coprocessor interface. ARM buses. **[8 Lectures]**

The ARM Instruction Set: General Purpose, special purpose architecture, control word, status registers and operating modes, Introduction, Exceptions, Conditional execution, Branch and Branch with Link (B, BL) and eXchange (BX, BLX), Software Interrupt (SWI), Data processing instructions, Multiply instructions, Count leading zeros (CLZ - architecture v5T only), Single word, Half-word and signed byte data transfer instructions, Multiple register transfer instructions, Swap memory and register instructions (SWP) **[6 Lectures]**

Status register to general register transfer instructions, General register to status register transfer instructions, Coprocessor- instructions, data operations, data transfers, register transfers, Breakpoint instruction (BRK - architecture v5T only), Unused instruction space, Memory faults, ARM architecture variants. **[3 Lectures]**

ARM Operation Modes: The Thumb bit in the CPSR, The Thumb programmer's model, Thumb branch instructions, Thumb software interrupt instruction, Thumb data processing instructions, Thumb single register data transfer instructions, Thumb multiple register data transfer instructions, Thumb breakpoint instruction, Thumb implementation, Thumb applications Example and exercises **[3 Lectures]**

Architectural Support for System Development: The ARM memory interface, The Advanced Microcontroller Bus Architecture (AMBA), The ARM reference peripheral specification **[6 Lectures]**

Architectural Support for System Development: Prototyping tools, JTAG boundary scan test architecture, The ARM debug architecture, Embedded Trace Signal processing support Example and exercises. Architectural Support for High-Level Languages: Abstraction in software design, Data types, Floating-point data types, The ARM floating-point architecture, Expressions Conditional statements, Loops, Functions and procedures **[6 Lectures]**

Course Outcome (CO):

CO1: Understand the concepts and methodologies employed in designing microprocessor core.
CO2: Understand the principles of microprocessor design using ARM.

References:

1. Steve Furber, “ARM system-on-chip architecture”, Addison-Wesley, 2000,2nd ed.
2. Andrew Sloss, Dominic Symes, Chris Wright, “ARM System Developer's Guide: Designing and Optimizing System Software”, Morgan Kaufmann, Year: 2004

Course Code: HST201	**Course Credit: 3**
Course Name: Engineering for Social Empowerment	**L-T-P: 3-0-0**
Course Prerequisite: An interest in applying Engineering for Social Empowerment	

Course Syllabus:

Introduction to Engineering for Social Empowerment - Engineers as the Problem Solvers- How can they bring change in the society, Elements of engineering for social empowerment, Complex Systems, Wicked Problems, Dancing with the system, Ethics, principles and practice in Community **[8 Lectures]**

Planning for Social Empowerment- How can engineers plan and bring positive social change through their work, Impact pathways for social empowerment, Understanding the system that you want to influence, Theory of Change, Gender, Case study **[8 Lectures]**

Engaging and Partnering- Who are the stakeholders anyway & why should engineers work with them? Developing Strategic partnerships, Principles of stakeholder engagement, Stakeholder engagement methodologies, Stakeholder engagement and power relations, challenges and opportunities when engaging with diverse groups of stakeholders. **[10 Lectures]**

Communicating for Impact - Moving beyond dissemination to bi-directional communication, what is strategic communication and why it is important for engineers to communicate their work to diverse stakeholders of the community? Planning for effective and impactful communication, The elevator pitch, Case Study **[7 Lectures]**

Building Capacities- Why do we need capacity development of all stakeholders, Different types and aspects of capacity development, dealing with challenges, whose capacities need to be developed, Case Study India - Developing Stakeholder Capacity through games and 3D models **[7 Lectures]**

Course Outcome (CO):

CO1: Develop an ability to identify, formulate, and solve engineering problems with a realistic world view.
CO2: Understand the need and develop the sensibility to work with community
CO3: Develop an ability to work with multi-disciplinary teams and various stakeholders
CO4: Understand professional and ethical responsibility towards community
CO5: Develop an ability to communicate effectively to all stakeholders
CO6: Develop a recognition of the need for, and an ability to engage in life-long learning and partnership with stakeholders

References:

1. Meadows, D. (2001). Dancing with systems. *Whole Earth*, *106*, 58-63.
2. Carden, F. (2009). *Knowledge to policy: Making the most of development research*. IDRC.
3. Reed, M. S. (2016). *The research impact handbook*. Fast Track Impact.
4. McLaughlin, M. W., & Mitra, D. (2001). Theory-based change and change-based theory: Going deeper, going broader. *Journal of educational change*, *2*(4), 301-323.
5. Bourne, L., & Weaver, P. (2010). Mapping stakeholders. *Construction stakeholder management*, 99-120.
6. Bryson, J. M. (2004). What to do when stakeholders matter: stakeholder identification and analysis techniques. *Public management review*, *6*(1), 21-53.
7. Chen, P. G., Diaz, N., Lucas, G., & Rosenthal, M. S. (2010). Dissemination of results in community-based participatory research. *American journal of preventive medicine*, *39*(4), 372-378.
8. Simmons, A., Reynolds, R. C., & Swinburn, B. (2011). Defining community capacity building: is it possible?. *Preventive medicine*, *52*(3-4), 193-199.
9. Hashagen, S. (2002). *Models of community engagement*. Glasgow: Scottish Community Development Centre.

Course Code: MAT203	**Course Credit: 4**
Course Name: Probability and Random Processes	**L-T-P: 3-1-0**
Course Prerequisite: None	

Course Syllabus:

Probability and Random variable– Probability Definitions and Axioms, Probability as a Relative Frequency, Joint Probability, Conditional Probability, Total Probability, Bayes' Theorem, Independent Events. Definition of a Random Variable, Conditions for a Function to be a Random Variable, Discrete and Continuous Variables Distribution & Density Functions – Distribution and Density functions and their Properties - Binomial, Poisson, Uniform, Gaussian, Exponential, Chi-Square, Student's T, F distributions and Properties. **[10 Lectures]**

Expectations – Introduction, Expected Value of a Random Variable, Function of a Random Variable, Moments about the Origin, Central Moments, Variance and Skew, Moment Generating Function, Statistical Independence, Sum of Two Random Variables, Sum of Several Random Variables, law of large numbers Central Limit Theorem (Proof not expected). **[8 Lectures]**

Distributions of Sampling statistics. – The sample mean, the sample variance, sampling distribution from a normal Population Central Limit Theorem (Proof not expected). Parameter Estimation- Point estimator and interval estimates. Confidence interval Hypothesis Testing- Introduction, Significance Levels Types of Errors. Test concerning the mean of Normal population, Testing the equality of means of two Normal populations. Testing of significance using t-test, Chi-square test and F test and Paired t-test. Analysis of Variance (one way classification only). Chi-square –test as a goodness of fit. **[8 Lectures]**

Poisson Random Process Discrete-time Markov Chains (DTMCs) – Definition and examples of Markov Chains, Transition probability matrix, Chapman-Kolmogorov equations; n-step transition and limiting probabilities, ergodicity, stationary distribution, random walk and gambler's ruin problem, applications of DTMCs. **[7 Lectures]**

Continuous-time Markov Chains (CTMCs) – Kolmogorov differential equations for CTMCs, infinitesimal generator, Poisson and birth-death processes, stochastic Petri net, applications to queueing theory and communication networks. **[7 Lectures]**

Course Outcome (CO):

CO1: Understand the foundations of probabilistic and statistical analysis mostly used in varied applications in engineering and science like disease modeling, climate prediction and computer networks etc.
CO2: Evaluate and apply moments & characteristic functions and understand the concept of inequalities and probabilistic limits.
CO3: Understand the concept of random processes and determine covariance and spectral density of stationary random processes.

References:

1. Athanasios Papoulis, S. Unnikrishna Pillai, "Probability, Random Variables and Stochastic Processes", Tata McGraw Hill, 4th Edition
2. Pradip Kumar Gosh, "Theory of Probability and Stochastic Processes", University Press
3. Henry Stark, John W. Woods, "Probability and Random Processes with Application to Signal Processing", Pearson Education, 3rd Edition
4. George R. Cooper, Clave D. McGillem, "Probability Methods of Signal and System Analysis", Oxford, 3rd Edition

Course Code: CSP201	Course Credit: 1
Course Name: Computer Architecture and Organization Lab	**L-T-P: 0-0-2**
Course Prerequisite: None	

Course Syllabus:

Introduction to HDL and Xilinx tool chain for synthesis and FPGA Kit -- Example demo-- Implementation of logic gates, and combinational circuits. **[2 Labs]**

Single cycle and multicycle microarchitecture design, Concept of SAF and power calculation. **[2 Labs]**

SDF, SDC, XDC writing and analysis (timing analysis: PCP, Critical Path) **[3 Labs]**

How to build the system using different coding styles? Dataflow, structured and behavioural coding **[2 Labs]**

Design 8 bit microprocessor: ALU, control unit and all. **[1 Lab]**

Simple Scalar tool - System level Design and Cache profile executions, Exploring Power, Thermal and Reliability tool chains. **[2 Labs]**

Course Outcome (CO):

CO1: Describe the exact choice of implementation of a system choosing the correct HDL language.
CO2: Design the performance and power aware microarchitecture of hardware components.
CO3: Use industry specific and research-based tools and design.
CO4: Describe the memory design and implement the protocols on the simulator to view the impact of these protocols and techniques on the performance and power of the system.

References:

1. D.A. Patterson, J.L. Hennessy, “Computer Organization and Design”, Elsevier, 5th Edition
2. John P. Hayes, “Computer Architecture and Organization”, McGraw Hill, 5th Edition
3. Hamacher, Z.Vranesic, S. Zaky, “Computer Organization”, McGraw Hill, 5th Edition.

Course Code: CSP211	Course Credit: 2
Course Name: IT Workshop - III	**L-T-P: 0-1-2**
Course Prerequisite: None	

Course Syllabus:

Installation of Python Tool, Introduction to Python programming, Data types, Input/Output and library imports, Python strings operations, Doc strings, Objects - List, Tuples and Dictionaries. **[2 Labs]**

Control flow, functions working and some advanced functions, File handling and third party library integrations, Usage of image processing library, Data exchange mechanism - JSON, Understanding web services - REST APIs. **[5 Labs]**

Advanced part of python functions, Database interaction, Regular expressions and their uses in searching, Numpy, Matlab plot, pandas utility functions, JSON format for NoSQL database. **[5 Labs]**

Course Outcome (CO):

CO1: To acquire programming skills in core Python.
CO2: To implement basic principles of python programming language and implement object-oriented concepts.
CO3: To use backend database services and make graphical user interface applications.
CO4: To handle large dataset in real-time engineering problems and develop real-time, fast and flexible solutions.

References:

1. John Zelle and Michael Smith, Python Programming: An Introduction to Computer Science, Franklin, Beedle& Associates Inc
2. Allen Downey, Jeff Elkner and Chris Meyers, Learning with Python: How to Think Like a Computer Scientist, Latest Edition
3. David Beazley and Brian K. Jones, Python Cookbook: Recipes for Mastering Python 3, O'Reilly Media
4. Mark Lutz, Programming Python 4e: Powerful Object-Oriented Programming, O′Reilly

Course Code: ECP201	Course Credit: 1
Course Name: Microprocessors and Peripherals Lab	**L-T-P: 0-0-2**
Course Prerequisite: None	

Course Syllabus: 1 Lab per experiment unless otherwise mentioned

1. Data transfer operations using 8085 (Immediate, Direct, Indirect and Register addressing).
2. Flag related operations using 8085.
3. Arithmetic Operations using 8085 (8/16-bit Addition and Subtraction, One's Complement).
4. Logical Operations using 8085 (Mask Off Most Significant Four Bits, Set Bits, Logical Operations, Packed to Unpacked).
5. Branch Instructions using 8085 (8-bit Multiplication, 8-bit by 8-bit Division, Sum of N elements).
6. Code Conversion using 8085 (ASCII to Decimal Conversion, BCD to Hex Conversion, Hex to Decimal Conversion, Hex to Binary Form).
7. Array Operation using 8085 (Biggest Number in an Array; Arrange in Descending Order, Number of Zero, Positive and Negative Numbers; Square of a Number).
8. Interfacing peripherals 8255 and 8254 using 8085.
9. Assembly language programming with 8086 (Data Transfer, Arithmetic, Logical). **[2 labs]**
10. Assembly language programming with 8086 (Flag Manipulation, Control Transfer, Shift/Rotate, String, Machine or Processor Control). **[2 labs]**

Course Outcome (CO):

CO1: To identify a detailed software and Hardware structure of the Microprocessor 8085.
CO2: To introduce Assembly Language Programming of 8085 microprocessors.
CO3: To illustrate interfacing of different peripherals (8255, 8253, 8257 etc.) with 8085.
CO4: To introduce processor architectures and programming concepts of microprocessor such as 80X86

References:

1. Ramesh S. Gaonkar, "Microprocessor Architecture, Programming and Applications with the 8085", Penram Publishers.
2. Douglas V. Hall, "Microprocessors and Interfacing", Tata McGraw Hill.
3. Barry B. Brey, "The INTEL Microprocessor," Architecture, Programming, and Interfacing", PHI, 8th Edition Reference book(s).
4. John Uffenbeck, "Microcomputers and Microprocessors – The 8080, 8085 and Z80 Programming, Interfacing and Troubleshooting", Tata McGraw Hill, 3rd Edition.
5. Triebel, Walter A., Singh, Avtar, The 8088 and 8086 Microprocessors: Programming, Interfacing, Software, Hardware, and Applications, 4e: Programming, Interfacing, Software, Hardware and Applications, Prentice Hall.

Course Code: ECP203	Course Credit: 1
Course Name: Analog Integrated Circuits Lab	**L-T-P: 0-0-2**
Course Prerequisite: None	
Course Syllabus: 1 Lab per experiment 1. To study and design Inverting amplifier, non-inverting amplifier and voltage follower using op-amp IC741. 2. To study and design the Integrator circuit using Op-amp IC741. 3. To study and design the differentiator circuit using op-amp IC741. 4. Implementation of Adder and subtractor circuit using op-amp IC741. 5. Designing and implementation of positive and negative clipper and peak detector using op-amp IC741. 6. Designing and implementation of clamper circuits using op-amp IC741. 7. To design the half wave and full wave rectifier circuits using op-amp IC741. 8. To design the Schmitt trigger using op-amp IC741. 9. To study and design the low pass and high pass filter using op-amp IC741. 10. To study and design the Wein bridge oscillator using op-amp IC741. 11. To study and design the RC phase shift oscillator using op-amp IC741. 12. To study and design the astable multivibrators using op-amp IC741.	
Course Outcome (CO): CO1: Implementation of fundamental concepts of Op-amp. CO2: Designing of different type of Analog Circuits. CO3: Implementation of basic Kirchhoff's circuit laws (KVL & KCL) for designing of mathematical operations and solving electrical circuits. CO4: Use of Active components for designing waveform shifter, shaper, generators etc. CO5: Use of precision diodes for designing various analog circuits.	
References: 1. Ramakant Gayakwad, “Op-Amps and Linear Integrated Circuits”, Pearson Education, 4th Edition. 2. Sergio Franco, “Design with Operational Amplifiers & Analog Integrated Circuits”, McGraw Hill, 2nd Edition. 3. Adel S. Sedra, Kenneth C. Smith, “Microelectronic Circuits”, Oxford University Press, 5th Edition. 4. L.K. Maheshwari, M.M.S. Anand, “Analog Electronics”, Prentice Hall India, 1st Edition.	

Course Code: ECP211	Course Credit: 1
Course Name: Microprocessors and Microcontrollers Lab	**L-T-P: 0-0-2**
Course Prerequisite: None	

Course Syllabus:

1. Introduction to ARM Board, cables, connection procedure, and Keil software- How to write an Embedded C program on it, Build, and load the program on board **[2 labs]**
2. Interface and control a DC motor, ADC **[1 lab]**
3. Interface a stepper motor and rotate it clock and anti-clockwise and different application **[2 labs]**
4. LED interface and executing delay and pattern **[1 lab]**
5. LCD controller and its interfacing to board **[1 lab]**
6. Keyboard Interfacing **[1 lab]**
7. How PWM can be used and application programs **[2 labs]**
8. Project Evaluation: Build any automation systems using software and hardware **[2 labs]**

Course Outcome (CO):

CO1: Understand the architecture of ARM- based assembly programming.
CO2: Learn to design, construct, program, verify, analyze and troubleshoot ARM assembly and C language programs and supporting hardware.
CO3: Learn basic knowledge of sensor and board interfacing

References:

1. Steve Furber, “ARM system-on-chip architecture”, Addison-Wesley, 2000,2nd ed.
2. Andrew Sloss, Dominic Symes, Chris Wright, “ARM System Developer's Guide: Designing and Optimizing System Software”, Morgan Kaufmann, Year: 2004

Course Code: OTP201	**Course Credit: 2**
Course Name: Engineering Creativity, Innovation and Design	**L-T-P: 0-1-2**
Course Prerequisite: None	

Course Syllabus:

Creativity as a human need, its utility and creative expression, **[1 Tutorial]**
Discourse, philosophy of Human Creativity, Psychological basis of Human Creativity
Creative Expression in Art Design and Engineering **[2 Tutorials]**
Art v/s Design, Craft and Creative process, Engineering and Design
Fundamentals of Structuring creative process: **[2 Tutorials]**
Design Metholodologies, Design Thinking, Design Criticism and Subjectivity
Creative ideation and thinking visually. **[2 Tutorials]**
Doodling as Visual Thinking, Design Sketching basics,
Diagramming as structured design communication
Engineering concepts for design and creativity **[2 Tutorials]**
Simple machines, Common mechanisms
Innovation as a deliberate creative pursuit **[1 Tutorial]**
Designing and Engineering of Everyday objects **[2 Tutorials]**

Hands-on: Workshop involving ideation and brainstorming on selected themes (For example, Agriculture, Education, Energy, Environment Conservation, Health, Infrastructure, Safety, Transportation, Waste Management, Water Conservation, etc), Mind mapping exercises and design assignment, Theme based concept evaluation and allocation of project. [26 hrs]

Course Outcome (CO):

CO1: Understand the fundamentals of human creative expression and its need
CO2: Understanding how to appreciate criticize and empathise with creative expression
CO3: Learn engineering design principles, basics of design thinking, frugal innovation
CO4: Learning and applying principles of design and engineering innovation in practice, through projects
CO5: Learn technology and design through analyzing everyday objects and common mechanisms

References:

1. Berger, J. (2008). Ways of seeing. Penguin UK.
2. Deutsch, R. (2020). Think Like An Architect: How to develop critical, creative and collaborative problem-solving skills. RIBA Publishing. and 2. Berger, J. (2008).
3. Ways of Seeing. Penguin Books Ltd;
4. Norman, D. (2013). The design of everyday things: Revised and expanded edition. Basic books.
5. Lawson, B. (2006). How designers think: The design process demystified. Routledge.
6. Cross, N., & Roy, R. (1978). Design Methods Manual: Prepared for the {Open University, Man-Made Futures; Design and Technology} Course Team. Open UP.
7. Hanington, B., & Martin, B. (2012). Universal methods of design: 100 ways to research complex problems, develop innovative ideas, and design effective solutions. Rockport Publishers.

Course Code: CST202	**Course Credit: 3**
Course Name: Object Oriented System Design	**L-T-P: 3-0-0**
Course Prerequisite: Elementary knowledge of programming language C	

Course Syllabus:

INTRODUCTION: Principles of OOD; programming Paradigms; benefits of OOD, applications of OOD. Java – what, where and why? Platform independency Comparison in Java with C and C++. Java Evolution and History Features of Java Language. Difference between JVM, JDK JRE and JIT. Installing Java in WINDOWS. **[2 Lectures]**

Decision Making & Looping: int, char, float, double, Boolean, short, long, byte, UNICODE, Reference type. Static variables, Instance variable, Local variables, final variable, Static block and Non-static block, final, abstract, Decision Making & looping and operators in Java. **[4 Lectures]**

Classes and Objects: constructors, parameterized constructors, overloaded constructors, constructors with default arguments, Access Control, Modifiers, methods Nested, Inner Class & Anonymous Classes, Abstract Class & Interfaces, Argument Passing Mechanisms, Method Overloading, Dealing with Static Members and class. Finalize () Method. Use of "this" reference. **[5 Lectures]**

Arrays & Strings: Single, Double Dimensional Array, Arrays class, Methods in Arrays class, String – what and why Operation on String Immutable, String comparison and concatenation, Method of String class StringBuffer class and its methods. String Builderclass, Creating Immutable class like String. Tokenizing a String. **[6 Lectures]**

Inheritance & Polymorphism: types of inheritance, constructors in derived and base class, abstract classes, Compile and run time polymorphism, Role of Constructors in inheritance, Overriding Super Class Methods. Use of "super" keyword. Implementing interfaces. Dynamic method dispatching by down-casting and up-casting. **[7 Lectures]**

Packages & Exception Handling: Organizing Classes and Interfaces in Packages. Sub-Package CLASSPATH Setting for Packages. Making JAR Files for Library Packages Import and Static Import Creating .EXE and jar executable file. Exceptions & Errors, Types of Exception: Checked and Un-Checked Exceptions, Control Flow in Exceptions, Use of try and catch block, Multiple catch block, Nested try, finally block, throw keyword. **[8 Lectures]**

Input/ Output operations in Java: Understanding Streams File class and its methods, Creating file and folder using java code. File Output Stream & File Input Stream, File Writer & File Reader. Input from keyboard by Input Stream Reader. Print Stream class Print Writer class, Buffered Reader and Buffered Writer class. Scanner class. AWT class. **[8 Lectures]**

Course Outcome (CO):

CO1: Ability to analyze and model software specifications.
CO2: Ability to abstract object-based views for generic software systems.
CO3: Ability to deliver robust software components.

References:

1. Ali Bahrami, Object Oriented Systems Development, McGraw Hill International Edition.
2. Craig Larman, Applying UML and Patterns: An Introduction to Object-Oriented Analysis and Design and Iterative Development, Latest Edition, Pearson Education.
3. Java: A Beginner's Guide, Eighth Edition by Schildt, Herbert
4. Head First Java by Kathy Sierra & Bert Bates, ORELY

Course Code: ECT202	**Course Credit: 3**
Course Name: Analog Communication	**L-T-P: 3-0-0**
Course Prerequisite: None	

Course Syllabus:

Introduction of Communication, Concept of Bandwidth, Review of Random Signals, Basic Mechanism and Application of Modulation, Elements of communication - point to point and broadcast.Wired and wireless Communication. **[3 Lectures]**

Amplitude Modulation: AM Modulation and Demodulation Implementation, Hilbert Transformation, Variations of AM (DSB, SSB, VSB), Frequency Division Multiplexing, Time and Frequency Domain Analysis, Applications, Implementation. **[11 Lectures]**

Angle Modulation: Introduction, Mathematical analysis of FM and PM, Modulation index for FM and PM, Frequency spectrum and bandwidth of FM, Narrow band and wide band FM, Direct and indirect methods of FM generation, Pre emphasis and de-emphasis, Comparison of AM, FM and PM. **[11 Lectures]**

Introduction, Performances characteristic of receivers: Sensitivity, Selectivity, Fidelity, Image frequency and IFRR, Tracking and double spotting, TRF, Super heterodyne receivers, RF amplifier, Local oscillator and mixer, IF amplifier, AGC. AM Detectors: Envelope detector and practical diodedetector, FM Detectors: Slope detector, phase discriminator and ratio detector. **[10 Lectures]**

Noise: Introduction, sources of noise, classification of noise, SNR, Noise figure, Performance of analog modulation systems in presence of noise. **[3 Lectures]**

Sampling Theory: Introduction of sampling Pulse amplitude modulation, pulse width modulation, pulse position modulation, PCM. **[2 Lectures]**

Course Outcome (CO):

CO1: Able to understand the basic concepts of analog communication systems.
CO2: Analyze and understand various linear and nonlinear continuous modulation and demodulation techniques.
CO3: Able to evaluate the performance of the analog communication system in the presence of noise.
CO4: Able to analyze various analog pulse modulation and demodulation techniques.

References:

1. B.P. Lathi, “Modern Digital & Analog Communications Systems”, Oxford University Press
2. J. G. Proakis, M. Salehi, "Communication Systems Engineering", Pearson Education, 2002.
3. S. Haykin,"Communication Systems", John Wiley and Sons, 20014. Frederick J. Hill, Gerald R. Peterson, “Computer Aided Logical Design with Emphasis on VLSI”, John Wiley, 4th Edition

Course Code: ECT204	**Course Credit: 3**
Course Name: Measurement and Instrumentation Technology	**L-T-P: 3-0-0**
Course Prerequisite: None	

Course Syllabus:

Introduction to measurement and instrumentation technology, Generalized configuration of measurement systems, Static and Dynamic performance characteristics of measurement systems. **[8 Lectures]**

Basic principles of transducers (resistive, inductive, capacitive, piezoelectric, Hall-effect, photosensitive) **[6 Lectures]**

Signal conditioning circuits (DC and AC bridges, basic circuits for instrumentation such as amplifiers/signal converters/filters, instrumentation and isolation amplifiers, analog-to-digital and digital-to-analog converters). **[6 Lectures]**

Measurement of physical quantities (displacement, velocity, force, torque, vibration, sound, pressure, flow, temperature, level, viscosity, density, pH, humidity). **[16 Lectures]**

Introduction to Virtual Instrumentation and Data Acquisition Systems. **[4 Lectures]**

Course Outcome (CO):

CO1: Understand the fundamentals of measurement systems.
CO2: Understand the principle of operation of transducers.
CO3: Learn criteria-based design of basic instrumentation circuits.
CO4: Learn the techniques for measurement of physical quantities.
CO5: Learn to acquire data and build virtual instruments.

References:

1. E.O. Doeblin, D.Manik, “Measurement Systems: Application and Design”, McGraw-Hill
2. A.K. Sawhney, “Electrical & Electronics Measurement and Instrumentation”, DhanpatRai& Co
3. D.V.S. Murthy, “Transducers and Instrumentation”, PHI, 1st Edition
4. B.E. Jones, “Instrumentation, Measurement and Feedback”, Tata McGraw Hill, 1978
5. R.S. Figliola, D.E. Beasley, “Theory and Design for Mechanical Measurements”, John Wiley & Sons

Course Code: ECT206	Course Credit: 3
Course Name: Microcontrollers and Interfacing	L-T-P: 3-0-0
Course Prerequisite: None	

Course Syllabus:

Introduction to 8051 Microcontroller: Introduction to 8 bit microcontrollers; Basic differences and similarities between Microprocessor and Microcontroller, Types of various architectures; Harvard and Von-Neumann, RISC and CISC, Concept of pipelining. Intel 8051 history, Pin diagram of 8051, 8051- architecture, Registers, Timers Counters, Flags, Special Function Registers, DPTR, PC, PSW, SP etc. Additional features in 8052. **[12 Lectures]**

8051 Assembly Programming: Addressing Modes, Data types and Directives, Jump, Loop and Call instructions, Arithmetic instructions and their simple programming applications. Logic Instructions Single–bit instructions, Timer and Counter programming, Interrupts programming, Serial communication, Memory accessing and their simple programming applications. **[10 Lectures]**

Introduction to Advanced microcontrollers: Overview of Microchip PIC 16Fxxx, Motorola 680XX, ARM, Texas MSP430 etc. and their comparison with 8051. **[10 Lectures]**

Hardware interfacing (8051 and any one advance microcontroller): I/O Port programming, Bit manipulation, Interfacing to a LED, LCD, Keyboard, ADC, DAC, Stepper Motors and sensors etc. **[8 Lectures]**

Course Outcome (CO):

CO1: Learn basic concept of microcontroller architectures.
CO2: Learn Programming microcontrollers for different hardware interfacing applications.
CO3: Learn concept of advanced microcontrollers.

References:

1. Ayala, K.J., The 8051 Microcontroller Architecture, Programming and applications, Penram International Publishing (India) Pvt. Ltd. (2007).
2. Mazidi, M.A., The 8051 Microcontroller and Embedded System, Pearson Education (2008).
3. Predko, M., Customizing The 8051 Microcontroller, Tata McGraw-Hill (2002).
4. Martin P. Bates, “Programming 8 bit PIC Microcontrollers in C with Interactive Hardware Simulation”, Newness, 2008.
5. PIC Micro Mid-Range MCU Family Reference Manual, Micro Chip Technology Inc.
6. Manuel Jiménez, Rogelio Palomera, Isidoro Couvertier, “Introduction to Embedded Systems Using Microcontrollers and the MSP430”, Springer, 2014.
7. Jonathan W. Valvano, “Introduction to ARM®CORTEX-M Microcontrollers,” Fifth Edition, 2014 self-published

Course Code: ECT208	**Course Credit: 4**
Course Name: Electromagnetic Theory	**L-T-P: 3-1-0**
Course Prerequisite: None	

Course Syllabus:

Phasors and transmission lines: Electromagnetism; Travelling wave in lossless and lossy medium; Electromagnetic spectrum; Review of phasors; Role of wavelength; Lumped element model; Transmission-Line Equations; Wave propagation on a Transmission line; Lossless transmission line-Voltage reflection coefficient, standing waves, wave impedance, special cases, power flow; Smith chart; Impedance matching. **[14 Lectures]**

Vector Analysis: Coordinate systems and transformation; Concept and physical interpretation of gradient, divergence and curl; Divergence theorem and Stokes's theorem; Laplacian operator. **[4 Lectures]**

Electrostatics: Charge distributions; Electric field due to continuous charge distribution; Electric flux density; Gauss's law; Electric potential; Relationship between and V; Electrostatic energy; Convection and conduction currents; Conductors; Polarization in dielectrics; Continuity equation; Poisson's and Laplace's equation; Electric boundary conditions. **[8 Lectures]**

Magnetostatics: Biot-Savart's law; Ampere's circuital law; Magnetic flux density; Magnetic scalar and vector potentials; Magnetic energy; Magnetization in materials; Magnetic boundary conditions; Analogy between electric and magnetic field. **[8 Lectures]**

Time-Varying Fields: Faraday's **law**; Displacement currents and equation of continuity; Modified Ampere's circuital law; Maxwell's equation in final form; Boundary conditions for electromagnetics. **[6 Lectures]**

Course Outcome (CO):

CO1: Understand theoretical concepts about transmission lines and familiarize with smith charts.
CO2: Describe transmission modes through rectangular and circular waveguides.
CO3: Understand the fundamentals of electrostatics and magnetostatics.
CO4: Distinguish between static and time varying fields.
CO5: Analyze Maxwell's equation in different forms (differential and integral).

References:

1. Sadiku, Matthew NO., "Elements of electromagnetics. Oxford university press, 4th Edition.
2. Shevgaonkar, R. K., "Electromagnetic waves", Tata McGraw-Hill Education.
3. Ulaby, Fawwaz T., Eric Michielssen, and Umberto Ravaioli. "Fundamentals of applied electromagnetics", Prentice Hall, 7th Edition.
4. William H. Hayt Jr., "Engineering Electromagnetics", Tata McGraw Hill, 5th Edition
5. Jordan and Balmain, "Electromagnetic Waves and Radiating Systems", PHI.

Course Code: ECT210	**Course Credit: 4**
Course Name: Control Systems	**L-T-P: 3-1-0**
Course Prerequisite: None	

Course Syllabus:

Basic Concepts of Control Systems, Open loop and closed loop systems, Classification of Systems- continuous, discrete, linear and non-linear control systems, Mathematical modelling of physical systems, Derivation of Transfer functions, block-diagram model and signal flow graphs. **[9 Lectures]**

Time response of first order systems to unit step and unit ramp inputs, Time Response of Second order systems to unit step input, Steady State Errors and Static Error Constants of different types of systems. Generalised error series and Generalised error coefficients. **[8 Lectures]**

The concept of stability and Algebraic criteria, Routh-Hurwitz stability criteria and its application. Concept of relative stability, Root locus construction and its analysis. **[8 Lectures]**

Frequency response techniques - Polar and Bode plots, Correlation between time and frequency responses with respect to second order system, Gain Margin and Phase Margin, Nyquist stability criterion, Closed-loop frequency response, sensitivity analysis in frequency domain. **[8 Lectures]**

Preliminary considerations for classical design, Realization of basic compensators, Concept of controllers, State model of LTI systems, state equations, state transition matrix, solution of state equations. **[7 Lectures]**

Course Outcome (CO):

CO1: To introduce the concepts of control system, linear and nonlinear systems, mathematical modeling and reduction techniques.
CO2: To illustrate the principle of time domain analysis of first order and second order systems.
CO3: To understand the concept of stability in control systems.
CO4: To describe the principle of frequency domain analysis in control systems.
CO5: To design the basic compensators and understand the concept of state model.

References:

1. Katsuhiko Ogata, “Modern Control Engineering”, Prentice Hall, 5th Edition.
2. I.J. Nagrath, M. Gopal, “Control Systems Engineering”, New Age International Publishers, 5th Edition.
3. Farid Golnaraghi, Benjamin C. Kuo, “Automatic Control Systems”, John Wiley & Sons, 9th Edition.
4. R.C. Dorf, R.H. Bishop, “Modern Control Systems”, Addison Wesley, 11th Edition.

Course Code: ECT212	**Course Credit: 3**
Course Name: Communication Systems	**L-T-P: 3-0-0**
Course Prerequisite: None	

Course Syllabus:

Basic history of electronic communication systems, Types of communication systems, Analog vs. Digital communication, Issues and design aspects of communication systems. Emerging communication technologies. **[5 Lectures]**

Classification of signals and useful signal operations. concepts of signal-to-noise ratio, Frequency domain representation of signals using Fourier transform, Important properties of Fourier transform, rate of communication, randomness, redundancy, coding, signal transmission through a linear system, Ideal and practical filters, Energy and power of a signal, Energy and power spectral density, Basic concept of data communication. **[12 Lectures]**

Principle of modulation, Generation and demodulation of Amplitude modulated signal, DSB-FC, DSB-SC, SSB-SC, VSB-SC signals, channel bandwidth, Carrier acquisition, Super heterodyne AM receiver. Frequency division multiplexing. **[8 Lectures]**

Concept of Angle modulation (frequency modulation and phase modulation), FM transmitter and receivers, Interference and bandwidth considerations in angle modulated systems, Comparison of AM and FM. **[8 Lectures]**

Overview of Sampling theorem, Baseband digital modulation - Pulse analog modulation (Pulse Amplitude Modulation, Pulse Width Modulation, Pulse Position Modulation), Pulse Digital Modulation (Pulse Code Modulation); Digital communication system, Binary signaling scheme (Amplitude Shift Keying, Phase Shift Keying, Frequency Shift Keying). **[7 Lectures]**

Course Outcome (CO):

CO1: Able to understand the basic concepts of analog communication systems.
CO2: Analyze and understand various linear and nonlinear continuous modulation and demodulation techniques.
CO3: Able to evaluate the performance of the analog communication system in the presence of noise.
CO4: Able to analyze various analog pulse modulation and demodulation techniques.

References:

1. B.P. Lathi, “Modern Digital & Analog Communications Systems”, Oxford University Press
2. Behrouz A. Forouzan "Data communication and Networking", Tata McGraw Hill, 2007
3. H. Taub, D.L. Schilling, "Principles of Communication Systems", Tata McGraw Hill, 2001
4. S. Haykin,"Communication Systems", John Wiley and Sons, 2001

Course Code: CSP202	Course Credit: 1
Course Name: Object Oriented System Design Lab	**L-T-P: 0-0-2**
Course Prerequisite: Elementary knowledge of programing language C	

List of Experiments: 1 Lab per experiment

1. Write a program to give the examples of operators. Increment and decrement, Bitwise Complement, Arithmetic, Relational, Conditional Operators.
2. Write a program to give the example of control statements. If, Else-If, Statements, Switch case, For, While loops.
3. Operations with one-dimensional array, two-dimensional array and multi-dimensional arrays.
4. To find the sum of command line arguments and count the invalid integers entered.
5. Write a program to create a room class, the attributes of this class is Room no, room type, room area and AC machine. In this class the member functions are set data and display data.
6. Write a program to create a class ‘simple object’. Using constructor and destructor to display the message given by you.
7. Write a program for the following 1. Example for call by value. 2. Example for call by reference.
8. Write a program to give the example for ‘this’ operator. And also use the ‘this’ keyword as return statement.
9. Write a program to demonstrate static variables, methods, and blocks. Write a program to demonstrate static variables, methods, and blocks.
10. Write a program to create a package named my pack and import it in circle class. Write a program to create a package named pl, and implement this package in ex1 class.
11. Create class named as ‘a’ and create a sub class ‘b’. Which is extends from class ‘a’. And use these classes in ‘inherit’ class.
12. Write a program to get the input from the user and store it into file. Using Reader and Writer file.

Course Outcome (CO):

CO1: Practice object-oriented programs and build java applications.
CO2: Implement java programs for establishing interfaces.
CO3: Implement sample programs for developing reusable software components.
CO4: Create database connectivity in java and implement GUI applications.

References:

1. Core Java: Vol I Fundamentals, Cay S. Horstmann. Latest Edition – 11th Edition, Publisher – Prentice Hall
2. Java: A Beginner's Guide, Eighth Edition by Schildt, Herbert.
3. Core Java Professional for Students by Harry H. Chaudhary, 2nd Edition
4. Core Java: An Integrated Approach by Dr. R. Nageswara Rao, Dreamteach

Course Code: ECP202	Course Credit: 1
Course Name: Analog Communication Lab	**L-T-P: 0-0-2**
Course Prerequisite: None	

List of Experiments: 1 Lab per experiment

1. Amplitude Modulation and Demodulation
2. Double sideband suppressed carrier
3. Single sideband suppressed carrier.
4. Synchronous Detector.
5. Frequency Modulation.
6. Pre-Emphasis and De-Emphasis.
7. Verification of Sampling Theorem.
8. Diode Detector Characteristics.
9. Design of Mixer.
10. Pulse width modulation demodulation.
11. Pulse position modulation demodulation.
12. Pulse amplitude modulation demodulation.

Course Outcome (CO):

CO1: Able to design and analyze various analog modulation signals using suitable equipment's/MATLAB/Simulink.
CO2 Able to design and analyze various demodulators using discrete components and breadboards/MATLAB/Simulink.
CO3: Able to verify sampling theorem using MATLAB/Simulink.
CO4: Design and analyses various pulse modulation and demodulation techniques

References:

1. B.P. Lathi, "Modern Digital & Analog Communications Systems", Oxford University Press.
2. J. G. Proakis, M. Salehi, "Communication Systems Engineering", Pearson Education, 2002.
3. S. Haykin,"Communication Systems", John Wiley and Sons, 2001

Course Code: ECP204	Course Credit: 1
Course Name: Measurement and Instrumentation Technology Lab	**L-T-P: 0-0-2**
Course Prerequisite: None	

List of Experiments: 1 Lab per experiment

1. Characterization of various sensors and data acquisition devices
2. Design of first-order and second-order system based virtual instruments
3. Design of virtual instruments based digital multimeter
4. Design of signal converter and instrumentation amplifier circuits
5. Design of analog-to-digital and digital-to-analog converters
6. Design of electronic displacement measurement system
7. Design of electronic velocity measurement system
8. Design of electronic weight measurement system
9. Design of electronic temperature measurement system
10. Design of electronic level measurement system
11. Design of speed-control of dc motor.
12. Design of pH control system.

Course Outcome (CO):

CO1: Understand the functioning of electronic instruments.
CO2: Understand the operation of data acquisition devices.
CO3: Learn to build virtual instruments using LabVIEW.
CO4: Learn to build electronics instruments and interface it with LabVIEW.
CO5: Understand the applications of physical sensors.

References:

1. E.O. Doeblin, D.Manik, “Measurement Systems: Application and Design”, McGraw-Hill
2. A.K. Sawhney, “Electrical & Electronics Measurement and Instrumentation”, Dhanpat Rai & Co
3. User manual for LabVIEW
4. D.V.S. Murthy, “Transducers and Instrumentation”, PHI, 1st Edition
5. B.E. Jones, “Instrumentation, Measurement and Feedback”, Tata McGraw Hill, 1978
6. R.S. Figliola, D.E. Beasley, “Theory and Design for Mechanical Measurements”, John Wiley & Sons

Course Code: ECP206	Course Credit: 1
Course Name: Microcontrollers and Interfacing Lab	**L-T-P: 0-0-2**
Course Prerequisite: None	
List of Experiments: Programming and Application development around 8051 and any other advance microcontroller: 1. Interfacing to LED, LCD, Keyboard, ADC, DAC, Stepper Motors and sensors etc. **[10 Labs]** 2. A minor project based on 8051/ ARM/PIC/ in the semester **[2 Labs]**	
Course Outcome (CO): CO1: Developing programming skills. CO2: Learning interfacing microcontrollers with different devices.	
References: 1. Ayala, K.J., The 8051 Microcontroller Architecture, Programming and applications, Penram International Publishing (India) Pvt. Ltd. (2007). 2. Mazidi, M.A., The 8051 Microcontroller and Embedded System, Pearson Education (2008). 3. Predko, M., Customizing The 8051 Microcontroller, Tata McGraw-Hill (2002). 4. Martin P. Bates, "Programming 8 bit PIC Microcontrollers in C with Interactive Hardware Simulation", Newness, 2008. 5. PIC Micro Mid-Range MCU Family Reference Manual, Micro Chip Technology Inc. 6. Manuel Jiménez, Rogelio Palomera, Isidoro Couvertier, "Introduction to Embedded Systems Using Microcontrollers and the MSP430", Springer, 2014. 7. Jonathan W. Valvano, "Introduction to ARM®CORTEX-M Microcontrollers," Fifth Edition, 2014 self-published	

Course Code: OTP202	Course Credit: 2
Course Name: Entrepreneurship and Business Incubation	**L-T-P: 0-1-2**
Course Prerequisite: None	

Course Syllabus: Total 12 Labs

- Introduction to entrepreneurship and intrapreneurship
- Success stories of 6-8 entrepreneurs.
- Identification of critical success factors to be a successful entrepreneur
- Entrepreneurship as a career option; profile of a successful entrepreneur; process of becoming an entrepreneur; personal assessment and understanding of self.
- Business plan preparation; constituents of a business plan. Statuary requirements for becoming an entrepreneur. Governmental rules and regulations. Development of a Business Idea.
- Start-Ups and Micro Businesses, Self-Employment. Motivations and the Process of Self-Assessment, Risks and Rewards. Dealing with business failure.
- Overcoming Social, Economic and Cultural barriers to Entrepreneurships; Process of Idea Generation, Invention, Discovery, Innovation and Expansion.
- Franchising and Business Partnerships; Working in teams, finding your co-founder, team dynamics. Negotiation skills; Types of Legal Entities, Incorporation and Exit.
- Familiarizing with the Companies Act and other Legal Aspects of running a business. Taxes and Exemptions relevant to StartUps; Product and Service Design – Creative Problem Solving and Process of Solutions design; Opportunity Identification, Estimation and Evaluation.

Mini Project:
Student should prepare a business plan in a group and register themselves as a startup in an incubation center.
(Finalization of business plan; floating their own company; start prototype development; customer identification; market survey; demand analysis; start the enterprise after arranging funds/ finances from venture capitalists/ angle investors/ govt. agencies etc.)

Course Outcome (CO):

CO1: Understand the fundamentals of Entrepreneurship.
CO2: Understand the entrepreneurial behaviour.
CO3: Business Creation and StartUp Development.
CO4: Implementation of Business Plan

References:

1. Stay Hungry Stay foolish: Rashmi Bansal; CIIIE, IIM Ahmadabad, 2008.
2. Arise, Awake: The Inspiring Stories of Young Entrepreneurs Who Graduated From College Into A Business of Their Own, Westland Books Private Limited (20 January 2015)
3. Moodi, Y. (2012). Game changers: 20 extraordinary success stories of entrepreneurs from IIT Kharagpur. Noida: Random House.
4. Bansal, R. (2013). Follow every rainbow: the inspiring stories of 25 women entrepreneurs whose gentle touch created strong business. Chennai: Westland Ltd

Course Code: ECT301	**Course Credit: 3**
Course Name: Digital Signal Processing	**L-T-P: 3-0-0**
Course Prerequisite: None	

Course Syllabus:

Introduction – DSP Applications, Concepts of Frequency and Filtering, Commonly used signals in DSP, Overview of LTI systems and Z transform. **[5 Lectures]**

Frequency Domain Representation of Signals–Concept of spectrum, Sampling theorem-decimation and interpolation of discrete signals, Frequency representation of discrete time signals-Discrete time Fourier transform (DTFT), Discrete Fourier transform (DFT), Fast Fourier transform (Decimation in Time and Decimation in Frequency), Concepts of circular shift and convolution, Filtering of long data sequence. **[8 Lectures]**

Linear Time Invariant (LTI) Systems in Transform Domain–Concept of filtering revisited (lowpass, bandpass and highpass filters), Transfer function and the frequency response of a system, Types of transfer functions - FIR filters, ideal filters, linear phase filters, zero locations of linear phase FIR filters; IIR filters, pole and zero locations of IIR filters, all pass filters, stability issues for IIR filters. Filter Structures – IIR system (direct, cascade and parallel form), FIR system (direct and cascade form, and structure for linear phase FIR systems). **[12 Lectures]**

Filter Design Techniques – Digital filter specifications, selection of filter type, and filter order; FIR filter design using windowing Techniques; FIR filter design using frequency sampling method; IIR filter design using Impulse Invariance; IIR filter design using bilinear transformation; Spectral transformations for designing a filter with new characteristics based on a previously designed filter. **[10 Lectures]**

Finite precision (Quantization and round-off error, Finite word length effects in digital filter, Introduction to Adaptive Filters and Digital Signal Processors. **[5 Lectures]**

Course Outcome (CO):

CO1: To identify the signals and systems, apply the principles of discrete-time signal analysis to perform various signal operations.
CO2: To introduce principles of z-transforms to finite difference equations.
CO3: To illustrate the principles of Fourier transform analysis to describe the frequency characteristics of discrete-time signals and systems.
CO4: To describe the principles of signal analysis to filtering and use computer programming tools to process and visualize signals.
CO5: To illustrate different filtering concepts to design different types of filters.

References:

1. John G. Proakis, Dmitris G. Manolakis, “Digital Signal Processing: Principles, Algorithms and Applications”, Pearson, 4th Edition.
2. Sanjit K. Mitra, “Digital Signal Processing: A Computer-Based Approach”, McGraw Hill, 4th Edition.
3. Shlomo Engelberg, “Digital Signal Processing: An Experimental Approach”, Springer, 2008.
4. Dag Stanneby, Willian Walker, “Digital Signal Processing and Applications”, Elsevier, 2nd Edition

Course Code: ECT303	**Course Credit: 3**
Course Name: Digital Communication	**L-T-P: 3-0-0**
Course Prerequisite: None	

Course Syllabus:

Introduction of Digital Communication Systems, Line coding scheme, Power Spectral density of Digital PAM signal, Matched filtering, Gram Schmidt Ortho-normalisation Procedure (GSOP). **[10 Lectures]**

Analog to digital Conversion, Sampling, Quantization (Uniform and Non-uniform), Pulse Code Modulation (PCM), PCM generation and reconstruction, Companding, Differential PCM, Delta Modulation, Adaptive Delta Modulation, Slope overload and Granular noise. **[12 Lectures]**

Generation and Detection of various digital modulation techniques and its probability error calculation. **[12 Lectures]**

Introduction of Information theory, Entropy, Channel Capacity, Source coding (Shannon Fano and Huffman) **[6 Lectures]**

Course Outcome (CO):

CO1: Understand the concepts of Sampling process, time division multiplexing, A/D convertor and GSOP.
CO2: Understand the concepts of waveform coding techniques, PSD of different line coding schemes and analysis of ISI Mitigation Techniques.
CO3: Understand the concepts of digital modulation techniques and evaluate their probability of error and bandwidth efficiency.
CO4: Understand the concepts of error control coding schemes.

References:

1. John G. Proakis, “Digital Communications”, Tata McGraw Hill, 2001.
2. B. P. Lathi, “Modern Digital & Analog Communications Systems”, Oxford University Press, 1998.
3. Robert G. Gallager, “Principles of digital communication”, Cambridge University Press, 2008.
4. H. Taub, D.L. Schilling, “Principles of Communication Systems”, Tata McGraw Hill, 2001.
5. S. Haykin, “Communication Systems”, John Wiley and Sons, 2001.
6. S. Haykin, “An Introduction to Analog and Digital Communications”, John Wiley and Sons, 2009

Course Code: ECT305	Course Credit: 3
Course Name: Digital MOS IC Design	L-T-P: 3-0-0
Course Prerequisite: None	

Course Syllabus:

Fabrication of MOSFETs: Fabrication Process Flow: Basic Steps, The CMOS n-Well Process, Layout Design Rules, Full-Custom Mask Layout Design. **[6 Lectures]**

MOS transistor: The Metal Oxide Semiconductor (MOS) Structure, The MOS System under External Bias Structure and Operation of MOS Transistor (MOSFET), MOSFET Current-Voltage Characteristics, MOSFET Scaling and Small-Geometry Effects, MOSFET Capacitances **[9 Lectures]**

MOS inverters: Static characteristics, Resistive-Load Inverter, Inverters with n-Type MOSFET Load, CMOS Inverter, switching characteristics and interconnect effects: Delay-Time Definitions, Calculation of Delay Times, Inverter Design with Delay Constraints, Estimation of Interconnect Parasitic, Calculation of Interconnect Delay, Switching Power Dissipation of CMOS Inverters **[9 Lectures]**

Combinational MOS logic circuit: Introduction, MOS Logic Circuits with Depletion n-MOS Loads, CMOS Logic Circuits, Complex Logic Circuits, CMOS Transmission Gates (Pass Gates). **[8 Lectures]**

Sequential MOS logic circuits: Introduction, Behavior of Bistable Elements, The SR Latch Circuit, Clocked Latch and Flip-Flop Circuits, CMOS D-Latch and Edge-Triggered Flip-Flop. Semiconductor memory: Static and Dynamic memory realization. **[8 Lectures]**

Course Outcome (CO):

CO1: To introduce the trends in semiconductor technology, scaling and its effect on device density, speed, and power consumption.
CO2: To understand the static and dynamic behavior of MOSFETs and the secondary effects of the MOS transistor model.
CO3: To understand MOS transistor operation in designing combinational and sequential circuits.

References:

1. Sung-Mo Kang, Yusuf Leblebici, “CMOS Digital Integrated Circuits Analysis and Design”, McGraw-Hill, 2nd Edition, 1999.
2. Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic, “Digital Integrated Circuits - A Design Perspective”, Pearson education, 2nd Edition.
3. Neil H.E. Weste, Kamran Eshraghian, “Principles of CMOS VLSI Design: A Systems Perspective”, Pearson Education, 2nd Ed.
4. Ken Martin, “Digital Integrated Circuit Design”, Oxford University Press, 1st Ed.
5. Douglas A. Pucknell, Kamran Eshraghian, “Basic VLSI Design”, Prentice-Hall, 3rd Ed.

Course Code: ECT307	**Course Credit: 3**
Course Name: RF and Microwave Engineering	**L-T-P: 3-0-0**
Course Prerequisite: None	

Course Syllabus:

Plane wave propagation: Time harmonic fields; Plane wave propagation in lossless media; Wave polarization; Plane wave propagation in lossy media; Current Flow in good conductors; Electromagnetic power density; Wave reflection and transmission at normal incidence; Wave reflection and transmission at oblique incidence. **[8 Lectures]**

Waveguides: Rectangular waveguides - TE and TM modes, Wave propagation, Power transmission and attenuation, Mode excitation. Circular waveguide- Basic idea of TE and TM modes. **[8 Lectures]**

Passive microwave components: Rectangular and circular cavity resonators – Q-factor. Waveguide Tees and Scattering matrices, Magic Tee and Hybrid Rings and their Scattering matrices; Waveguide Corners, Bends and Twists; Directional couplers, S-matrix of a Directional Coupler, Circulator and Isolators. **[8 Lectures]**

Radiation and antennas: Potential functions and concept of radiation, Power radiated, Fundamental parameters of antennas, Radiation from Hertzian dipole antenna and monopole antenna. **[8 Lectures]**

Microwave Devices: Microwave transistor, Tunnel diode, Varactor Diode, Schottky Diode, Gunn diode, IMPATT diode, Limitation of Conventional Tubes, Klystron, Magnetron, Travelling wave tubes. **[8 Lectures]**

Course Outcome (CO):

CO1: Define planar electromagnetic wave, reflection and transmission of power in lossless and other media.
CO2: Describe transmission modes through rectangular and circular waveguides.
CO3: Understand the principle behind various microwave components.
CO4: Perceive the concept of radiation and propagation of EM waves in space.
CO5: Understand working of various microwave amplifiers and oscillators.

References:

1. Sadiku, Matthew NO., “Elements of electromagnetics. Oxford university press, 4th Edition.
2. D. M. Pozar., “Microwave Engineering” John Wiley & Sons.
3. R.E. Collin, “Foundation for Microwave Engineering”, Wiley-IEEE Press.
4. S. M. Liao, “Microwave Devices and Circuits”, Prentice Hall of India.
5. Shevgaonkar, R. K., “Electromagnetic waves”, Tata McGraw-Hill Education.

Course Code: ECD301	**Course Credit: 3**
Course Name: Study of Technical Articles	**L-T-P: 0-2-2**
Course Prerequisite: None	
Course Syllabus: In this course, a group of students are required to study technical articles recently published in reputed Transactions, Journals, Conferences or Magazines. Students will be pursuing this study under the guidance of a faculty member. At the end of the course, student is expected to learn recent technical advances in the selected domain, prepare a technical report on it, and present it.	
Course Outcome (CO):	
References:	

Course Code: ECP301	Course Credit: 1
Course Name: Digital Signal Processing Lab	**L-T-P: 0-0-2**
Course Prerequisite: None	

Course Syllabus: 1 Lab per experiment

1.To study the basic signals Unit Impulse, Ramp, Unit Step, Exponential, Discrete sine and cosine signals with given sampling frequency.
2. Represent complex exponentials as a function of real and imaginary part, and impulse and step response of two vectors using MATLAB.
3.Convolution between two vectors using MATLAB without using conv function, and cross correlation between two vectors using MATLAB.
4. Compute DFT and IDFT of a given sequence using MATLAB.
5. Linear convolution of two sequences using DFT using MATLAB.
6. Compute z-transform from the given transfer function and its ROC using MATLAB.Compute rational z-transform from the given poles and zeros using MATLAB.
7. Compute partial fraction expansion of rational z-transform using MATLAB.
8. Design a Type -1 Chebyshev IIR highpass filter using MATLAB.
9. Design an IIR Elliptic low pass filter using MATLAB, and an IIR Butterworth bandpass filter using MATLAB.
10. Design a low pass filter using the Kaiser window using MATLAB.
11. Determine coefficient quantization effects on the frequency response of a cascade form IIR filter using MATLAB.
12. Lab Projects

Course Outcome (CO):

CO1: Understand the basic concept of signals and various different functions.
CO2: Understand the concept of on convolution techniques.
CO3: Understand the concept of various transform techniques.
CO4: Understand the concept of various window techniques.
CO5: Investigate the performance of various types of filters.

References:

1. John G. Proakis, Dmitris G. Manolakis, “Digital Signal Processing: Principles, Algorithms and Applications”, Pearson, 4th Edition.
2. Sanjit K. Mitra, “Digital Signal Processing: A Computer-Based Approach”, McGraw Hill, 4th Edition.
3. Shlomo Engelberg, “Digital Signal Processing: An Experimental Approach”, Springer, 2008.
4. Dag Stanneby, Willian Walker, “Digital Signal Processing and Applications”, Elsevier, 2nd Edition

Course Code: ECP303	Course Credit: 1
Course Name: Digital Communication Lab	**L-T-P: 0-0-2**
Course Prerequisite: None	

Course Syllabus: 1 Lab per experiment

1. To generate different signals and Random Variables using MATLAB.
2. To generate the sampled signals (Impulse and Natural sampling) using MATLAB.
3. To generate the uniform quantized signals using MATLAB.
4. To generate the line coded (RZ, NRZ) signal using MATLAB.
5. To generate the line coded (Bipolar and Manchester) signal using MATLAB.
6. To find the PSD of a line coded signal using MATLAB.
7. To generate and demodulate amplitude shift keyed (ASK) signals using MATLAB.
8. To generate and demodulate Phase shift keyed (PSK) signals using MATLAB.
9. To generate and demodulate Frequency shift keyed (FSK) signals using MATLAB.
10. To generate and demodulate Quadrature Phase shift keying (QPSK) signals using MATLAB. 11. To generate the constellation diagram of M-ary signal with and without AWGN using MATLAB.
12. To simulate the BER of BPSK signal using MATLAB.

Course Outcome (CO):

CO1: Understand the concept of sampling and ADC.
CO2: Understand the concept of Line coded signals.
CO3: Understand the concept of Digital Modulation scheme.
CO4: Investigate the performance of various digital modulated signals.

References:

1. John G. Proakis, “Digital Communications”, Tata McGraw Hill, 2001.
2. B. P. Lathi, “Modern Digital & Analog Communications Systems”, Oxford University Press, 1998.
3. Robert G. Gallager, “Principles of digital communication”, Cambridge University Press, 2008.
4. H. Taub, D.L. Schilling, “Principles of Communication Systems”, Tata McGraw Hill, 2001.
5. S. Haykin, “An Introduction to Analog and Digital Communications”, John Wiley and Sons, 2009.

Course Code: ECP305	Course Credit: 1
Course Name: Digital MOS IC Design Lab	**L-T-P: 0-0-2**
Course Prerequisite: None	

Course Syllabus: 1 Lab per experiment unless otherwise mentioned

1. I-V characteristics of PMOS and NMOS
2. CMOS Inverter: a) Design and verify the circuit using transient analysis. b) Obtain VTC curve and threshold voltage of inverter for a specific parameter, verify with the value of threshold voltage obtained using formula.
3.Simulation of CMOS Inverter for different parameters Kn, Kp as a design variable.
4. Design NAND and NOR gate to perform transient analysis.
5. Design XOR gate by using NAND and NOR gate. Perform transient analysis.
6. Design 1-bit half adder and verify the circuit using transient analysis.
7. Design Full adder verify the circuit using transient analysis.
8. Design a multiplexer and perform all the analysis to verify its characteristics.
9. Design a MOS based SRAM cell and verify its characteristics. **[2 Labs]**
10. Design CMOS transmission gate and perform all the analysis to verify its characteristics. **[2 Labs]**

Course Outcome (CO):

CO1: To introduce the trends in semiconductor technology, scaling and its effect on device density, speed, and power consumption.
CO2: To understand the static and dynamic behavior of MOSFETs and the secondary effects of the MOS transistor model.
CO3: To understand MOS transistor operation in designing combinational and sequential circuits.

References:

1.Sung-Mo Kang, Yusuf Leblebici, “CMOS Digital Integrated Circuits Analysis and Design”, McGraw-Hill, 2 nd Edition, 1999.
2.Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic, “Digital Integrated Circuits - A Design Perspective”, Pearson education, 2nd Edition.
3.Neil H.E. Weste, Kamran Eshraghian, “Principles of CMOS VLSI Design: A Systems Perspective”, Pearson Education, 2nd Edition.

Course Code: ECT302	**Course Credit: 3**
Course Name: Wireless and Mobile Communication	**L-T-P: 3-0-0**
Course Prerequisite: Analog Communication, Digital Communication	

Course Syllabus:

Evolution of mobile radio communication, Different generations of wireless communication and their technical specifications. Cellular concept: frequency reuse, channel assignment, Handoff, co-channel and adjacent channel interference, improving system capacity and cell coverage. **[8 Lectures]**

Mobile radio propagation: free space propagation, Two ray propagation model, Okumura Model, Hata Model, Link budget design, Traffic engineering in Telecommunication, Blocking Probability and Grade of service (GoS). **[10 Lectures]**

Multipath propagation, wireless channel modeling, Rayleigh Fading in wireless system, Deep fade scenario, BER analysis of wired and wireless communication systems. **[10 Lectures]**

Small scale fading, Flat vs frequency selective fading, Coherent time, Coherent BW, RMS delay spread, Max delay spread, Inter symbol interference (ISI), Doppler shift, Doppler spread and Jakes model. **[6 Lectures]**

Introduction of 5G and beyond technologies, concept of Multi-antenna systems, Diversity, Rake receiver and Multiple access scheme. **[6 Lectures]**

Course Outcome (CO):

CO1: Understand the concept of Wireless and mobile communication.
CO2: Analyze the performance of Wireless channel environment and Traffic engineering.
CO3: Investigate the various performance measures.
CO4: Understand the concept of Diversity and multiple access schemes

References:

1. T. S. Rappaport, “Wireless Communications: Principles and Practice”, Pearson Education, 2010.
2. K. Jagannatham, “Principles of Modern Wireless Communication Systems”, Tata McGraw Hill, 2015.
3. T. S. Rappaport and W. H. Tranter, “Principles of Communication Systems Simulation with Wireless Applications”, Pearson Education, 2004.
4. S. Haykin and M. Moher, “Modern Wireless Communications”, Pearson Education, 2005.
5. A. Goldsmith, “Wireless Communications”, Cambridge university press, 2005.
6. R. S. Kshetrimayum, “Fundamentals of MIMO Wireless Communications”, Cambridge University press, 2017.

Course Code: ECT304	**Course Credit: 3**
Course Name: Optical Communication	**L-T-P: 3-0-0**
Course Prerequisite: None	

Course Syllabus:

Key elements of optical fiber systems, optical windows and spectral bends, nature of light, basic optical laws, propagation of light, propagation of light in a cylindrical dielectric rod, light as ray model and wave model. **[5 Lectures]**

Different types of optical fibers: single mode fiber, multimode fiber, step index and graded index fiber, ray optics representation, numerical aperture, modal analysis inside optical fiber, cutoff wavelength and V number, mode- field diameter, fiber materials. **[8 Lectures]**

Signal degradation due to attenuation and dispersion: Absorption loss, scattering losses, bending losses, dispersion of light: intermodal dispersion, intra-modal dispersion, material dispersion, waveguide dispersion, polarization mode dispersion, various refractive index profiles. **[8 Lectures]**

Optical sources, quantum efficiency, photo-detectors, coherent/noncoherent optical receivers, fiber joints, fiber connectors and fiber splicing. Optical link design, system design considerations, receiver sensitivities, power penalties, Optical amplifiers, WDM systems, OTDR. **[11 Lectures]**

Challenges and mitigation of high speed optical communication links, concepts of Free-space optical communication, Visible light communication, LiFi, Hybrid Wireless-Optical Broadband-Access Network. **[8 Lectures]**

Course Outcome (CO):

CO1: Understand the fundamental concepts of Optical Communication.
CO2: Learn the transmission of light signal in different fibers such as Step Index, Graded index fibers, Single and Multimode.
CO3: Understand the concepts of optical sources and detectors.
CO4: Learn various causes of signal degradation due to attenuation and dispersion.
CO5: Design short haul and long haul optical communication system and explain advanced optical transmission systems.

References:

1. Gerd Keiser, “Optical Fiber Communications”, McGraw-Hill, 5th Edition.
2. Govind P. Agrawal, “Fiber Optic Communication Systems”, Wiley, 4th Edition.
3. Govind P. Agrawal, “Nonlinear Fiber Optics”, Academic Press, 2nd Edition.
4. John Gowar, “Optical Communication Systems”, Pearson.
5. John M. Senior, “Optical Fiber Communications: Principles and Practice”, 3e: Pearson

Course Code: ECT306	Course Credit: 3
Course Name: Digital System Design & FPGAs	**L-T-P: 3-0-0**
Course Prerequisite: Digital Design	

Course Syllabus:

Sequential Logic Design - Introduction, Basic Bistable Memory Devices, additional bistable devices, reduced characteristics an excitation table for bistable devices. **[6 Lectures]**

Synchronous Sequential Logic Circuit Design - Introduction, Moore, Mealy and Mixed type Synchronous State Machines. Synchronous sequential design of Moore, Melay Machines, **[8 Lectures]**

Algorithmic State Machine - An Algorithm with inputs, digital solution, Implementation of traffic light controller, ASM charts, Design Procedure for ASMs. **[8 Lectures]**

Data path and Control design. **[6 Lectures]**

Introduction to VHDL/Verilog - Data types, Concurrent statements, sequential statements, behavioral modeling. Introduction to programmable logic devices- PALs, PLDs, CPLDs and FPGAs. **[12 Lectures]**

Course Outcome (CO):

CO1: To be able to apply the basic design principles of sequential logic systems.
CO2: To understand the design concepts of synchronous state machines in Moore and Mealy architectures.
CO3: To analyze & design data path, control path design and various programmable devices.
CO4: To be able to implement a digital system using HDLs.

References:

1. Digital System Design, Ercegovac, Wiley.
2. Richard S. Sandige, Modern Digital Design, McGraw-Hill, 1990.
3. Zvi Kohavi, Switching and Finite Automata Theory, Tata McGraw-Hill.
4. Navabi. Analysis and modeling of digital systems. McGraw Hill, 1998.
5. Perry. Modeling with VHDL. McGraw Hill, 1994.
6. Navabi. Verilog Digital Design. McGraw Hill, 2007.
7. Fundamentals of Digital Logic with Verilog Design, Stephen Brown and Zvonko Vranesic, McGraw Hill, 2002.

Course Code: HST302	Course Credit: 2
Course Name: Professional Development	**L-T-P: 2-0-0**
Course Prerequisite: None	

Course Syllabus:

Basics of Professional Communication: Purpose; Audience; Clarity and Precision; Cohesion and Coherence; Tone and style; Using visuals; Ethical issues.
Writing a Statement of Purpose: Introduction and Importance of the SOP, Essential Components, Style, Errors to be avoided, Drafting an effective SOP. **[6 Lectures]**

Personal SWOT Analysis for Professional Development: Introduction and Importance of Personal SWOT Analysis; Identifying one's Strengths, Weaknesses, Opportunities and Threats; Using the Findings to Develop a Short-term and Long-Term Personal Development Plan
Preparing the Cover Letter and Resume: Introduction, Significance and Basic Components of a Cover letter and a Resume; Common errors; Drafting a Good Resume. **[5 Lectures]**

Gearing up for the Interview: Significance and types of Interviews (Face to face, video telephonic,), Interview preparation: company background, refreshing one's theoretical knowledge.
Interview Skills: Personal introduction; Dress code and Personal grooming; Punctuality and Listening skills; Interview Procedure; Important questions; Situation, Task, Approach and Response (STAR Approach) for acing an interview; Errors to be avoided. **[5 Lectures]**

Group Discussion Skills: Introduction and significance; Procedure of conducting GD; Importance of Preparation and Practice; Attitude and Etiquette; Body language during a GD.
Team Skills: Effective Listening; Brainstorming; Negotiation; Communicating in Teams.
Presentation Skills: Introduction and Significance; Planning and Preparing Presentations; Presentation Strategies; Using technology effectively; Handling questions. **[6 Lectures]**

Report-writing: Introduction & Importance, Basic features & components, Types, Structure, Drafting the Report, Using visual elements.
Drafting Executive Summaries: Importance and basic elements; Format and Style.
Writing Emails: Drafting Professional Electronic Mails. Writing Positive, Negative. Persuasive messages. Sending notices, agenda and minutes of a meeting through mails. **[5 Lectures]**

Course Outcome (CO):

CO1: Understand the basics of professional communication.
CO2: Learn the technique of identifying one's professional talents and weaknesses.
CO3: Understand the steps to developing the professional Cover Letter and Resume.
CO4: Learn the techniques to prepare for employment and internship Interviews, and participate in Group Discussions, prepare and deliver effective presentations.
CO5: Learn the essential components and features of reports, executive summaries, and professional emails, and steps to drafting them.

References:

1. Wentz, Fredrick H. Soft skills Training. Amazon Digital Services, 2012
2. Mitra, Barun K. Personality Development and Soft Skills. Oxford University Press, 2016.
3. Sharma, R.C. & Krishna Mohan. Business Correspondence and Report Writing. Tata McGraw Hill, 2020.
4. Desarda, Sheetal. Master the Group Discussion and Personal Interview. Notion Press, 2015.
5. Rizvi, M. Ashraf. Effective Technical Communication, McGraw Hill, 2009.

Course Code: ECD302	Course Credit: 5
Course Name: Skill Transformation based Engineering Project - I	**L-T-P: 0-2-6**
Course Prerequisite: None	
Course Syllabus: The aim of this course is to give an opportunity to the student, under supervision of faculty supervisor, to find a problem which can be researched, apply their subject knowledge to the chosen problem, train the student in the research methodology, cultivate a logical and creative thinking, and to enable them to express their findings in the form of a scientific report.	
Course Outcome (CO):	
References:	

Course Code: ECP308	**Course Credit: 1**
Course Name: Microwave Engineering Lab	**L-T-P: 0-0-2**
Course Prerequisite: RF and Microwave Engineering (ECT307)	

List of Experiments: 1 Lab per experiment

1. Study of Microwave bench and its components.
2. Operation of bench as transmission line and reading operating frequency from DRFM (direct reading frequency meter).
3. Verification of frequency measurement with slotted section.
4. Study of characteristics of reflex klystron.
5. Determination of standing wave ratio and reflection coefficient.
6. Measurement of Low & High VSWR using double minima method.
7. Calculation of impedance of SS tuner using microwave bench.
8. Measurement of Gain and polar radiation pattern of horn antenna using microwave bench.
9. Study of E-plane tee, H-plane tee and magic tee.
10. Study of directional coupler
11. Study of isolator, circulator & attenuator.
12. Study of I-V characteristics of Gunn diode along with frequency measurement.

Course Outcome (CO):

CO1: Understand the operation of waveguides and components based on the same principle.
CO2: Understand the concept of reflex klystron.
CO3: Learn the concept of impedance matching.
CO4: Learn the concept of radiation.

References:

1. R.E. Collin, “Foundation for Microwave Engineering”, Wiley-IEEE Press.
2. D. M. Pozar., “Microwave Engineering” John Wiley & Sons.
3. S. M. Liao, “Microwave Devices and Circuits”, Prentice Hall of India.

Course Code: HSP302	Course Credit: 1
Course Name: Professional Development Lab	**L-T-P: 0-0-2**
Course Prerequisite: None	

Course Syllabus:

Exercises based on Basics of Professional Communication: Purpose; Audience; Clarity & Precision; Cohesion & Coherence; Tone & Style; Using Visuals; Ethical issues.
Statement of Purpose: Drafting an effective SOP; Errors to be avoided. **[2 Labs]**

SWOT Analysis for Professional Development - Identifying one's Strengths, Weaknesses, Opportunities & Threats; Using the Findings to Develop a Short-term and Long-Term Personal Development Plan
Preparing the Cover Letter and Resume: Drafting an Effective Cover Letter and Resume; Common errors to be avoided. **[2 Labs]**

Gearing up for the Interview - Preparing for different types of Interviews (Face to face, telephonic, video), Body language and personal etiquettes.
Interview Skills: Personal introduction; Honing Listening skills; Responses to Important questions; Applying Situation, Task, Approach and Response (STAR Approach) for acing an interview; Errors to be avoided. Mock interview drills. **[3 Labs]**

Group Discussion Skills: Preparation and Practice; Focus on Attitude, Group dynamics and Body language during a GD. Group Discussions for problem solving and decision-making.
Presentation Skills: Practice of Planning and Preparing Presentations; Presentation Strategies; Using technology effectively; Handling questions.
Team Skills: Practice of Brainstorming; Negotiation; Communicating in Teams; Effective Listening; Team-building activities. **[3 Labs]**

Report-writing: Drafting different types of Reports, Using visual elements.
Executive Summaries: Preparing Executive Summaries of documents
Professional Emails: Drafting professional Emails. Writing Positive, Negative, Persuasive messages. Sending notices, agenda & minutes of a meeting through mails. **[2 Labs]**

Course Outcomes (CO):

CO1: Understand the basics of professional communication.
CO2: Learn the technique of identifying one's professional talents and weaknesses.
CO3: Understand the steps to developing the professional Cover Letter and Resume.
CO4: Learn the techniques to prepare for employment and internship Interviews, participate in Group Discussions, prepare effective Presentations.
CO5: Learn the essential components and features of reports, executive summaries, and professional emails, and steps to drafting them.

References:

1. Raman, Meenakshi, Sangeeta Sharma. Professional Communication. Oxford University Press, 2018
2. Mitra, Barun K. Personality Development and Soft Skills. Oxford University Press, 2016.
3. Sharma, RC & Krishna Mohan. Business Correspondence and Report Writing. Tata McGraw Hill, 2020.
4. Desarda, Sheetal. Master the Group Discussion and Personal Interview. Notion Press, 2015.
5. Rizvi, M. Ashraf, Effective Technical Communication, McGraw Hill, 2009.
6. Prince, Emma Sue. Practical Business Communication (Macmillan Study Skills), 2017.

Course Code: OTT401 (7th Sem) / OTT402 (8th Sem)	Course Credit: 2
Course Name: Living Ethics	**L-T-P: 2-0-0**
Course Prerequisite: The learner should have interest in learning about ethics in everyday life	

Course Syllabus:

Introduction to Ethics- What Does It Mean to Be "Ethical"? The rising urgency for ethics in a pluralistic society, Sustainable Development and the Need for Ethics in Action **[4 Lectures]**
Professional Ethics & Personal Value- Dealing with ethical dilemmas at workplace, Leadership and Ethics, Ethics and Responsibility for all stakeholders at workplace, Breaking the glass ceiling-Gender and Ethics at workplace [**7 Lectures]**
Academic Ethics- From working 'on' the community to working 'with' the community, Ethical consideration in research, Dealing with the stakeholders with Ethics, Ethics in publication **[8 Lectures]**
Ethics in the age of social media- Discussing social media use, which takes the form of hate speech, increased surveillance, lack of anonymity and questionable use of our data. What ethical considerations do we need to follow to use social media spaces effectively, in a way that is safe and productive for all? **[8 Lectures]**

Course Outcome (CO):

CO1: Understand the fundamentals of living ethics
CO2: Learn the central issues of living ethics and also considers how these can be applied to several contemporary issues.
CO3: Understand interdisciplinary perspectives and thematic issues in the fields of ethics and enable learners to reflect on major ethical dilemmas arising in everyday life.

References:

1. Adams, R. B., & Funk, P. (2012). Beyond the glass ceiling: Does gender matter? Management science, 58(2), 219-235.
2. Biedenweg, K., Monroe, M. C., & Oxarart, A. (2013). The importance of teaching ethics of sustainability. International Journal of Sustainability in Higher Education.
3. Hoke, T. (2012). A question of ethics: The importance of understanding engineering ethics. Civil Engineering Magazine Archive, 82(5), 40-41.
4. Iphofen, R., & Tolich, M. (Eds.). (2018). The SAGE handbook of qualitative research ethics. Sage.
5. Macfarlane, B., Zhang, J., & Pun, A. (2014). Academic integrity: a review of the literature. Studies in Higher Education, 39(2), 339-358.
6. Resnik, D. B. (2015, December). What is ethics in research & why is it important. In ideas.
7. Singer, P. (2011). Practical ethics. Cambridge university press.
8. Wellman, M. L., Stoldt, R., Tully, M., & Ekdale, B. (2020). Ethics of authenticity: social media influencers and the production of sponsored content. Journal of Media Ethics, 35(2), 68-82.

Course Code: ECD401 (7th Sem) / ECD402 (8th Sem)	Course Credit: 5
Course Name: Skill Transformation based Engineering Project - II	**L-T-P: 0-2-6**
Course Prerequisite: None	
Course Syllabus: The aim of this course is to give an opportunity to the student, under supervision of faculty supervisor, to find a problem which can be researched, apply their subject knowledge to the chosen problem, train the student in the research methodology, cultivate a logical and creative thinking, and to enable them to express their findings in the form of a scientific report.	
Course Outcome (CO):	
References:	

Course Code: OTD402 (8th Sem) / OTD401 (7th Sem)	Course Credit: 10
Course Name: Internship and Training for Skilled Engineering Practice	**L-T-P: 0-0-20**
Course Prerequisite: None	
Course Syllabus: The aim of this course is to give an opportunity to the student, under supervision of IIIT Kota faculty supervisor and institute project mentor, to undertake internship and training at approved premier institutions for practical knowledge, skill transformation and career growth. At the end of the course, student is expected to prepare a technical report on work done, and present it.	
Course Outcome (CO):	
References:	

Course Code: ECTXXX	**Course Credit: 3**
Course Name: Advanced Digital Communication	**L-T-P: 3-0-0**
Course Prerequisite: Analog Communication, Digital Communication	

Course Syllabus:

Review of random variables and random process, signal space concepts, Common modulated signals and their power spectral densities, optimum receivers for Gaussian channels, Coherent and non-coherent receivers and their performance. **[8 Lectures]**

Basics of Information theory, source and channel coding, capacity of channels, band-limited channels and ISI, multicarrier and spread-spectrum signaling, multiple access techniques. **[8 Lectures]**

Matched Filter, Error Rate due to Noise. Intersymbol Interference, Nyquist's Criterion, Duobinary Signaling. optimum Linear Receiver, Geometric Representation of Signals. **[8 Lectures]**

Coherent Detection of Signals in Noise, Probability of Error. Coherent Digital Modulation Schemes: MPSK, MFSK, MQAM; Error Analysis. Noncoherent FSK, Differential PSK. **[8 Lectures]**

Comparison of Digital Modulation Schemes, Bandwidth Efficiency. Pseudo-Noise Sequences and Spread Spectrum, Trellis coded modulation, Digital signaling over fading multipath channels, OFDM communications systems. **[8 Lectures]**

Course Outcome (CO):

CO1: Understand the various blocks that constitute a digital communication system and understand how they interrelate.
CO2: main concepts and techniques used in the analysis and design of digital communication systems
CO3: Be able to qualitatively and quantitatively analyze and evaluate digital communication systems
CO4**:** Recognize the broad applicability of digital communication systems in society

References:

1. B. Sklar, 'Digital Communications: Fundamentals and Applications', Prentice Hall, 2nd edition
2. T. Cover, J. Thomas, 'Elements of Information Theory', Wiley, 2nd edition
3. R. G. Gallager, 'Principles of Digital Communication', Cambridge University Press

Course Code: ECTXXX	Course Credit: 3
Course Name: Advanced Digital Signal Processing	**L-T-P: 3-0-0**
Course Prerequisite:	
Course Syllabus: Review of sampling theory. Sampling rate conversion by integer and rational factors. Efficient realization and applications of sampling rate conversion. **[4 Lectures]** Wiener filtering. Optimum linear prediction. Levinson-Durbin algorithm. Prediction error filters. Adaptive filters. FIR adaptive LMS algorithm. Convergence of adaptive algorithms. Fast algorithms. Applications: Noise canceller, echo canceller and equalizer. **[12 Lectures]** Recursive least squares algorithms. Matrix inversion lemma. Convergence analysis of the RLS algorithm. Adaptive beam forming. Kalman filtering. **[12 Lectures]** Spectrum estimation. Estimation of autocorrelation. Periodogram method. Nonparametric methods. Parametric methods. **[12 Lectures]**	
Course Outcome (CO):	
References: 1. J.G. Proakis, M. Salehi, “Advanced Digital Signal Processing”, McGraw–Hill, 1992. 2. S. Haykin, “Adaptive Filter Theory”, Prentice-Hall, 1996. 3. D.G. Manolakis, V. K. Ingle, S. M. Kogon , ”Statistical and Adaptive Signal Processing”, McGraw-Hill, 2005 4. S.L. Marple, ”Digital Spectral Analysis”, 1987. 5. M.H. Hays,” Statistical Digital Signal Processing and Modeling”, John-Wiley, 2001.	

Course Code: ECTXXX	Course Credit: 3
Course Name: Advanced Microwave Engineering	**L-T-P: 3-0-0**
Course Prerequisite: RF and Microwave Engineering	

Course Syllabus:

Smith chart and impedance matching techniques: Reflection coefficient, VSWR, Need of impedance matching at microwave frequency, Smith chart, Application of Smith chart for finding unknown impedance, Lumped element based impedance matching, Distributed impedance matching, broadband impedance matching. **[10 Lectures]**

Scattering parameter: Introduction and properties of S-matrix, S-matrix for lossless junction, two-port junction, Transmission matrix representation, Relation between S-parameter and Transmission parameters. **[6 Lectures]**

Passive circuit design: Terminations, Phase shifters, Review of directional coupler, Branch-line coupler, Power dividers, Rat race junction. **[8 Lectures]**

Microwave filters: Introduction, Image parameter method, Insertion loss method, Low pass filter design, Frequency transformations. **[6 Lectures]**

Microstrip Antennas: Basic characteristics, types and feeding methods of microstrip antennas, Analysis of rectangular microstrip antennas using simplified models. **[10 Lectures]**

Course Outcome (CO):

CO1: Become well versed with the working on Smith chart.
CO2: Perform scattering parameter analysis for RF circuits.
CO3: Learn to design passive circuits for microwave circuits.
CO4: Understand the design principle of microwave filters.
CO5: Understand and design various microstrip antennas.

References:

1. Foundation for Microwave Engineering; R.E. Collin.
2. Broadband microstrip antenna; Girish Kumar, K.P.Ray

Course Code: ECTXXX	**Course Credit: 3**
Course Name: Advanced Optical Communication	**L-T-P: 3-0-0**
Course Prerequisite: Optical Communication	

Course Syllabus:

Overview of optical fiber communication, advanced fiber design: Dispersion issues, Dispersion shifted, Dispersion flattened, Dispersion compensating fiber, Design optimization of single mode fibers. Nonlinear effects in fiber optic links. Concept of self- phase modulation, group velocity dispersion and soliton based communication. **[8 Lectures]**

Designing and working principle of various optical components, Passive optical splitter, Isolators, Circulator, Arrayed waveguide grating, Fiber Bragg grating, Fiber grating filters, and Diffraction grating etc. **[8 Lectures]**

Advanced transmitter and receiver designs, optical modulation techniques, receiver sensitivity and degradation. Optical receiver performance calculation - noise effect on system performance, rise time and power budget link analysis. **[8 Lectures]**

Semiconductor laser amplifiers, Raman amplifiers, Erbium doped fiber amplifiers, pumping phenomenon, LAN and cascaded in-line amplifiers. Limitations, Post- and Pre-compensation techniques, equalizing filters. **[8 Lectures]**

Optical system performance analysis, BER measurement, sensitivity degradation, power penalty against various system parameters, Multichannel, WDM, multiple access networks, WDM Components, TDM, Next Generation Optical Network, Flexibility, Reliability, Scalability and latency awareness in Optical Networks. **[8 Lectures]**

Course Outcome (CO):

CO1: Understanding of various fiber design concepts and nonlinear effects.
CO2: Understanding of designing concepts and working principle of various optical components.
CO3: Analyze different modulation schemes along with their system performance, various detection schemes.
CO4: Designing of advanced transmitters, receivers.
CO5: Evaluate the performance of optical communication systems under high power conditions and various non-linear effects.
CO6: Understanding of the next generation optical network with various issues including Flexibility, Reliability, Scalability and latency awareness.

References:

1. Gerd Keiser, “Optical Fiber Communications”, McGraw-Hill, 5th Edition.
2. Govind P. Agrawal, “Fiber Optic Communication Systems”, Wiley, 4th Edition.
3. Govind P. Agrawal, “Nonlinear Fiber Optics”, Academic Press, 2nd Edition.
4. John Gowar, “Optical Communication Systems”, Pearson.
5. John M. Senior, “Optical Fiber Communications: Principles and Practice”, 3e: Pearson

Course Code: ECTXXX	**Course Credit: 3**
Course Name: Advance Wireless Communication	**L-T-P: 3-0-0**
Course Prerequisite: Wireless and Mobile Communication	

Course Syllabus:

Wireless Propagation Channel: Physical Modeling for Wireless Channels, Time and Frequency Coherence, Statistical Channel Models and the concept of diversity. **[10 Lectures]**

Fading channel characterization and modeling: Concept of classical and generalized fading distributions, characterization of the fading channel, Modeling of flat fading channel, Lognormal shadowing, Composite multipath fading, Frequency selective fading channel. **[10 Lectures]**

UWB Technology: Definition of UWB, FEC mask, properties and limitation of UWB signal. UWB channel Modelling: IEEE 802.15.3a and IEEE 8032.15.4a standards and applications. **[6 Lectures]**

mmWave technologies: Concept of mmWave communication, channel characterization and resource allocation in mmWave communication, MIMO-mmWave, IEEE 802.15.3c WPAN standard and smart antenna technologies. **[8 Lectures]**

5G and beyond wireless technologies: OFDM-MIMO, OFDM-IM, antenna beam forming, Spatial Modulation and concept of LTE and LTE-A. **[6 Lectures]**

Course Outcome (CO):

CO1: Understand the concept of MU-MIMO
CO2: Understand the concept of potential technologies for 5G
CO3: Understand the concept diversity and smart antenna technologies
CO4: Understand the concept of UWB and mmWave technologies.

References:

1. R. S. Kshetrimayum, Fundamentals of MIMO Wireless Communications, Cambridge University Press, 2017.
2. S. Emami, UWB Communication Systems: Conventional and 60 GHz, 2013
3. Chung G. Kang, Jaekwon Kim, Wŏn-yŏng Yang, and Yong Soo Cho, “MIMO-OFDM Wireless Communications with MATLAB”, John Wiley & Sons, 2010.
4. Marvin k. Simon and Mohd. Slim Alouini, ”Digital Communication over Fading Channel”, Wiley, 2005.
5. Goldsmith, “Wireless Communication”, Cambridge University Press, 2005

Course Code: ECTXXX	**Course Credit: 3**
Course Name: Antenna Theory and Design	**L-T-P: 3-0-0**
Course Prerequisite: RF and Microwave Engineering	

Course Syllabus:

Fundamental Concepts: Radiation mechanism, Radiation pattern, near-and far-field regions, reciprocity, directivity and gain, bandwidth, quality factor, effective aperture, polarization, input impedance, efficiency, Friis transmission equation, reciprocity theorem, vector potentials for electric and magnetic current sources. **[6 Lectures]**

Radiation from Wires and Loops: Infinitesimal dipole, finite-length dipole, linear elements near conductors, dipoles for mobile communication small circular loop. **[10 Lectures]**

Antenna Arrays: Analysis of uniformly spaced Two-element and N-element linear arrays with uniform and non-uniform amplitudes excitation, extension to planar arrays, synthesis of antenna arrays. **[10 Lectures]**

Aperture Antennas: Field equivalence/ Huygens', Principle, radiation from rectangular and circular apertures, design considerations, Babinet's principle. **[8 Lectures]**

Microstrip Antennas: Basic characteristics of microstrip antennas, feeding techniques, methods of analysis, design of rectangular and circular patch antennas, microstrip antenna arrays and feed networks, basics of active antennas. **[6 Lectures]**

Course Outcome (CO):

CO1: Learn the fundamentals of antennas.
CO2: Understand how wire or loop antennas radiate
CO3: Understand the fundamentals of antenna arrays.
CO4: Learn about basics of aperture antennas.
CO5: Analyse and design microstrip antennas.

References:

1. Antenna Theory: Analysis and Design, Constantine A. Balanis, Wiley, Indian Edition, 2005.
2. Antenna and Wave propagation, J D Kraus, TMH.
3. Jordan and Balmain, "Electromagnetic Waves and Radiating Systems", PHI.

Course Code: ECTXXX	Course Credit: 3
Course Name: Biomedical Measurement and Instrumentation	**L-T-P: 3-0-0**
Course Prerequisite:	
Course Syllabus: Introduction to bio-medical Instrumentation: Definition, concepts, significance& scope of topic, fields of biomedical engineering, classification of biomedical instruments, roots, prefixes, suffixes in media terminology, Biometrics, Man-instrument system, Physiological systems of body, Challenges in measuring a living system. Transducers for bio-medical applications, Signal conditioning techniques, Bioelectode potential, biopotential amplifiers, bio-electrodes **[12 Lectures]** Cardiovascular system: Functioning of heart, measurement of blood pressure, blood flow, pulse rate, heart sound, ECG. Respiratory Systems: Physiology, tests and instruments. Nervous Systems: Anatomy, instrumentation, EEG, EMG, EOG, EEG, ERG. Sensory and behavioural measurements: psycho physiological measurements, GSR. **[14 Lectures]** X-RAY and Radioisotope instrumentation. Imaging systems [Ultrasonic, MRI, CT, PET etc.]. Therapeutic and prosthetic devices. Clinical laboratory instruments. Electrical safety of biomedical equipment. Lasers and fiberoptic in medical instrumentation. Patient monitoring systems. ITC in bio-medical instrumentation. **[14 Lectures]**	
Course Outcome (CO):	
References: 1. Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, “Biomedical Instrumentation and Measurements”, PHI, New Delhi, 2nd Edition. 2. J.J. Carr, J.M. Brown, “Introduction to Biomedical Equipments & Technology”, Pearson Education, 4th Edition. 3. Mandeep Singh, “Introduction to biomedical instrumentation”, EEE edition 4. John G Webster, “Medical Instrumentation Application and Design”, John Wiley & Sons 5. R.S. Khandpur, “Handbook of biomedical instrumentation”, Tata McGraw-Hill	

Course Code: ECTXXX	**Course Credit: 3**
Course Name: Computational Electromagnetics	**L-T-P: 3-0-0**
Course Prerequisite: RF and Microwave Engineering	

Course Syllabus:

Overview: Review of vector calculus, Review of Maxwell's equations, Review of numerical integration, Overview of computational electromagnetics. **[5 Lectures]**

Integral equation methods: Introduction to integral equations, Surface integral equations: mathematical derivation of Huygen's principle, Introduction to Green's functions: 1D example of string, 2D and 3D wave equation, Solving integral equations using the method of moments (MoM). **[10 Lectures]**

Finite element methods: History of FEM, FEM in the method of moments framework; 1 and 2D basis functions in FEM, solving 1D wave equation using FEM, 2D edge-based (vector) FEM. **[10 Lectures]**

Finite Difference Time Domain methods: Introduction to FDTD: update equations, Analysis, convergence, accuracy and numerical dispersion, absorbing boundary conditions, failure of ABCs and introduction of perfectly matched layers (PML). **[10 Lectures]**

Application of computational electromagnetics: Microwave inverse imaging, Antenna radiation problems, Calculating the modes of a waveguide structure using the integral equation method, Hybrid methods in CEM -- Finite Element - Boundary Integral method. **[5 Lectures]**

Course Outcome (CO):

CO1: Understand the need of computational electromagnetics.
CO2: Learn the concepts of Integral equation method.
CO3: Understand the fundamentals of FEM.
CO4: Analyze problems using FDTD method.

References:

1. Advanced Engineering Electromagnetics; C A Balanis
2. Finite Element Method for Electromagnetics: Antennas, Microwave Circuits, and Scattering Applications; Volakis1, Chatterjee, and Kempel

Course Code: ECTXXX	**Course Credit: 3**
Course Name: Digital Image Processing	**L-T-P: 3-0-0**
Course Prerequisite: None	

Course Syllabus:

Digital Image Processing Fundamentals and Examples, Mathematical Operations used in Digital Image Processing **[6 Lectures]**

Image Enhancements using Intensity Transformations and Filtering Applications in Spatial and Frequency domains, Image Restoration and Reconstruction **[12 Lectures]**

Colour Image Processing, Image Compression, Morphological Image Processing **[12 Lectures]**

Overview of Image Segmentation, Pattern Description and Recognition **[10 Lectures]**

Course Outcome (CO):

CO1: Learn about fundamentals of digital signal processing
CO2: Learn about image enhancement techniques in the time-domain and frequency-domain
CO3: Learn about advanced image processing techniques like color image processing, image compression, and morphological image processing
CO4: Learn about concepts related to pattern recognition and description

References:

1. Rafael C. Gonzalez, Richard Eugene Woods, “Digital Image Processing”, Prentice Hall, 3rd Edition.
2. S. Sridhar, “Digital Image Processing”, Oxford University Press, 2011
3. Chris Solomon, Toby Breckon, ‘’ Fundamentals of Digital Image Processing A Practical Approach with Examples in Matlab’’, Wiley, 2011
4. John C. Russ, ‘’The Image Processing Handbook’’, CRC Press, 2006
5. Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins, ‘’ Digital Image Processing Using MATLAB’’, McGraw Hill, 2010

Course Code: ECTXXX	Course Credit: 3
Course Name: Electromagnetic Interference and Compatibility	**L-T-P: 3-0-0**
Course Prerequisite: Electromagnetic Theory	

Course Syllabus:

Basic Concepts: Introduction and Definition of EMI and EMC with examples, various Parameters, Sources of EMI, EMI coupling modes - CM and DM, ESD Phenomena and effects, Transient phenomena and suppression, Various issues of EMC, EMC Testing categories. **[7 Lectures]**

Coupling Mechanism: Electromagnetic field sources and Coupling paths, Coupling via the supply network, Common mode coupling, Differential mode coupling, Impedance coupling, Inductive and Capacitive coupling, Radiative coupling, Ground loop coupling, Cable related emissions and coupling, Transient sources, Automotive transients. **[7 Lectures]**

EMI Mitigation Techniques: Working principle of Shielding and Murphy's Law, LF Magnetic shielding, Apertures and shielding effectiveness, Choice of Materials for H, E, and free space fields, Gasketting and sealing, PCB Level shielding, Principle of Grounding, Isolated grounds, Grounding strategies for Large systems, Grounding for mixed signal systems, Filter types and operation, Surge protection devices, Transient protection. **[7 Lectures]**

Standards and Regulations: Need for Standards, Generic/General Standards for Residential and Industrial environment, Basic Standards, Product Standards, National and International EMI Standardizing Organizations; IEC, ANSI, FCC, AS/NZS, CISPR, BSI, CENELEC, ACEC. Electromagnetic Emission and susceptibility standards and specifications, MIL461E Standards. **[9 Lectures]**

Measurement Methods and Instrumentation: Fundamental considerations, EMI Shielding effectiveness tests, Open field test, TEM cell for immunity test, Shielded chamber , Shielded anechoic chamber, EMI test receivers, Antennas, LISN, Feed through capacitor, current probe, EMC analyzer , Spectrum analyzer, EMI test wave simulators, EMI coupling networks, Line impedance stabilization networks, Feed through capacitors, Current probes, MIL -STD test methods. **[10 Lectures]**

Course Outcome (CO):

CO1: Explain the requirement of EMI & EMC concept and impart knowledge on different units and standards used for Electromagnetic compatibility in electronic/electric systems
CO2: Analyze, measure and evaluate radiated and conducted emissions to examine the electromagnetic compatibility.
CO3: Analyze and evaluate the impact of EMI mitigation techniques such as shielding and grounding.
CO4: Explain the impact of EMI on system design.

References:

1. Clayton R.Paul, Introduction to Electromagnetic Compatibility, John Wiley & Sons.
2. Ott, W. Henry, Electromagnetic Compatibility Engineering, John Wiley & Sons,
3. V. P. Kodali, "Engineering EMC Principles, Measurements and Technologies" 1996, IEEE Press, New York.

Course Code: ECTXXX	**Course Credit: 3**
Course Name: Industrial Microwave	**L-T-P: 3-0-0**
Course Prerequisite: Electromagnetic Theory, RF and Microwave Engineering	

Course Syllabus:

W**aveguide Components:** Overview of Attenuators, Phase Shifters, Matched Loads, Detector Mounts, slotted sections, E and H Plane Tees, etc. Signal Generators: Fixed Frequency, Sweep frequency and synthesized frequency oscillators, PLL for high frequency generation **[10 Lectures]**

Industrial Microwave: Noise Sources and Noise meters used in microwave measurements, frequency meters and VSWR meters, Measurement of frequency, attenuation, VSWR and impedance, cavity measurements: Q factor, bandwidth; Dielectric and magnetic properties of materials: Cavity and waveguide methods, Measurement of Power: Calorimetric and Microwave bridges; principles of Time and frequency domain reflectometry, Spectrum Analyzer and Network Analyzer, Measurement of Scattering parameters of passive and active devices **[10 Lectures]**

Processes in Industrial Microwave: Microwave in process control instrumentation, Microwave waste disposal, Microwave in agriculture and medicine, hyperthermia, etc. Microwave Heating, Microwave absorbers, EMC and EMI. **[10 Lectures]**

Microwave Communication: Microwave Radio and its components, Free space propagation model, ground reflection, Earth and its effect on propagation, Clutter theory, Fresnel Zones: First and Second order Fresnel Zones, Signature width of radio, tolerance limits, Practical Link Budget calculations, Atmospheric Attenuation **[10 Lectures]**

Course Outcome (CO):

CO1. Become familiar with the industrial microwave devices and components
CO2. Be able to do measurements of various microwave parameters
CO3. Understand the different types of processes in industrial microwave.
CO4. Will learn how radio waves get transmitted through space.

References:

1. Microwave Devices and Circuits, Samuel Y Liao, Pearson Education.
2. Microwave Engineering, David M Pozar, Wiley.
3. T.S. Rappaport, “Wireless Communications,” Pearson Education

Course Code: ECTXXX	**Course Credit: 3**
Course Name: MIMO Wireless Communication	**L-T-P: 3-0-0**
Course Prerequisite: Wireless and Mobile Communication, Probability and Random Processes	

Course Syllabus:

Introduction: Evolution of wireless generation technologies and their transition challenges. Need and expectation of 5G and beyond wireless technology. Introduction of Diversity-multiplexing trade-off, combining techniques, advantages and applications of MIMO systems. **[8 Lectures]**

Analytical MIMO channel models: MIMO Channels, ergodic and deterministic Capacity for SISO and MIMO system, Capacity of i.i.d., separately correlated and keyhole Rayleigh fading MIMO channels. Power allocation in MIMO systems: Uniform, adaptive and near optimal power allocation, classical channel fading distributions. **[10 Lectures]**

Space-Time codes: Advantages, code design criteria, Alamouti space-time codes, SER analysis of Alamouti space-time code over fading channels, Space-time block codes, Space-time trellis codes, Performance analysis of Space-time codes over separately correlated MIMO channel, Space-time turbo codes. **[8 Lectures]**

MIMO detection: ML, ZF, MMSE, ZF-SIC, MMSE-SIC, LR based detection. **[8 Lectures]**

Advances in MIMO wireless communications: Spatial modulation, MIMO based cooperative communication and cognitive radio, multiuser MIMO and large MIMO systems for 5G wireless. **[6 Lectures]**

Course Outcome (CO):

CO1: Understand the concept of various wireless generation.
CO2: Understand the concept of multi antenna technologies.
CO3: Able to investigate the wireless systems under various propagation environments.

References:

1. R. S. Kshetrimayum, Fundamentals of MIMO Wireless Communications, Cambridge University Press, 2017.
2. B. Kumbhani and R. S. Kshetrimayum, "MIMO Wireless Communications over Generalised Fading Channels", 2017.
3. Mohinder Janakiraman, "Space-Time Codes and MIMO Systems", Springer New York, 2004.
4. David Tse and Pramod Viswanath," fundamentals of wireless communication", Cambridge university press, December 2004.

Course Code: ECTXXX	**Course Credit: 3**
Course Name: Pattern Recognition	**L-T-P: 3-0-0**
Course Prerequisite: Basic probability and algebra	

Course Syllabus:

Basics of Probability, Random Processes and Linear Algebra: Probability: independence of events, conditional and joint probability, Bayes' theorem; Random Processes: Stationary and non-stationary processes, Expectation, Autocorrelation, Cross-Correlation, spectra; Linear Algebra: Inner product, outer product, inverses, eigen values, eigen vectors; Bayes Decision Theory **[8 Lectures]**

Bayes Decision Theory: Minimum-error-rate classification, Classifiers, Discriminant functions, Decision surfaces, Normal density and discriminant functions, discrete features
Parameter Estimation Methods: Maximum-Likelihood estimation: Gaussian case; Maximum a Posteriori estimation; Bayesian estimation: Gaussian case **[8 Lectures]**

Unsupervised learning and clustering: Criterion functions for clustering; Algorithms for clustering: K-Means, Hierarchical and other methods; Cluster validation; Gaussian mixture models; Expectation-Maximization method for parameter estimation; Maximum entropy estimation **[7 Lectures]**

Sequential Pattern Recognition: Hidden Markov Models (HMMs); Discrete HMMs; Continuous HMMs **[4 Lectures]**

Nonparametric techniques for density estimation: Parzen-window method; K-Nearest Neighbour method **[3 Lectures]**

Dimensionality reduction: Fisher discriminant analysis; Principal component analysis; Factor Analysis **[4 Lectures]**

Linear discriminant functions: Gradient descent procedures; Perceptron; Support vector machines **[3 Lectures]**

Non-metric methods for pattern classification: Non-numeric data or nominal data; Decision trees: CART **[3 Lectures]**

Course Outcome (CO):

References:

1. R. O. Duda, P. E. Hart and D. G. Stork, Pattern Classification, John Wiley, 2001
2. S. Theodoridis and K. Koutroumbas, Pattern Recognition, 4th Ed., Academic Press, 2009
3. C. M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006

Course Code: ECTXXX	Course Credit: 3
Course Name: Satellite Communication	**L-T-P: 3-0-0**
Course Prerequisite: Analog Communication, Digital Communication	

Course Syllabus:

Introduction: A Brief History of Satellite Communications, Satellite Communications in Today's world, Overview of Satellite Communications. Orbital Mechanics and Launchers Orbital Perturbations, Orbital Effects in Communications Systems Performance. **[8 Lectures]**

Satellite Subsystems, Equipment Reliability and Space Qualification. Satellite Link Design: Transmission Theory, System Noise Temperature and G/T Ratio, Design of Downlinks, Ku-Band GEO Satellite Systems, Uplink Design, Design for Specified CNR: Combining CNR and C/I Values in Satellite Links, System Design for Specific Performance. **[8 Lectures]**

Digital Transmission and Error Control: Digital Transmission, Implementing Zero ISI Transmission in the Time Domain, Probability of Error in Digital Transmission, Digital Transmission of Analog Signals, Time Division Multiplexing, Packets, Frames, and Protocols, Error Control. Modulation and Multiple Access: Digital Modulation, Frequency Division Multiple Access (FDMA), Time Division Multiple Access (TDMA), Synchronization in TDMA Networks, Demand Assignment Multiple Access (DAMA), Random Access (RA), Packet Radio Systems and Protocols, Code Division Multiple Access. **[8 Lectures]**

Propagation Effects and Their Impact on Satellite-Earth Links: Propagation Phenomena, Quantifying Attenuation and Depolarization, Propagation Effects That are Not Associated with Hydrometeors, Rain and Ice Effects, Prediction of Rain Attenuation, Prediction of XPD, Propagation Impairment Countermeasures. **[5 Lectures]**

Applications and Advances in Satellite Communication: Low Throughput Mobile Communications Satellite Systems, VSAT Systems, NGSO Satellite Systems, Direct Broadcast Satellite Television and Radio, Satellite Internet, Relay Satellite etc. **[11 Lectures]**

Course Outcome (CO):

CO1: Able to understand the fundamentals of satellite communication
CO2: Able to understand the information exchange between the two earth stations.
CO3: Understand the modulation and multiplexing techniques of satellite communication.
CO4: Understand the multiple access schemes used in satellite communication.

References:

1. T. Pratt, Ch. Bostain, J.Allnutt, Satellite Communications, 2nd edition, John Wiley & Sons, 1986.
2. D. Roddy, Satellite Communications, 3rd ed., McGraw-Hill, 2001
3. B. Elbert, Introduction to Satellite Communications, 2nd ed., Artech House, 1999
4. Pritchard Wilbur Satellite Communications Systems Engineering", 2nd Edition, Pearson India (2003)

Course Code: ECTXXX	**Course Credit: 3**
Course Name: Advanced CMOS and Beyond CMOS	**L-T-P: 3-0-0**
Course Prerequisite:	

Course Syllabus:

Review of CMOS scaling. Problems with traditional geometric scaling. Power crisis. CMOS Technology Evolution, Dual Gate CMOS Technology, High-K dielectric CMOS, Gate-All-Around and Vertical MOS concept **[8 Lectures]**

Mobility enhancement techniques. Review of stress and strain and how it affects band structure of silicon. Types and realization of stress elements. Problem with stress elements. Gate oxide scaling trend. High k material selection. Fermi level pinning. Process integration of high k gate dielectrics and metal gates. **[8 Lectures]**

Beyond CMOS options, Tunnel Junction Devices, Carbon Nanotube FETs, Graphene devices, Spintronic, Photonics **[8 Lectures]**

More-Than Moore Nanosystems, RF Systems, Biochips, Advances in Memory and processors **[8 Lectures]**

Multi-gate transistors, realization, Fabrication issues and integration challenges. Ultra-shallow junctions. Dopant activation methods. Reduction of parasitic RC Interconnects, advance layout concepts and layout dependent effects. Basics of sub wavelength lithography. **[8 Lectures]**

Course Outcome (CO):

CO1: Able to know the basics of modern CMOS devices for better performance
CO2: To be able to work on advanced devices and to know, how the design-technology interaction needed for a successful implementation for system design

References:

1. International Technological RoadMap for Semiconductors
2. Selected Research papers from reputed journals and proceedings
3. J. P. Colinge, “FinFETs and Other Multi-Gate Transistors,” Springer, 2010.
4. S. Deleonibus, “Electronic Device Architectures for the Nano-CMOS Era,” Pan Stanford 2009
5. B. Wong, A. Mittal, Y. Cao, G. Starr, “Nano-CMOS Circuit and Physical Design”, Wiley Inter-science 2004
6. B. Wong, F. Zach, V. Moroz, A. Mittal, G. Starr, A. Kahng, “Nano-CMOS Design for Manufacturability”, Wiley 2009
7. Yongke Sun, Scott E. Thompson, Toshikazu Nishida, “Strain Effect in Semiconductors: Theory and Device Applications”, Springer 2010
8. Hei Wong , “Nano-CMOS Gate Dielectric Engineering,” CRC, 2011.
9. Journal Papers and ITRS Road map Reports

Course Code: ECTXXX	**Course Credit: 3**
Course Name: Analog CMOS IC Design	**L-T-P: 3-0-0**
Course Prerequisite:	
Course Syllabus: Introduction to Analog IC Design, The Design Flow of Analog ICs, MOSFET Parameters, MOSFET models, MOS Diode, MOS Capacitors, MOS Switch, Noise in MOSFETs **[8 Lectures]** MOS Current sources and current sink circuits, Voltage and Current reference circuits **[8 Lectures]** MOS Amplifiers, Source Followers, Differential Amplifiers, Operation Amplifiers, Stability Analysis, Theory and Compensation in CMOS Operational Amplifiers, Op-amp Design Techniques and practical consideration in design of Op-amp, High Performance CMOS Op-amp Design **[10 Lectures]** Design of MOS Comparators, Data Converter Fundamentals, Digital-to-Analog Converters, Analog-to-Digital Converters, Switch Capacitor Filters **[10 Lectures]** Mismatch Issues in Analog Layouts, Phase locked loop **[4 Lectures]**	
Course Outcome (CO): CO1: To be versed with fundamentals, modelling and analysis of MOSFET based circuits. CO2: To be able to analyse and design analog and mixed mode circuits such as Differential Amplifier, OP-AMP, Current mirrors, Biasing circuits, Comparator, ADCs, DACs, PLL etc. CO3: To be able to solve practical analog IC design problems to cater the needs of VLSI industries.	
References: 1. Design of Analog CMOS Integrated Circuits, Behzad Razavi, McGraw-Hill 2. Analog Integrated Circuit Design, David Johns and Ken Martin, Wiley 3. CMOS Analog Circuit Design, Phillip e. Allen, Oxford 4. R. J. Baker, H. W. Li, D. E. Boyce, CMOS Circuit Design, Layout, and Simulation, PHI, 2002	

Course Code: ECTXXX	**Course Credit: 3**
Course Name: MEMS and NEMS	**L-T-P: 3-0-0**
Course Prerequisite:	
Course Syllabus:	
Course Outcome (CO):	
References:	

Course Code: ECTXXX	Course Credit: 3
Course Name: Nanoelectronic Devices Modeling and Simulation	**L-T-P: 3-0-0**
Course Prerequisite:	
Course Syllabus: Introduction to Quantum Mechanics: Principle of Quantum Mechanics, Schrodinger's wave equation, Application of Schrodinger's wave equation, extension of wave theory to atoms. **[5 Lectures]** Introduction to the Quantum Theory of Solids: Electrical conductions in solids, Drift current, Density of states function, Statistical mechanics. **[5 Lectures]** The Semiconductor in Equilibrium: Charge carriers in semiconductor, Dopant atoms and energy levels, Extrinsic semiconductor, Statistics of donors and acceptors, charge neutrality, position of Fermi level. **[5 Lectures]** Carrier Transport Phenomena: Carrier drift, carrier diffusion, Hall effect, graded impurity distribution. **[5 Lectures]** Non equilibrium excess carriers: Carrier generation and recombination, Characteristics of excess carriers, Ambipolar transport, Quasi-Fermi energy level. The PN Junction: Basic structures of the PN junction, Zero bias condition, forward bias, reverse bias condition. **[5 Lectures]** The PN Junction Diode: PN junction current, small signal model of PN junction, generation-recombination current, junction breakdown, charge storage and diode transient. **[5 Lectures]** Fundamentals of the Metal-Oxide-Semiconductor Field-Effect Transistor: Two terminal MOS structure, basic MOSFET operation, non-ideal effects, MOSFET scaling, threshold voltage modification, radiation and hot electron effects. **[5 Lectures]**	
Course Outcome (CO):	
References: 1. Donald Neamen, "Semiconductor Physics and Devices", McGraw-Hill, 4th Edition 2. Simon M. Sze, Kwok K. Ng, "Physics of Semiconductor Devices", Wiley, 3rd Edition 3. B.G. Streetman, S. Banerjee Solid State, "Solid State Electronic Devices", Prentice Hall India	

Course Code: ECTXXX	**Course Credit: 3**
Course Name: Power Electronics	**L-T-P: 3-0-0**
Course Prerequisite:	

Course Syllabus:

Introduction to Solid State Power Devices & Operation – Power Diode, Power Transistor, MOSFET, IGBT, SCR, GTO, Classification of SCR triggering methods, Design and operation of triggering circuits, Commutation methods, Pulse transfer and isolation scheme, Protection of power devices, Series and parallel operation of SCRs. **[12 Lectures]**

Phase Controlled Converters – Single-phase uncontrolled, half-controlled and fully controlled converters. Three-phase half-controlled and full controlled bridge converters. **[8 Lectures]**

Choppers – Different schemes and circuit configurations. Buck (half bridge, full bridge, push-pull), Boost, Buck-boost, Flyback, and Cuk converter. **[6 Lectures]**

Inverters – Single-phase and three-phase bridge converter operating as line-commutated voltage source inverters, force commutated inverters, Pulse width modulated inverters with IGBTs/MOSFETs, Gate driving Circuit, Dead-time, Design of Snubber Circuit, Current source inverter. **[10 Lectures]**

Cycloconverters – Three-phase to single-phase and three-phase to three-phase configurations. **[4 Lectures]**

Course Outcome (CO):

CO1: To learn about solid state power devices.
CO2: To design protection circuits for power devices.
CO3: To learn different power converter.
CO4: To learn about single-phase and three-phase systems.

References:

1. P.S. Bimbhra, “Power Electronics”, Khanna Publishers, 2012.
2. Muhammad H. Rashid, “Power Electronics: Circuits, Devices and Applications”, Pearson, 3rd Edition.
3. Robert W. Erickson, “Fundamentals of Power Electronics”, Springer, 1997.
4. Denis Fewson, “Introduction to Power Electronics”, Arnold Publishers, 1998.

Course Code: ECTXXX	**Course Credit: 3**
Course Name: Semiconductor Memory Design	**L-T-P: 3-0-0**
Course Prerequisite:	
Course Syllabus:	
Course Outcome (CO):	
References:	

Course Code: ECTXXX	**Course Credit: 3**
Course Name: Semiconductor Optoelectronic Devices	**L-T-P: 3-0-0**
Course Prerequisite: Optical Communication, Electronic Devices & Circuits	

Course Syllabus:

Review of Semiconductor Device Physics: Energy bands in solids, the E-k diagram, Density of states, Occupation probability, Fermi level and quasi Fermi levels, p-n junctions, Schottky junction and Ohmic contacts. Semiconductor optoelectronic materials, Bandgap modification, Heterostructures and Quantum Wells. **[10 Lectures]**

Interaction of photons with electrons and holes in a semiconductor: Rates of emission and absorption, Condition for amplification by stimulated emission, the laser amplifier. [**5 Lectures]**

Semiconductor Photon Sources: Electroluminescence. The LED: Device structure, materials and characteristics. The Semiconductor Laser: Basic structure, theory and device characteristics; direct current modulation, Quantum-well lasers; DFB-, DBR- and vertical-cavity surface-emitting lasers (VCSEL); Laser diode arrays. Device packages and handling. **[10 Lectures]**

Semiconductor Optical Amplifiers & Modulators: Semiconductor optical amplifiers (SOA), SOA characteristics and some applications, Quantum confined Stark Effect and Electro-Absorption Modulators. **[5 Lectures]**

Semiconductor Photodetectors: Types of photodetectors, Photoconductors, Single junction under illumination: photon and carrier-loss mechanisms, Noise in photodetection, Photodiodes, PIN diodes and APDs: structure, materials, characteristics, and device performance, Photo-transistors, solar cells, and CCDs, Optoelectronic integrated circuits - OEICs. **[10 Lectures]**

Course Outcome (CO):

CO1: Understand and apply the concepts of semiconductor physics for optoelectronic devices.
CO2: Understand, explain and analyze various optical processes in a semiconductor and use them to build various optoelectronic devices.
CO3: Explain the working of various commonly used light sources and photo detectors used in optoelectronics.
CO4: Explain and design semiconductor optical amplifiers used in optoelectronic systems.

References:

1. Bhattacharya Pallab, "Semiconductor Optoelectronic Devices", Second Edition, Pearson Education
2. Jasprit Singh "Semiconductor Optoelectronics: Physics and Technology", First Edition, McGraw Hill Education.
3. John Wilson and John Hawkes "Optoelectronics", Third edition, Pearson Education.
4. Larry A. Coldren Scott W. Corzine Milan L. Mašanović, "Diode Lasers and Photonic Integrated Circuits", Second Edition, Wiley-Interscience.
5. A. Yariv and P. Yeh, "Photonics: Optical Electronics in Modern Communications", Oxford University Press, New York (2007), 6th Ed.

Course Code: ECTXXX	Course Credit: 3
Course Name: Simulation of Devices and Circuits	**L-T-P: 3-0-0**
Course Prerequisite:	
Course Syllabus: Introduction to SPICE Simulation, Analysis of complex electronic circuits, simulation and analysis using SPICE, AC/DC operation, DC sweep transfer function, frequency response, feedback control analysis, transient response, device models, simulation and analysis of electronic circuits and systems. **[12 Lectures]** Review of semiconductor physics, The pn junction, The built-in voltage, Depletion width and junction capacitance, Diode current/voltage characteristic, Minority carrier charge storage. MOS transistors, Threshold voltage and the body effect, Current/voltage characteristics, Subthreshold current, Short channel effect and narrow width effect, Drain induced barrier lowering Channel length modulation, Hot carrier effects, Effective mobility and velocity saturation SPICE models, MOS inverter circuits **[14 Lectures]** Bipolar transistors, Current gain, Gummel plots and output characteristics, Recombination in the emitter/base depletion region, Charge storage and forward transit time, Cut-off frequency, TTL gates. Basic SPICE Models, Ebers-Moll and basic Gummel-Poon model, Small-signal model, Parameter extraction. **[14 Lectures]**	
Course Outcome (CO):	
References: 1. B.G. Streetman, S. Banerjee Solid State, “Solid State Electronic Devices”, Prentice Hall India 2. D.A.Hodges, H.G. Jackson, “Analysis and Design of Digital Integrated circuits”, McGrraw-Hill 3. J.P. Uyemura, “Introduction to VLSI circuit and systems”, John Wiley and Sons. 4. Y. Taur, T.H. Ning, “Fundamentals of Modern VLSI devices”, Cambridge University Press 5. K. Eshraghian, “Principles of CMOS VLSI design , A systems perspective”, Addison Wesley.	

Course Code: ECTXXX	**Course Credit: 3**
Course Name: VLSI Signal Processing Architectures	**L-T-P: 3-0-0**
Course Prerequisite:	
Course Syllabus:	
Course Outcome (CO):	
References:	

Course Code: ECTXXX	Course Credit: 3
Course Name: Advanced Digital System Design and FPGAs	**L-T-P: 3-0-0**
Course Prerequisite: Digital Design, Digital System Design and FPGAs	
Course Syllabus: Advanced topics in combinational and sequential design: Use of CAD, design methodologies, system decomposition, arithmetic modules, and design of complex sequential systems. **[10 Lectures]** Introduction to FPGA architectures: Overview, programming technologies, configurable logic block, FPGA routing architectures. **[8 Lectures]** Logic design with Verilog: Introduction to Verilog, logic design with behavioral models of combinational and sequential logic, synthesis of combinational and sequential logic, design and synthesis of data path controllers, programmable logic and storage devices, algorithms and architectures for digital processors, architectures for arithmetic processors, coding for FPGAs. **[14 Lectures]** Designing with FPGAs: Design flow for FPGAs, prototyping with FPGAs, and debugging. (Utilize commercial FPGA development tools for compilation, simulation, synthesis, implementation, and debugging). **[8 Lectures]**	
Course Outcome (CO):	
References: 1. Michael D.Ciletti, "Advanced Digital Design with the Verilog HDL", Pearson, 2nd ed. 2017 2. Steve Kilts, "Advanced FPGA Design: Architecture, Implementation, and Optimization" Wiley, 2007 3. Richard C. Dorf, John V. Oldfield, "Field-Programmable Gate Arrays: Reconfigurable Logic for Rapid Prototyping and Implementation of Digital Systems", Wiley, 2008. 4. Cem Unsalan, Bora Tar, "Digital System Design with FPGA: Implementation Using Verilog and VHDL", McGraw Hill Publications. 5. Sanjay Churiwala, "Designing with Xilinx FPGAs using Vivado", Springer 2016.	

Course Code: ECTXXX	**Course Credit: 3**
Course Name: Advanced Microprocessors and Microcontrollers	**L-T-P: 3-0-0**
Course Prerequisite:	
Course Syllabus:	
Course Outcome (CO):	
References:	

Course Code: ECTXXX	Course Credit: 3
Course Name: CAD Algorithms for Synthesis of VLSI Systems	**L-T-P: 3-0-0**
Course Prerequisite: None	

Course Syllabus:

Introduction to CAD Algorithms: Role of CAD in digital system design, levels of design, modeling & description and support of languages, RTL, gate and system level synthesis; Technological alternatives and technology mapping **[8 Lectures]**

CAD Tools for synthesis: CAD tools for synthesis, optimization, simulation and verification of design at various levels as well as for special realizations and structures such as microprogrammes, PLAs, gate arrays etc. Technology mapping for FPGAs. Low power issues in high level synthesis and logic synthesis. **[8 Lectures]**

Architectural-Level Synthesis and Optimization: Architectural Synthesis, Scheduling, Data path synthesis and control unit synthesis, scheduling algorithm, Resource Sharing and Binding **[8 Lectures]**

Logic-Level Svnthesis and Optimization: Two-Level Combinational Logic Optimization, Multiple-Level Combinational Logic Optimization, Sequential Logic Optimization **[8 Lectures]**

CAD Algorithms for VLSI Physical Design: Introduction to VLSI Physical Design flow. Circuit partitioning, placement and routing algorithms. Design Rule verification, Circuit Compaction; Circuit Extraction and post layout simulation. FPGA design flow- partitioning, placement and routing algorithms. Deep sub-micron issues; interconnects modeling and synthesis **[8 Lectures]**

Course Outcome (CO):

CO1: Understand various operations on graphs, clique, coloring, partitioning etc & apply graph algorithms and its applications into Boolean function representation.
CO2: Understand graph models for architecture representation.
CO3: Understand, analyze & implement two level/Multilevel/ sequential logic synthesis algorithms (approximate & exact algorithms).
CO4: Understand, analyze & implement library binding algorithms- FSM equivalence & optimization.
CO5: Understand core concept of VLSI Physical Design algorithms.

References:

1. G. D. Micheli. Synthesis and optimization of digital systems.
2. Dutt, N. D. and Gajski, D. D. High level synthesis, Kluwer, 2000.
3. T. H. Cormen, C. E. Leiserson and R. L. Rivest, “Introduction to Algorithms,” McGraw-Hill, 1990.
4. N. Deo, Graph Theory, PH India.
5. Sait, S. M. and Youssef, H. VLSI Physical design automation. IEEE press, 1995.
6. Sherwani, N. VLSI physical design automation. Kluwer, 1999.

Course Code: ECTXXX	**Course Credit: 3**
Course Name: Computer Arithmetic & Micro-architecture Design	**L-T-P: 3-0-0**
Course Prerequisite: None	

Course Syllabus:

Computer arithmetic- conventional & higher radix number systems, residue & logarithmic number systems;
sequential & parallel (and high speed) algorithms for addition, multiplication, division; evaluation of elementary functions- sin, cos, sin-1, cos-1, sinh etc; CORDIC method for trigonometric functions. **[15 Lectures]**

Languages for design description (HDLs) like VHDL or Verilog; Modeling and simulation of circuits at various levels; Data path design for high performance- pipelining & systolic arrays; Control design- sequential, hardwired & microprogrammed control. **[15 Lectures]**

Topics in design-yield and redundancy, Low power design techniques. **[10 Lectures]**

Course Outcome (CO):

CO1: Understand the radix number system
CO2: Learn the sequential & parallel algorithm for computer arithmetic
CO3: Understand the CORDIC method for evaluation of elementary functions
CO4: Learn basic concepts in HDLs
CO5: Understand basics of data path and control path design methods

References:

For Review
1. Kohavi, Switching & finite automata theory, Mc Graw Hill
For Computer arithmetic
2. Ercegovac, Digital Systems, Wiely, 2004
3. Parhami, Computer Arithmetic- Algorithms & Hardware Design, Oxford Univ. Press
4. Koren, Computer Arithmetic Algebra, Prentice Hall Inc.
For Data-path/Control Design
5. Hayes, J P, Computer Architecture & organization, Mc Graw Hill, 2003
For HDLs
6. Navabi. Introduction to VHDL. Mc Graw Hill, 2000
7. Bhaskar. VHDL Primer. Prentice Hall India, 2001
8. Navabi. Verilog digital systems. Mc Graw Hill, 2000
9. Palnitkar, Verilog…., Pearson India/Prentice-Hall India
Low power design
10. Chandrakasan, A. P. Low-power design methodologies. IEEE Press, 1998.
11. Mead & Conway, VLSI circuit design
12. Raguram, R. Modeling and Simulation of Electronic circuits. PH India, 1996.
13. Weste and Eshraghian. Principles of CMOS VLSI design. Addison Wesley, 1998.
14. K. Roy and et al, Low power design, Wiley

Course Code: ECTXXX	**Course Credit: 3**
Course Name: Digital System Synthesis	**L-T-P: 3-0-0**
Course Prerequisite: Algorithms, Graph Theory, Digital Design and Computer Architecture	

Course Syllabus:

Fundamentals of CAD: Microelectronics, semiconductor technology, and circuit taxonomy, microelectronic design styles, CAD, and optimization. Graph Theory and optimization problems, Design and analysis of algorithms. **[7 Lectures]**

Boolean Algebra and Application: Computational Boolean Algebra: Basics, Boolean Difference, Quantification Operators, Application to Logic Network Repair, Recursive Tautology. Recursive Tautology—URP Implementation. BDD Basics and its details. Satisfiability (SAT), Part, Boolean Constraint Propagation (BCP) for SAT, Using SAT for Logic. Introduction to Digital VLSI Design Flow Specification, High-level Synthesis, RTL Design, Logic Optimization, Verification, and Test Planning, Design Representation, Hardware Specific Transformations. **[10 Lectures]**

Scheduling, Allocation, and Binding: Problem Specification: Scheduling, Allocation, and Binding, Basic Scheduling Algorithms (Time constrained and Resource-Constrained), Allocation Steps: Unit Selection, Functional Unit Binding, Storage Binding, Interconnect Binding, Allocation Techniques: Clique Partitioning, Left-Edge Algorithm, Iterative Refinement. **[10 Lectures]**

Logic Optimization and Synthesis: 2-Level Logic, Multilevel Logic **[13 Lectures]**

Course Outcome (CO):

CO1: Fundamental of Synthesis
CO2: Scheduling and Binding concepts for resource and timing constraints.
CO3: Synthesis and optimization of digital circuits
CO4: CAD algorithms for Area, Power and Timing.

References:

1. Synthesis and Optimization of Digital synthesis by Giovanni De Micheli.
2. High-Level Synthesis: From Algorithm to Digital Circuit by Philippe Coussy (Editor), Adam Morawiec (Editor)
3. Introduction to Logic Synthesis Using Verilog HDL (Synthesis Lectures on Digital Circuits and Systems) Paperback – by Robert B. Reese (Author), Mitchell A. Thornton (Author).
4. Finite State Machine Datapath Design, Optimization, and Implementation (Synthesis Lectures on Digital Circuits and Systems) Paperback – by Justin Davis (Author), Robert Reese (Author).

Course Code: ECTXXX	**Course Credit: 3**
Course Name: Embedded System Design	**L-T-P: 3-0-0**
Course Prerequisite: Microprocessor and Peripherals, Microcontroller and Applications	

Course Syllabus:

Overview of Embedded System, Performance Design Metrics, Hardware and Software Technologies, Design Trade-offs **[6 Lectures]**

Design of Single-Purpose, General-Purpose and Application Specific Processors **[12 Lectures]**

Interfacing and Communication with Peripherals and Memory, Programming with FPGAs and Microcontrollers **[12 Lectures]**

Embedded System Design Examples, Overview of Low Power Embedded Systems and Real Time Systems **[10 Lectures]**

Course Outcome (CO):

CO1: Learn about Hardware and Software based Embedded System Design concepts
CO2: Learn about interfacing and communication with peripherals and memory
CO3: Learn about programming using FPGAs and microcontrollers
CO4: Learn about low power embedded systems and real time systems

References:

1. Frank Vahid, Tony Givargis, "Embedded System Design: A Unified Hardware/Software Introduction", Wiley, 3rd Edition.
2. Wayne Wolf, "Computers As Components - Principles of Embedded Computing System Design", Morgan Kaufman Publishers, 2nd Edition
3. Steve Heath, "Embedded System Design", Newnes, 3rd Edition.
4. Shantanu Chattopadhyay, ''Embedded System Design'', PHI, 2nd Edition
5. A. Arockia Bazil Raj, ''FPGA-based Embedded System Developer's Guide'', CRC Press, 2018
6. Alexander G. Dean,''Embedded Systems Fundamentals with ARM Cortex-M Based Microcontrollers A Practical Approach'', ARM Education Media
7. Mazidi Muhammad Ali, '' The 8051 Microcontroller and Embedded Systems:Using Assembly and C'', Pearson India, 2007

Course Code: ECTXXX	Course Credit: 3
Course Name: Internet of Things	L-T-P: 3-0-0
Course Prerequisite: None	

Course Syllabus:

INTRODUCTION TO INTERNET OF THINGS: Definition and characteristics of IoT, physical design of IoT, logical design of IoT, IoT enabling technologies, IoT levels and deployment, domain specific IoTs. **[8 Lectures]**

IoT AND M2M: Introduction, M2M, difference between IoT and M2M, software defined networking (SDN) and network function virtualization (NFV) for IoT, basics of IoT system management with NETCONF-YANG. **[8 Lectures]**

IoT PLATFORMS DESIGN METHODOLOGY: IoT Architecture: State of the art introduction, state of the art; Architecture reference model: Introduction, reference model and architecture, IoT reference model. Logical design using Python: Installing Python, Python data types and data structures, control flow, functions, modules, packages, file handling. **[8 Lectures]**

IoT PHYSICAL DEVICES AND ENDPOINTS: Introduction to Raspberry Pi interfaces (Serial, SPI, I2C), programming Raspberry PI with Python, other IoT devices. **[8 Lectures]**

IoT PHYSICAL SERVERS AND CLOUD OFFERINGS: Introduction to cloud storage models and communication APIs, WAMP – AutoBahn for IoT, Xively cloud for IoT, case studies illustrating IoT design – home automation, smart cities, smart environment. **[8 Lectures]**

Course Outcome (CO):

1. Able to understand the application areas of IOT.
2. Able to realize the revolution of Internet in Mobile Devices, Cloud & Sensor Networks.
3. Able to understand building blocks of Internet of Things and characteristics.

References:

1. Arshdeep Bahga, Vijay Madisetti, ―Internet of Things: A Hands-on-Approach, VPT, 1st Edition, 2014.
2. Matt Richardson, Shawn Wallace, ―Getting Started with Raspberry Pi, O'Reilly (SPD), 3rd Edition, 2014.
3. Adrian McEwen, Hakim Cassimally, ―Designing the Internet of Things, John Wiley and Sons 2014.
4. Francis daCosta, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything, A press Publications, 1st Edition2013.

Course Code: ECTXXX	Course Credit: 3
Course Name: Memory Design & Testing	**L-T-P: 3-0-0**
Course Prerequisite: None	

Course Syllabus:

Processing technology for Memories: Multipoly Floating Gate and Control Gate, Trench Capacitors and thin Oxide. Memory Modeling and testing faults in SRAMs, Marching Tests; Delay Faults. **[10 Lectures]**

Semiconductor memory architecture, Space of memory faults- fault primitives. **[8 Lectures]**

Preparation of Circuit Simulation: Definition & location of open, short, and bridge fault, Simulation methodology. Test for single cell and two port SRAMs, Functional fault modeling and testing of RAMS, Fault Diagnosis & Repair Algorithms. **[8 Lectures]**

Built –in self Test and design for testabiltity of RAMs. Built in self repair architecture. **[8 Lectures]**

Trend in Embedded Memory testing **[6 Lectures]**

Course Outcome (CO):

CO1: Understand the basics of evaluation of elementary functions
CO2: Understand fundamentals of Memory Modeling and testing faults
CO3: Learn the techniques and algorithm for testing and fault diagnosis
CO4: Understand basics of built-in self test and related issues

References:

1. Pinaki Mazumder, Kanad Chakraborty, Testing and Testable Design of High-Density Random-Access
Memories (Frontiers in Electronic Testing), Kluwer academic pub.
2. Said Hamdioui, Testing Static Random Access Memories: Defects, Fault Models and Test Patterns (Frontiers in Electronic Testing), Kluwer academic pub 2004.
3. Pinaki Mazumder and Kanad Chakraborty, Fault –Tolerence and reliability techniques for High –Density Random- Acess Memories, Pearson India, 2002.

Course Code: ECTXXX	**Course Credit: 3**
Course Name: Real Time Systems	**L-T-P: 3-0-0**
Course Prerequisite:	
Course Syllabus:	
Course Outcome (CO):	
References:	

Course Code: ECTXXX	**Course Credit: 3**
Course Name: VLSI Testing & Testability	**L-T-P: 3-0-0**
Course Prerequisite: None	

Course Syllabus:

Introduction to VLSI design flow and need of VLSI testing. Physical Faults and their modeling; Stuck at Faults, Bridging Faults; Fault collapsing; Fault Simulation: Deductive, Parallel, and Concurrent Fault Simulation. Critical Path Tracing **[8 Lectures]**

ATPG for Combinational Circuits: D-Algorithm, Boolean Differences, PODEM Random, Deterministic and Weighted Random Test Pattern Generation; Aliasing and its effect on Fault Coverage. **[8 Lectures]**

PLA Testing, Cross Point Fault Model and Test Generation. Memory Testing- Permanent, Intermittent and Pattern Sensitive Faults, Marching Tests; Delay Faults. **[8 Lectures]**

ATPG for Sequential Circuits: Time Frame Expansion ; Controllability and Observability Scan Design, BILBO , Boundary Scan for Board Level Testing ; BIST and Totally self checking circuits. **[8 Lectures]**

System Level Diagnosis & repair- Introduction; Concept of Redundancy, Spatial Redundancy, Time Redundancy, Error Correction Codes. Latest trends in VLSI Testing and Testability **[8 Lectures]**

Course Outcome (CO):

CO1: Understand core concepts of digital system testing and testability.
CO2: Understand how a faulty circuit may cause disasters and affect the nature as well as society.
CO3: Understand fault detection using different fault simulation techniques.
CO4: Develop ability to design algorithms for automatic test generation for combinational circuits, sequential circuits, PLAs and memory.
CO5: Apply probabilistic approaches for random test generation.
CO6: Apply different redundancy based fault tolerance techniques to increase circuit reliability.
CO7: Design BIST for a CUT in Verilog/HDL and implement ATPG algorithms in C/C++/MATLAB.

References:

1. Abramovici, M., Breuer, M. A. and Friedman, A. D. Digital systems testing and testable design. IEEE press (Indian edition available through Jayco Publishing house), 2001.
2. Bushnell and Agarwal, V. D. VLSI Testing. Kluwer.
3. Agarwal, V. D. and Seth, S. C. Test generation for VLSI chips. IEEE computer society press.
4. Hurst, S. L. VLSI testing: Digital and mixed analog/digital techniques. INSPEC/IEE, 1999.

Course Code: ECTXXX	**Course Credit: 3**
Course Name: Control Theory	**L-T-P: 3-0-0**
Course Prerequisite: Control Systems, Mathematics-I and II	

Course Syllabus:

Introduction, concept of state, state variables and state model, state modeling of linear systems, linearization of state equations. State space representation using physical variables, phase variables & canonical variables. Derivation of transfer function from state model, diagonalization, Eigen values, Eigen vectors, generalized Eigen vectors. **[12 Lectures]**

Solution of state equation, state transition matrix and its properties, computation using Laplace transformation, power series method, Cayley-Hamilton method, concept of controllability & observability, methods of determining the same. **[8 Lectures]**

Internal Stability, Different notions of stability, stability improvements by state feedback, necessary & sufficient conditions for arbitrary pole placement, state regulator design, and design of state observer. **[10 Lectures]**

Behavior of non-linear system, common physical non linearity-saturation, friction, backlash, dead zone, relay, multi variable non-linearity. Lyapunov's stability criteria, Lyapunov functions, Lyapunov's theorem. **[10 Lectures]**

Course Outcome (CO):

CO1: To understand the formulation of state space model and different structure of system matrices.
CO2: To understand the different notions of stability of a control system.
CO3: To design different state feedback controllers.
CO4: To understand basic idea of nonlinear systems and their stability.

References:

1. T. Kailath, Linear Systems, Prentice Hall, 1980.
2. J.-J. E Slotine, and W. Li, Applied nonlinear control, Prentice Hall, New Jersey, 1991
3. K. Ogata, Modern control engineering, Prentice Hall, 2010.
4. S. Zak, Systems and Controls, Oxford University Press, 2003.

Course Code: ECTXXX	**Course Credit: 3**
Course Name: Digital Control	**L-T-P: 3-0-0**
Course Prerequisite: Control System	

Course Syllabus:

Introduction to digital control, Discrete time system representation, Mathematical modeling of sampling process, Data reconstruction, Modeling discrete-time systems by pulse transfer function. **[6 Lectures]**

Revisiting Z-transform, Mapping of s-plane to z-plane, Pulse transfer function of closed loop system, Sampled signal flow graph, Jury stability test, Stability analysis using bi-linear transformation, Time response of discrete systems. **[10 Lectures]**

Design of sampled data control systems: Root Locus method, Nyquist criterion, Bode plot, Lag, Lead, Lag-Lead compensator design, Design of digital control systems with deadbeat response. **[12 Lectures]**

Discrete state space model: State variable model and various canonical forms, Characteristic equation and state transition matrix, solution to discrete state equation, Controllability, observability and stability of discrete state space models. **[12 Lectures]**

Course Outcome (CO):

CO1: To learn about sampled data systems
CO2: To model linear systems in discrete domain.
CO3: To understand the concept of stability in discrete domain.
CO4: To learn digital controller design using time and frequency domain methods.
CO5: To learn the concept of state modelling in discrete domain

References:

1. B. C. Kuo, Digital Control Systems, Oxford University Press, 2/e, Indian Edition, 2007.
2. M. Gopal, Digital Control and State Variable Methods, Tata Mcgraw Hill, 2/e, 2003.
3. K. Ogata, Discrete Time Control Systems, Prentice Hall, 2/e, 1995.
4. G. F. Franklin, J. D. Powell and M. L. Workman, Digital Control of Dynamic Systems, Pearson Education, Asia, 3/e, 2000.
5. K. J. Astroms and B.Wittenmark, Computer Controlled Systems - Theory and Design, Prentice Hall, 3/e,1997.

Course Code: ECTXXX	**Course Credit: 3**
Course Name: Evolutionary Computation Techniques	**L-T-P: 3-0-0**
Course Prerequisite: None	

Course Syllabus:

Introduction to evolutionary computation, A history of evolutionary computation, Biological and artificial evolution, Evolutionary computation and AI, Different historical branches of EC, e.g., GAs, EP, ES, GP, etc., A simple evolutionary algorithm, No free lunch theorem. **[5 Lectures]**

Introduction to optimization: A practical Example, Classification of optimization problems, Principle of optimization, Duality principle, Traditional methods of optimization: Exhaustive search methods, Random walk method, Steepest descent methods, Drawback of traditional optimization techniques. **[9 Lectures]**

Genetic Algorithms: Concept of GA, GA Operators: Encoding schemes-binary encoding, real encoding, permutation encoding, tree encoding, hexadecimal encoding. GA Operators: Selection schemes – canonical selection, roulette wheel selection, rank-based selection, tournament selection. GA Operators: Crossover operation for binary code GA - single point crossover, two-point crossover, multi-point crossover, uniform crossover, half uniform crossover, shuffle crossover. GA Operators: Crossover operation in real coded GA- linear crossover, blend crossover, binary simulated crossover. GA Operators: Crossover techniques in order GA- single point order crossover, two-point order crossover, precedence preservation crossover, position based crossover. GA Operators: Mutation operation in binary code GA-flipping, interchanging, reversing; Mutation operation in Real coded GA- random mutation, polynomial mutation. **[10 Lectures]**

Multi-Objective Evolutionary Optimization: Introduction to MOO, Some Approaches to solved MOO problems: Weighted some approach, Vector evaluated genetic algorithms, Distance based Pareto GA, Non-Dominated sorting GA-I (NSGA-I) and NSGA-II. **[8 Lectures]**

Ant Colony Optimization, Particle Swarm Optimization, Simulated Annealing, Tabu Search, Artificial bee colony optimization. Grey wolf optimization. **[8 Lectures]**

Course Outcome (CO):

CO1. Understand the basic concepts of Evolutionary Computation.
CO2. Understand Optimization and Some traditional methods.
CO3. Understand the details of Genetic Algorithms:
CO4. Introduction to Multi-Objective Evolutionary Optimization like NSGA-I and II.
CO5. Understand the other non-traditional optimization methods other than evolutionary computation.

References:

1. Deb, Kalyanmoy, “Optimization for engineering design: Algorithms and examples”, PHI Learning Pvt. Ltd., 2012.
2. Deb, Kalyanmoy, “Multi-objective optimization using evolutionary algorithms”, John Wiley & Sons, 2010.
3. D E Goldberg, “Genetic Algorithms in Search, Optimisation & Machine Learning”, Addison Wesley, 1989.
4. Melanic Mitchell, “An Introduction to Genetic Algorithm” (MIT Press)
5. Xin-She Yang, “Introduction to Mathematical Optimization – From Linear Programming to Metaheuristics”.

Course Code: ECTXXX	**Course Credit: 3**
Course Name: Fuzzy Logic and Applications	**L-T-P: 3-0-0**
Course Prerequisite: None	

Course Syllabus:

The case of Imprecision, A historical perspective, The utility of fuzzy systems, Limitations of fuzzy systems, Uncertainties and information, Introduction to fuzzy control, Why fuzzy control? Benefits of fuzzy control, On when to use fuzzy control? Introductory examples. **[6 Lectures]**

Introduction to Fuzzy logic, Crisp set, Fuzzy versus Crisp set, Fuzzy sets and membership functions, Chance versus fuzziness, Operations on Fuzzy sets, properties of fuzzy sets, Crisp Relations, Fuzzy relations, operations on fuzzy relations, Fuzzy extension principle. Properties of membership functions, Standard forms, Fuzzification, Methods of defuzzification and their performance evaluation, examples. **[8 Lectures]**

Classical Predicate Logic – Tautologies, Contradictions, Equivalence, Exclusive OR and Exclusive NOR, Logical proofs, Deductive inferences, Fuzzy logic, Approximate reasoning, Other forms of the implication and composition operations. Structure of fuzzy logic system. **[9 Lectures]**

Introduction to type-2 fuzzy logic, Type-1 fuzzy logic versus Type-2 fuzzy logic, Type-2 fuzzy sets, Representation of type-2 fuzzy sets, Operations of type-2 fuzzy sets, Interval type-2 fuzzy sets, Operations on interval type-2 fuzzy sets, Interval type-2 fuzzy systems: Fuzzifier, Rules, Inference, Type Reducer, Defuzzifier. Fuzzy logic controller principles, Review of conventional PID controller, Fuzzy P Controller, Fuzzy PD Controller, Fuzzy PD+I Controller, Fuzzy Incremental Controller, Tuning, Nonlinear Fuzzy PID Control, Matlab implementation. **[11 Lectures]**

Fundamentals of Genetic Algorithms, basic concepts, working principle, encoding, fitness function, reproduction, Genetic modelling. A Brief Introduction GA Tools in Fuzzy Logic Controller Design. Projects on Fuzzy Logic Controllers design for different types of linear and non-linear plants. **[6 Lectures]**

Course Outcome (CO):

CO1. Understand the basic concepts of Fuzzy logic (FL), Fuzzy sets, Crisp sets.
CO2. Understand the properties of membership functions, Fuzzification, Methods of defuzzification and their performance evaluation, examples.
CO3. Understand the Classical logic – Tautologies, Contradictions, Equivalence, Exclusive OR and Exclusive NOR, Logical proofs, Deductive inferences and Fuzzy logic.
CO4. Understand the basics concepts Type-2 fuzzy logic (T2FL) and Interval Type-2 fuzzy logic (IT2FL).
CO5. Understand the optimization techniques using Genetic Algorithm (GA) and the Fuzzy Logic Controller and its different control structures.

References:

1. Timothy J. Ross, “Fuzzy Logic with Engineering Applications”, Wiley, 3rd Edition.
2. Jan Jantzen, “Foundations of Fuzzy Control: A Practical Approach”, Wiley, Second Edition.
3. N.P.Padhy, S.P.Simon, “Soft Computing with MATLAB Programming”, Oxford University Press, 2015.
4. John Yen, Reza Langari, “Fuzzy Logic: Intelligence, Control, And Information”, John Wiley & Sons, 9th Edition.
5. Driankov, D., Hellendoorn, H. and Reinfrank, M, “An Introduction to Fuzzy Control” Narosa.

Course Code: ECTXXX	**Course Credit: 3**
Course Name: Industrial Automation and Control	**L-T-P: 3-0-0**
Course Prerequisite: Control Systems	

Course Syllabus:

Objectives of Industrial Automation and Control, Terms, concepts used in process dynamics. Mathematical modeling of dynamical (physical) systems and system response (impulse and step). **[4 Lectures]**

Theory of Controllers: Continuous and Discrete control algorithms (On-Off control, PID control), Effect on dynamic behavior of process with different controller modes in closed loop, Integral-windup, Controller tuning (Ziegler, Cohen-Coon, Integral performance), Electronic Controllers, Introduction to sampled-data systems; Tools of discrete-time systems analysis; Dynamic analysis of discrete-time systems; Design of digital controllers. Control Valves and its characteristics. **[12 Lectures]**

Complex Control Schemes: Cascade, Feed-forward and Ratio control, Multivariable processes and controller design (Multi-Input Multi-Output systems), multi-loop interactions, RGA Analysis, multivariable decoupling control, Introduction to model predictive control; Convolution models; Model predictive control of MIMO systems. **[12 Lectures]**

Programmable Logic Controllers: PLC vs relay Logic, PLC vs PCs, hardware components. Ladder diagram, selection of PLCs. Distributed Digital Control Systems: History, functional requirements, system architecture, configuration. Introduction to SCADA. **[12 Lectures]**

Course Outcome (CO):

CO1: To get familiar with industrial control systems.
CO2: To learn about continuous and discrete controllers.
CO3: To learn controller design for multivariable systems.
CO4: Introduction to model predictive control.
CO5: To learn about PLCs and DCS.

References:

1. C.D. Johnson, “Process Control Instrumentation Technology”, Prentice Hall of India, 1993
2. B. A. Ogunnaike and W. H. Ray, “Process Dynamics, Modelling and Control”, Oxford Press, 1994.
3. Surekha Bhanot, “Process Control: Principles and Applications”, Oxford University press, Fourth Impression 2010
4. D.R. Coughanour, ‘Process Systems analysis and Control’, McGraw-Hill, 2nd Edition, 1991.
5. Stephanopoulos George, “Chemical Process Control”, Pearson, 2015.
6. D.E. Seborg, T.F. Edger, and D.A. Millichamp, ‘Process Dynamics and Control’, John Wiley and Sons, 2nd Edition, 2004

Course Code: ECTXXX	**Course Credit: 3**
Course Name: Intelligent Control	**L-T-P: 3-0-0**
Course Prerequisite: None	

Course Syllabus:

Introduction to Fuzzy logic, Introduction to crisp sets and fuzzy sets (type-1 and type-2), basic fuzzy set operation and approximate reasoning, Fuzzy membership functions, Fuzzy relations, Fuzzy propositions, Fuzzy implications, Fuzzy inferences such as Mamdani minimum and Larsen product, Different Defuzzification Techniques like CoG, CoA, CoS, Height methods. **[10 Lectures]**

Fuzzy logic controllers, Architecture of fuzzy logic controllers, Knowledge-based control, Fuzzy knowledge and rule bases, Mamdani type and Takagi-Sugeno type fuzzy controllers, Fuzzy PI and Fuzzy PD controllers, parallel distributed compensation method. Implementation of fuzzy logic controller using Matlab fuzzy-logic toolbox. Stability analysis of fuzzy control systems. **[10 Lectures]**

Solving optimization problems, Basic concept of Genetic algorithm and detailed algorithmic steps, adjustment of free parameters, GA Operators: Encoding, GA Operators: Selection, GA Operators: Crossover, GA Operators: Mutation, Multi-Objective optimization, Pareto optimality. Some other optimization methods such as particle swarm optimization, ant-colony optimization, etc. **[10 Lectures]**

Concept of Artificial Neural Networks and its basic mathematical model, ANN Architecture, Feed-forward Multilayer Perceptron, Learning and Training the neural network, Applications of ANN, Recurrent Neural Networks, Radial Basis Function Network, Networks: Hopfield network, Self-organizing network and Recurrent network. Neural Network based controller Case studies: Identification and control of linear and nonlinear dynamic systems using Matlab-Neural Network toolbox. Stability analysis of Neural-Network interconnection systems. **[10 Lectures]**

Course Outcome (CO):

CO1: Understanding of fuzzy set theory and can differentiate between crisp and fuzzy sets
CO2: Different applications of fuzzy logic such as fuzzy logic controllers
CO3: Understand the concept of evolutionary optimization techniques such as genetic algorithms, particle swarm optimization etc.
CO4: Understand the working of artificial neural networks and applications of ANN for problem solving.
CO5: Learning MATLAB toolbox for fuzzy logic and neural network.

References:

1. An Introduction to Fuzzy Control - Dimiter Driankov, Hans Hellendoorn, Michael Reinfrank (Springer-Verlag Berlin Heidelberg; 2nd edition)
2. Intelligent Systems and Control: Principles and Applications - Laxmidhar Behera, Indrani Kar (Oxford University Press)
3. Genetic Algorithms in Search, Optimization, and Machine Learning - David E. Goldberg (Addison-Wesley Longman Publishing Co.; 1st edition)
4. Introduction to Artificial Neural Systems - Jacek M. Zurada (Jaico; 1st edition)
5. Fuzzy Logic With Engineering Applications - Timothy J. Ross (Wiley; 3rd edition)
6. Neural Networks and Learning Machines - Simon S. Haykin (Pearson; 3rd edition)
7. Optimization for Engineering Design: Algorithms and Examples - Kalyanmoy Deb (Prentice Hall India Learning Private Limited; 2nd edition)

Course Code: ECTXXX	**Course Credit: 3**
Course Name: Neural Networks and Applications	**L-T-P: 3-0-0**
Course Prerequisite: None	

Course Syllabus:

Introduction to Neural Networks, Models of Neuron, Neural Network Architectures, Learning Processes, Perceptron Algorithm. **[8 Lectures]**

Model building through regression, Least-Mean-Square Algorithm, Multilayer Perceptron, Back-Propagation Algorithm and its variants, Generalization, Virtues and Limitations of Back-Propagation Algorithm, Dynamic Networks. **[12 Lectures]**

Associative Learning, Competitive Networks, Radial-Basis Function Networks, Hopfield Networks, Support Vector Machines. **[12 Lectures]**

Applications of Neural Network in Function Approximation, Pattern Recognition, Clustering, Prediction, Control, and Hybrid Systems. **[8 Lectures]**

Course Outcome (CO):

CO1: Learn about fundamentals of neural networks and their architectures
CO2: Learn about training and learning of feed-forward neural networks
CO3: Learn about training and learning of feedback neural networks
CO4: Learn about engineering applications of neural networks

References:

1. Martin T. Hagan, Howard B. Demuth, Mark Hudson Beale, Orlando De Jesús, ‘’Neural Network Design’’, Free e-book by Martin Hagan, 2014
2. S. Haykin, ‘’Neural Networks and Learning Machines’’, Pearson Press, 2009.
3. K. Murphy, ‘’Machine Learning: A Probabilistic Perspective’’, MIT Press, 2012.
4. G. James, D. Witten, T. Hastie, R. Tibshirani, ‘’An Introduction to Statistical Learning’’, Springer, 2013.
5. Y. S. Abu-Mostafa, M. Magdon-Ismail, H. Lin, ‘’Learning from Data’’, AML Book, 2012.

Course Code: ECTXXX	**Course Credit: 3**
Course Name: Optimization Techniques and Applications	**L-T-P: 3-0-0**
Course Prerequisite: Mathematics-I and II	

Course Syllabus:

An overview of optimization problem, some examples of optimum design problem. Concepts and terms related to optimization problem, necessary and sufficient conditions for a multivariable function. Effects of scaling or adding a constant to an objective function and understanding constrained and unconstrained optimization problems. Concept of Lagrange multipliers and its application to unconstrained optimization problem. Solution of unconstrained minimization problem using-Gradient descent method, Steepest descent method, Newton's method, Davison-Fletcher-Powell method, and Exterior point method, Solution of constrained minimization problems using Karush-Kuhn-Tucker (KKT) necessary and sufficient conditions. **[10 Lectures]**

Convex sets, convex and concave functions, properties of convex function, definiteness of a matrix and test for concavity of function. Problem statement of convex optimization, quadratic optimization, quadratically constrained quadratic optimization, local and global optima. Solution of quadratic programming problems using KKT necessary condition. Basic concept of interior penalties and solution of convex optimization problem via interior point method. **[8 Lectures]**

Linear programming (LP): Simple method; matrix form of the simplex method. Solution of LP problems in tabular form via simplex method. Two-phase simplex method. Primal and dual problem: Determination of primal solution from its dual form solution and vice-versa. Properties of dual problems and sensitivity analysis. Basic concept of multi-objective optimization problem. **[10 Lectures]**

Dynamic Programming (DP): Sequential optimization; Representation of multistage decision process; Types of multistage decision problems; Concept of sub optimization and the principle of optimality , Recursive equations –Forward and backward recursions; Computational procedure in dynamic programming (DP) Discrete versus continuous dynamic programming; Multiple state variables; curse of dimensionality in DP. **[8 Lectures]**

Integer Programming: Integer linear programming, Concept of cutting plane method, Mixed integer programming; Solution algorithms; Examples. **[4 Lectures]**

Course Outcome (CO):

CO1: Introduction to basic concept of Optimization techniques.
CO2: Understand convex optimization problem.
CO3: Understand the detail of linear programing (LP)
CO4: Understand the detail Dynamic Programming (DP)
CO5: Introduction to Integer Programming, Integer linear programming and Mixed integer programming.

References:

1. Jasbir S. Arora, Introduction to optimum design, Elsevier, 2006.
2. S.S. Rao, Engineering Optimization: Theory and Practice, New Age International Pvt. Ltd., New Delhi, 2000.
3. A Ravindran, K.M.Ragsdell, and G.V. Reklaitis, Engineering optimization: Methods and Applications, Wiley India Edition, 2006.
4. K. Deb, Optimization for Engineering Design-Algorithms and Examples, Prentice-Hall of India Pvt. Ltd., New Delhi, 1995.

Course Code: ECTXXX	**Course Credit: 3**
Course Name: Soft Computing	**L-T-P: 3-0-0**
Course Prerequisite: None	

Course Syllabus:

Introduction to Soft Computing: Overview of Artificial Intelligence and its Applications, Major AI Technologies, Soft Computing and its Components **(5 lectures)**

Introduction to Expert Systems: Overview of Expert Systems, Development of an Expert System, Examples of Real-life Expert Systems **(5 lectures)**

Fundamentals of Artificial Neural Network and Applications: Model of Artificial Neuron, Architecture, Learning methods, Perceptron Network, Back Propagation, ANN Applications Modeling and Prediction, Matlab Implementation **(10 lectures)**

Fundamentals of Fuzzy Logic and Applications: Fuzzy Set theory, Fuzzy Set Operations, Fuzzy Applications in Control, Neuro-Fuzzy System, Matlab Implementation **(10 lectures)**

Fundamentals of Nature-inspired Optimization Techniques: Overview of Optimization Techniques, Genetic Algorithm, Differential Evolution, Particle Swarm, Applications of Optimization Techniques, Design of Optimized Fuzzy Controller, Matlab implementation **(10 lectures)**

Course Outcome (CO):

CO1: Understand the importance of soft computing and machine learning.
CO2: Understand the basic concepts of fuzzy logic.
CO3: Understand the basic concepts of neural networks.
CO4: Understand the basic concepts of evolutionary computation.
CO5: Understand the usefulness of hybrid systems.

References:

1. Hung T. Nguyen, N R Prasad, C L Walker, E A Walker, “A first course in Fuzzy and Neural Control”, Chapman & Hall/CRC Press.
2. Martin D Hagen et al, “Neural Network Design”
3. Xin-She Yang, “Nature-inspired Metaheuristic Algorithms”, Luniver Press
4. Samir Roy, Udit Chakraborty, “Introduction to Soft Computing”, Pearson
5. Timothy J Ross, “Fuzzy Logic with Engineering Application”, Wiley
6. Laurene Fausett, “Fundamentals of Neural Networks, Architecture, Algorithms and Applications”, Pearson Education

Course Code: ECTXXX	**Course Credit: 3**
Course Name: System Identification	**L-T-P: 3-0-0**
Course Prerequisite: Signals and Systems, Control Systems, Probability and Random Variables	

Course Syllabus:

Introduction and overview of Systems Identification, Stochastic vs. Non-stochastic Formulation, Random Variables and Stochastic Processes. **[6 Lectures]**

Parameter Estimation: Least Square, Generalized and Recursive Least Square, Estimator properties including error bounds and convergence, MES, ML and MAP estimators, Nonlinear Least Squares. Model Parameterization and Prediction. Singular value decomposition (SVD). **[11 Lectures]**

Recursive Identification of Linear dynamic systems: RLS, ELS, IV, RML, Stochastic Approximation, Extended Kalman Filter, generalized prediction error framework and its application to ARMA and state models, convergence analysis, Time varying parameters. **[11 Lectures]**

Nonlinear System Identification. Adaptive schemes. Adaptive control theory and applications. Linear -in- the-parameters model. Least squares estimation. Recursive estimators. Extended least squares. Robust estimation methods (dead zone, projection). Nonlinear System Identification Techniques. **[12 Lectures]**

Course Outcome (CO):

CO1: To learn about random variables and stochastic processes.
CO2: To learn different algorithms for parameter estimation.
CO3: To learn identification of linear dynamic systems.
CO4: To learn identification of nonlinear systems.
CO5: Introduction to adaptive control theory.

References:

1. K.J. Astrom and B. Wittenmark, Adaptive Control, Pearson 2nd Edition, 1994.
2. L. Ljung, System Identification Theory for the user, Prentice-Hall, 2007.
3. K.S. Narendra and A.M. Annaswamy, Stable Adaptive Systems,, Prentice-Hall, 1989.
4. Miroslav Krsti, Ioannis Kanellakopoulos, and Petar V. Kokotovic, Nonlinear and Adaptive Control Design, Wiley-Interscience, 1995.

Course Code: CSTXXX	**Course Credit: 3**
Course Name: Artificial Intelligence and Machine Learning	**L-T-P: 3-0-0**
Course Prerequisite: None	

Course Syllabus:

Intelligent Agent, Problem Solving by Searching. **[4 Lectures]**

Beyond Classical Search, Local Search Problem and its Solution. **[3 Lectures]**

Adversarial Search in Game Theory, Zero Sum Min-Max Problem, Optimal Decision in Games, Stochastic Behaviour. **[3 Lectures]**

Knowledge-based Agents, Reasoning and Planning, Knowledge Inference, Forward and Backward Chaining. **[4 Lectures]**

Intelligent Agents based on Propositional Logic, Intelligent Agents based on First Order Logic, Intelligent Agents based on Fuzzy Logic. **[6 Lectures]**

Planning and Acting in Real World: Time, Schedule and Resources, Planning and Acting in Nondeterministic Domains, Multiagent Planning. **[4 Lectures]**

Uncertainty in Knowledge: Acting under Uncertainty, Independence, Problem Solving using Bayes Theorem. **[3 Lectures]**

Introduction to Machine Learning; Learning Problems, Types of Machine learning, Goals and applications of machine learning. **[2 Lectures]**

Classification: Naïve Bayes; Regression: Linear Models. Decision Trees, k-Nearest Neighbors. **[4 Lectures]**

Linear Models for Regression & Classification, Logistic Regression. Bias-Variance; Training/Testing, Evaluation: Cross-Validation. **[4 Lectures]**

Perceptron and Support Vector Machines. Soft-Margin SVMs; Kernel Methods. **[3 Lectures]**

Course Outcome (CO):

References:

1. S. Russell and P. Norvig, “Artificial Intelligence – A Modern Approach”, Prentice-Hall, 2009.
2. Rajendra Akerkar, “Introduction to Artificial Intelligence”, PHI, 2005.
3. Machine Learning, Tom M. Mitchell, McGraw Hill, 1997.
4. Pattern Recognition and Machine Learning, Christopher M. Bishop, Springer, 2006
5. G. F. Luger, “Artificial Intelligence: Structures and Strategies for Complex Problem Solving”, Fifth Edition, Addition Wesley, 2005.
6. N. J. Nilsson, “Artificial Intelligence: A New Synthesis”, Morgan Kaufmann Publishers, 1998.
7. Kevin L. Priddy and Paul E. Keller, “Artificial Neural Networks – An Introduction”, SPIE Press, 2005.

Course Code: CSPXXX	**Course Credit: 1**
Course Name: Artificial Intelligence and Machine Learning Lab	**L-T-P: 0-0-2**
Course Prerequisite: None	
Course Syllabus: 1. Implement uninformed and informed search techniques **[3 Labs]** 2. Implement adversarial search in minimax game theory and generate optimal decisions **[2 Labs]** 3. Design and implement intelligent agents of various levels, environment sensing and reacting **[2 Labs]** 4. Introduction to machine learning problems. Tools: Weka, R, Scikit-learn. **[2 Labs]** 5. Implementation of linear regression using python. A car price prediction application. **[1 Labs]** 6. Implementation of univariate and multivariate logistic regression for classification ML. **[2 Labs]**	
Course Outcome (CO):	
References: 1. S. Russell and P. Norvig, "Artificial Intelligence – A Modern Approach", Prentice-Hall, 2009. 2. RajendraAkerkar, "Introduction to Artificial Intelligence", PHI, 2005. 3. Machine Learning, Tom M. Mitchell, McGraw Hill, 1997. 4. Pattern Recognition and Machine Learning, Christopher M. Bishop, Springer, 2006 5. G. F. Luger, "Artificial Intelligence: Structures and Strategies for Complex Problem Solving", Fifth Edition, Addition Wesley, 2005. 6. N. J. Nilsson, "Artificial Intelligence: A New Synthesis", Morgan Kaufmann Publishers, 1998. 7. Kevin L. Priddy and Paul E. Keller, "Artificial Neural Networks – An Introduction", SPIE Press, 2005.	

Course Code: CSTXXX	**Course Credit: 3**
Course Name: Compiler Design	**L-T-P: 3-0-0**
Course Prerequisite: None	

Course Syllabus:

Overview of Compilation: Phases of Compilation – Lexical Analysis, Regular Grammar and regular expression for common programming language features, pass and Phases of translation, interpretation, bootstrapping, data structures in compilation – LEX lexical analyzer generator. Top down Parsing: Context free grammars, Top down parsing – Backtracking, LL (1), recursive descent parsing, Predictive parsing, Preprocessing steps required for predictive parsing. **[8 Lectures]**

Bottom up parsing: Shift Reduce parsing, LR and LALR parsing, Error recovery in parsing, handling ambiguous grammar, YACC – automatic parser generator. **[8 Lectures]**

Semantic analysis: Intermediate forms of source Programs – abstract syntax tree, polish notation and three address codes. Attributed grammars, Syntax directed translation, Conversion of popular Programming languages language Constructs into Intermediate code forms, Type checker. **[8 Lectures]**

Symbol Tables: Symbol table format, organization for block structures languages, hashing, tree structures representation of scope information. Block structures and non block structure storage allocation: static, Runtime stack and heap storage allocation, storage allocation for arrays, strings and records. **[8 Lectures]**

Code optimization: Consideration for Optimization, Scope of Optimization, local optimization, loop optimization, frequency reduction, folding, DAG representation. Data flow analysis: Flow graph, data flow equation, global optimization, redundant sub expression elimination, Induction variable elements, Live variable analysis, Copy propagation. Object code generation: Object code forms, machine dependent code optimization, register allocation and assignment generic code generation algorithms, DAG for register allocation. **[8 Lectures]**

Course Outcome (CO):

CO1: To give students hands-on experience with crafting a simple compiler.
CO2: To understand the language translation and compiler design and to develop an awareness of the function and complexity of modern compilers.
CO3: To implement lexical analyzer using Lex tool & Syntax Analyzer or parser using YACC Tool.
CO4: To implement NFA and DFA from a given regular expression.

References:

1. Principles of compiler design -A.V. Aho .J.D.Ullman; Pearson Education.
2. Modern Compiler Implementation in C- Andrew N. Appel, Cambridge University Press.
1. lex&yacc – John R. Levine, Tony Mason, Doug Brown, O'reilly
2. Modern Compiler Design- Dick Grune, Henry E. Bal, Cariel T. H. Jacobs, Wiley dreamtech.
3. Engineering a Compiler-Cooper & Linda, Elsevier.
4. Compiler Construction, Louden, Thomson.

Course Code: CSPXXX	Course Credit: 1
Course Name: Compiler Design Lab	**L-T-P: 0-0-2**
Course Prerequisite: None	

Course Syllabus: 1 Lab per experiment unless otherwise mentioned

1. Introduction to compilers, translators, and interpreters, compilation process. Compare two complier front ends - GCC and Clang. **[2 Labs]**
2. Design and implement a lexical analyzer for given language using C
3. Implementation of Lexical Analyzer using Lex Tool
4. To write a Yacc program to valid arithmetic expression using Yacc .
5. Implementation of Calculator Using Lex & Yacc
6. Lexical Analysis, Syntax Analysis – create parsers using Lex and Yacc (Bison).
7. Use GCC to understand code optimization: Basic blocks, Control Flow Graphs, Global data flow analysis. **[2 Labs]**
8. Use GCC for implementing Loop optimization.
9. Understanding of code generation: Compilation of expression and control structures. **[2 Labs]**

Course Outcome (CO):

CO1: Hands-on to create a basic compiler with basic functionalities
CO2: To implement the different phases of compiler.
CO3: To implement and test simple optimization techniques.

References:

1. Compilers: Principles, Techniques and Tools, by Alfred V. Aho , Monika, Ravi Sethi , D. Jeffrey Ullman
2. Compilers Principles and Practice, D M Dhamdhere

Course Code: CSTXXX	**Course Credit: 3**
Course Name: Computer Networks	**L-T-P: 3-0-0**
Course Prerequisite: Basic understanding of computer systems	

Course Syllabus:

Introduction to Protocol Layering, OSI Reference Model and TCP/IP Protocol Stack. Networking core – packet switching, circuit switching, nodal delay (processing delay, queuing delay, transmission delay, propagation delay). Introduction to interconnecting networking devices. Application layer, DNS, HTTP, SMTP, etc. **[8 Lectures]**

Transport layer, UDP, TCP, Sliding Window, sender and receiver window size, silly window syndrome, Nagle's Algorithm, packet loss detection, retransmission, RTT, RTO, Karn/Patridge Algorithm, sequence number wrap around, bandwidth delay product. **[7 Lectures]**

Resource allocation classification, best effort service v/s QoS model, Fairness, fairness index, Queuing disciplines (FIFO, FQ, WFQ). Congestion Control: AIMD, Slow Start, Fast Retransmit and Recovery, Congestion Avoidance, TCP variants (Tahoe, Reno, Vegas). **[7 Lectures]**

Network layer, IP addressing scheme, private addresses, static and dynamic assignment (DHCP), sub-netting, CIDR. Routing, Scale, avoiding loops/failures, Distance Vector routing – RIP (15 hops), IGRP (255 hops). Link State Routing (OSPF). Brief introduction to multi-cast routing, MPLS, QoS, IPv6, etc. **[12 Lectures]**

Link layer (OSI – physical layer, MAC, LLC), Physical layer – bit stream, cables, hubs, repeaters, switches. Error detection – parity, CRC, checksum. MAC, Ethernet, CSMA/CD, ARP, ICMP, ARQ, bridging concepts. Introduction to Mobile Networks, Wi-Fi and Mobile IP. **[6 Lectures]**

Course Outcome (CO):

CO1: Students will understand fundamental underlying principles of computer networking
CO2: Students will understand details and functionality of layered network architecture.
CO3: Students will apply mathematical foundations to solve computational problems in computer networking
CO4: Students will analyze performance of various communication protocols.
CO5: Students will compare routing algorithms

References:

1. Computer Networks A Systems Approach by Peterson and Davie
2. Computer Networking A Top-Down Approach by Kurose and Ross.
3. An Engineering Approach to Computer Networking by S. Keshav.

Course Code: CSPXXX	**Course Credit: 1**
Course Name: Computer Networks Labs	**L-T-P: 0-0-2**
Course Prerequisite: Basic understanding of computer systems	
Course Syllabus: 1 Lab per experiment unless otherwise mentioned 1 Running and using services/commands like ping, trace route, nslookup, arp, telnet, ftp, etc. 2 Socket programming using UDP and TCP (e.g., simple DNS, data & time client/server, echo client/server, iterative & concurrent servers) **[2 Labs]** 3 Connecting hosts in a LAN 4 Implementation of DLL framing schemes viz bit stuffing / character stuffing 5 Implementation of Dijkstra's Algorithm to compute shortest path having given a path. 6 Obtaining a routing table while each node uses Distance Vector routing algorithm, given a subnet and weights quantifying delay between nodes of a subnet. 7 Implementation of checksum to detect errors during transmission, 8 Implementation of CRC given a generator polynomial. 9 Implementation of sliding window protocol. 10 Simulating wired/wireless network functions and protocols using NS2/NS3. **[2 Labs]**	
Course Outcome (CO): CO1: Students will understand the concepts of networking thoroughly. CO2: Students will be able to analyse the performance of the network. CO3: Students will be able to implement networking protocols. CO4: Students will learn to connect client and server through socket creation.	
References: 1. Computer Networks A Systems Approach by Peterson and Davie 2. Computer Networking A Top-Down Approach by Kurose and Ross. 3. NS2 manual	

Course Code: CSTXXX	**Course Credit: 3**
Course Name: Cryptography and Cyber Security	**L-T-P: 3-0-0**
Course Prerequisite: Basic concepts of Computer Science and Mathematics	

Course Syllabus:

Course Introduction and Terminology, Security Trends, Security Attacks, Security Mechanism. Conventional Cryptography: Definitions, Classical Encryption Techniques i.e. Substitution Techniques, Transposition Techniques, Rotor Machines and Steganography. **[8 Lectures]**

Finite Fields: Groups, Rings, Fields, Modulo Arithmetic GCD (Euclids Algorithm); Symmetric Cryptography: DES, AES and other Symmetric Cryptography. **[9 Lectures]**

Asymmetric Cryptography: Number Theory, Public Key Cryptography: RSA, Elgamal, and Elliptic Curve Cryptography, Key Management. **[8 Lectures]**

Authentication: Message Authentications and Hash Functions, Hash Algorithms, Digital Signatures and Authentication Protocols. **[5 Lectures]**

History of Internet, Cyber Crime, Information Security, Computer Ethics and Security Policies, Securing web browser, Antivirus, Email security, secure password and wi-fi security, Smartphone Security, Firewall, Defensive Programming, Counter Cyber Security Initiatives in India. **[10 Lectures]**

Course Outcome (CO):

CO1: Identify information security goals, classical encryption techniques and acquire fundamental knowledge on the concepts of finite fields and number theory.
CO2: Understand, compare, and apply different encryption and decryption techniques to solve problems related to confidentiality and authentication
CO3: Apply the knowledge of cryptographic checksums and evaluate the performance of different message digest algorithms for verifying the integrity of varying message sizes
CO4: Apply different digital signature algorithms to achieve authentication and create secure applications.
CO5: Analyze and resolve security issues in networks and computer systems to secure a digital infrastructure.
CO6: Develop policies and procedures to manage security risks.

References:

1. W Stallings, “Cryptography and Network Security: Principles and Practice, 5/e”, Prentice Hall.
2. B A Forouzan, “Cryptograpgy and Network Security”, Tata McGraw Hill, 2007.
3. Singer PW, Friedman A. “Cybersecurity: What everyone needs to know”, Oxford University Press India, 2014.
4. C Kaufman, R Perlman, M Speciner, Network Security, 2/e” , Pearson Education, 2006.
5. Alfred J. Menezes, et al, Handbook of Applied Cryptography, CRC Press

Course Code: CSPXXX	Course Credit: 1
Course Name: Cryptography and Cyber Security Lab	**L-T-P: 0-0-2**
Course Prerequisite: Basic concepts of Computer Science and Mathematics	
Course Syllabus: 1 Lab per experiment 1. Write a C program that contains a string (char pointer) with a value \Hello World'. The program should AND or and XOR each character in this string with 127 and display the result. 2. Write a Java program to perform encryption and decryption using the following algorithms: a) Ceaser Cipher b) Substitution Cipher 3. Write a Java program to perform encryption and decryption using Hill Cipher 4. Write a Java program to implement the DES algorithm. 5. Write a Java program to implement the DES algorithm. 6. Write a Java program to implement RSA Algorithm. 7. Implement the Diffie-Hellman Key Exchange mechanism using HTML and JavaScript. Consider the end user as one of the parties (Alice) and the JavaScript application as other party (bob). 8. Calculate the message digest of a text using the SHA-1 algorithm in JAVA. 9. Study of the features of firewall in providing network security and to set Firewall Security in windows. 10. Study of different types of vulnerabilities for hacking a websites / Web Applications. 11. Analysis the Security Vulnerabilities of E-commerce services and E-Mail Applications 12. Study and analysis of Counter Cyber Security Initiatives in India.	
Course Outcome (CO):	
References:	

Course Code: CSTXXX	**Course Credit: 3**
Course Name: Data Science	**L-T-P: 3-0-0**
Course Prerequisite: Mathematical background and programming skills	

Course Syllabus:

Introduction and importance of data science, data gathering and cleaning, understanding and working with data. Data Wrangling: Understanding the patterns and relationships among data, data preparation. Implementation in Python: Environment set-up, Jupyter overview, Python Numpy, Computation on NumPy Arrays: Universal Functions. Aggregations, computations operations on Data. Exploring Data Engineering Pipelines and Infrastructure. Defining Big Data. Big Data and Data Science. MapReduce and Hadoop. Data Leakage. **[8 Lectures]**

Data Manipulation with Pandas, Matplotlib, Python Scikit tool, data processing, Implement different techniques to analyze dataset. Data Indexing and Selection, Operations on Data, Handling Missing Data, Hierarchical Indexing, Aggregating, combining, vectorizing different operations on Data. High-Performance Pandas: eval() and query(). **[10 Lectures]**

Data Visualization: Explain and show the data graphically, Scatterplots, Visualizing Aggregate Values with Bar plots and Pie charts, diagrams, charts, tables, Lattice Cloud – 3D scatterplot, comparisons, images and graph. Data visualizing tools such as Excel, Tableau, etc. Layered Visualizations Using ggplot2. Using D3.js for Data Visualization. Basics of data analysis: quantitative and qualitative analysis. Making Maps from Spatial Data, Business intelligence tool (Tableau): Understanding Tableau, Deep diving with data, patterns and relationships, Creating tables and charts, mapping data in Tableau. **[8 Lectures]**

Exploratory data analysis (EDA): Understanding EDA meaning, EDA vs classical vs Bayesian, An approach to analyze data, deep looking insight the data, understanding the patterns and relationships among data, extract contributing variables, detect anomalies, underlying assumptions, techniques for testing assumptions, EDA graphical techniques, data visualization, box plot, scatter plot, histogram, chart. Measuring Data Symmetry Using Skewness and Kurtosis. **[8 Lectures]**

Using Data Science to Extract Meaning from Data. Regression analysis techniques: linear regression with with single variable and multiple variables, bias and variance, polynomial regression, stepwise regression, L1 and L2 regularization, Type-I and Type-II errors, ridge regression, lasso regression, elasticnet regression, logistic regression, multinomial logistic regression. How to select the right regression model, model evaluation using R-square, Chi-square. **[6 Lectures]**

Course Outcome (CO):

CO1: Collect, preprocess and analyze the dataset of real-world data problems
CO2: develop fundamental knowledge of concepts underlying data science
CO3: Practically implement data science approaches and analyze the results visually

References:

1. Jake Vanderplas, Python Data Science Handbook: Essential Tools for Working with Data, O′Reilly Pub.
2. W. McKinney, Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython, O′Reilly, Pub.
3. Joel Grus, Data Science from Scratch, O′Reilly Publication.
4. Peter Bruce, Practical Statistics for Data Scientists, O′Reilly Publication.

Course Code: CSPXXX	Course Credit: 1
Course Name: Data Science Lab	**L-T-P: 0-0-2**
Course Prerequisite: None	

Course Syllabus: 1 Lab per experiment unless otherwise mentioned

1. Implementation in Python: Environment set-up, Jupyter overview, Python Numpy, Computation on NumPy Arrays. **[2 Labs]**
2. Basics of NumPy-Computation on NumPy-Aggregations-Computation on Arrays-Comparisons, Masks and Boolean Arrays-Fancy Indexing-Sorting Arrays-Structured Data: NumPy's Structured Array. **[2 Labs]**
3. Data Manipulation with Pandas, Matplotlib, Scikit tool.
4. Data processing, Implement different techniques to analyze dataset. Data Indexing and Selection.
5. Operations on Data, Handling Missing Data.
6. Vectorising different operations on Data. High-Performance Pandas: eval() and query().
7. Implement and analysis important statistical methods on a given data used in data science using python.
8. Basic functions of matplotlib-Simple Line Plot, Scatter Plot-Density and Contour Plots.
9. Histograms, Binnings and Density-Customizing Plot Legends, Colour Bars-Three-Dimensional Plotting in Matplotlib.
10. Data visualization: Tableau. Creating charts, Mapping data in Tableau

Course Outcome (CO):

References:

1. Jake VanderPlas ,Python Data Science Handbook - Essential Tools for Working with Data, O'Reily Media,Inc, 2016
2. Zhang.Y ,An Introduction to Python and Computer Programming, Springer Publications,2016
3. Joel Grus ,Data Science from Scratch First Principles with Python, O'Reilly Media,2016
4. T.R.Padmanabhan, Programming with Python,Springer Publications,2016

Course Code: CSTXXX	**Course Credit: 3**
Course Name: Database Management Systems	**L-T-P: 3-0-0**
Course Prerequisite: Basic understanding of computers and logics	

Course Syllabus:

Introduction: An overview of database management system, database system Vs file system, Database system concept and architecture, data model schema and instances, data independence and database language and interfaces, data definitions language, DML, Overall Database Structure. Data Modeling using the Entity Relationship Model: ER model concepts, notation for ER diagram, mapping constraints, keys, Concepts of Super Key, candidate key, primary key, Generalization, aggregation, reduction of an ER diagrams to tables, extended ER model, relationship of higher degree. **[10 Lectures]**

Relational data Model and Language: Relational data model concepts, integrity constraints, entity integrity, referential integrity, Keys constraints, Domain constraints, relational algebra, relational calculus, tuple and domain calculus, Characteristics of SQL, advantage of SQL. SQL data type and literals. Types of SQL commands. SQL operators and their procedure. Tables, views and indexes. Queries and subqueries. Aggregate functions. Insert, update and delete operations, Joins, Unions, Intersection, Minus, Cursors, Triggers, Procedures in SQL/PL SQL. **[6 Lectures]**

Database Design & Normalization: Functional dependencies, normal forms- 1NF, 2NF, 3NF, BCNF, inclusion dependence, lossless join decompositions. **[8 Lectures]**

Transaction Processing Concept: Transaction system, Testing of serializability, 8 serializability of schedules, conflict & view serializable schedule, recoverability, Recovery from transaction failures, log based recovery, checkpoints, deadlock handling. Distributed Database: distributed data storage, directory system. **[10 Lectures]**

Concurrency Control Techniques: Concurrency control, Locking Techniques for concurrency control, Time stamping protocols for concurrency control, validation based protocol, multiple granularity, Multi version schemes, Recovery with concurrent transaction. **[6 Lectures]**

Course Outcome (CO):

CO1: Students understand the basic concepts of DBMS and various databases used in real applications
CO2: Students will be able to design relational database using E-R model and normalization
CO3: Students will be able to demonstrate structured query languages for various database applications
CO4: Students will be able to explain transaction management, recovery management, and concurrency control for real application

References:

1.Korth, Silbertz, Sudarshan," Database Concepts", McGraw Hill
2.Date C J, " An Introduction to Database Systems", Addision Wesley
3. Elmasri, Navathe, " Fundamentals of Database Systems", Addision Wesley
4. O'Neil, Databases, Elsevier Pub.

Course Code: CSPXXX	**Course Credit: 1**
Course Name: Database Management Systems Lab	**L-T-P: 0-0-2**
Course Prerequisite: Basic understanding of computers and logics	
Course Syllabus: 1 Lab per experiment unless otherwise mentioned 1. Practice My SQL queries for Data Manipulation (Insert, Update, Delete, Select) and Data Definition (Create, Drop, Truncate, Rename, etc.) Language **[3 Labs]** 2. Practice SQL queries using logical operations and operators (Arithmetic, Comparison, Logical, etc.) **[2 Labs]** 3. SQL queries using group by and order by functions 4. SQL queries for group functions (Avg, Count, Max, Min, Sum) 5. Practice Subqueries / Nested Queries 6. SQL queries to implement joins 7. SQL Queries for extracting data from more than one table 8. Implement a mini database project with all the sql query concepts learnt above. **[2 Labs]**	
Course Outcome (CO): CO1: Apply the basic concepts of Database Systems and Applications. CO2: Use the basics of SQL and construct queries using SQL in database creation and interaction. CO3: Students will be able to combine the theoretical knowledge and practical skills learnt in the course to build a mini database project.	
References: 1. Korth, Silbertz, Sudarshan," Database Concepts", McGraw Hill 2. Date C J, "An Introduction to Database Systems", Addision Wesley 3. Elmasri, Navathe, "Fundamentals of Database Systems", Addision Wesley 4. O'Neil, Databases, Elsevier Pub. 5. Leon & Leon, "Database Management Systems", Vikas Publishing House 6. Bipin C. Desai, "An Introduction to Database Systems", Galgotia Publications 7. Majumdar & Bhattacharya, "Database Management System", TMH.	

Course Code: CSTXXX	Course Credit: 3
Course Name: Design and Analysis of Algorithms	**L-T-P: 3-0-0**
Course Prerequisite: Data structures and programming	

Course Syllabus:

Asymptotic analysis, Worst average and best cases, Asymptotic notation, Little-o and little-omega notations, Lower and upper boundaries, Tractable and Intractable problems, Algorithms analysis using loops and trees, Solving recurrences, Amortized analysis. **[8 Lectures]**

Divide and conquer: General method, Binary search, Quick sort, randomized quick sort, Merge sort, Strassen's matrix multiplication, Recurrence equation for divide-and-conquer, Topological Sort. Graph Algorithms: Depth first search, Breadth first search, Applications of depth first search, Detecting cycle in a graph. **[8 Lectures]**

Basics of greedy approach, Knapsack problem, Kruskal and Prim's minimum spanning tree, Huffman coding, Efficient Huffman coding for sorted input, Dijkstra's shortest path algorithm, Basics of dynamic programming, Overlapping subproblems property, Optimal substructure property, Matrix chain multiplication, 0-1 Knapsack problem, Bellman Ford algorithm, Floyd-Warshall all pair shortest path algorithm. **[10 Lectures]**

String Matching Algorithms: Naïve method, KMP algorithm, Robin-Karp algorithm, Boyer Moore algorithm, Suffix array. Backtracking: N-queen problem, Subset sum, Graph m-coloring problem. **[6 Lectures]**

Polynomial time complexity and intractability, Decision Problems, Non-deterministic polynomial algorithms, Satisfiability and verification, NP-completeness, NP-hard, Cook's theorem, 2-SAT and 3-SAT problems, Problem reduction, Vertex cover problem, Graph coloring problem, Independent Set, Travelling Salesman Problem, Introduction to approximation algorithms. **[8 Lectures]**

Course Outcome (CO):

CO1: To analyze the complexity of algorithms in the form of recurrence relation and design improved algorithms.
CO2: To implement various algorithmic paradigms such as divide-and-conquer, greedy and dynamic programming.
CO3: To analyze the solutions derived from randomized and approximation algorithms in real-time problems.
CO4: Analyze the performance of various graph algorithms to find the shortest route and other operations.
CO5: Understand and analyze the NP-Hard problems and their approximate solutions.

References:

1. Thomas H. Cormen, et al. Introduction to Algorithms, Latest Edition, MIT Press
2. Narasimha Karumanchi, Data Structures and Algorithms Made Easy, Latest Edition, Career Monk Publication
3. Jon Kleinberg and Eva Tardos, Algorithm Design, Latest Edition, Pearson
4. Robert Sedgewick and Kevin Wayne, Algorithms, Latest Edition, Addison Wesley

Course Code: CSPXXX	Course Credit: 1
Course Name: Design and Analysis of Algorithms Lab	**L-T-P: 0-0-2**
Course Prerequisite: Data structures and programming	
Course Syllabus: 1. Divide and conquer: Quick sort, randomized quick sort, Merge sort, Strassen's matrix multiplication, Closest pair of points, Matrix chain multiplication **[3 Labs]** 2. Detecting cycle in a graph, Kruskal and Prim's minimum spanning tree, Dijkstra's shortest path algorithm, Bellman Ford algorithm **[3 Labs]** 3. Fractional Knapsack problem, 0-1 Knapsack problem **[2 Labs]** 4. String Matching Algorithms: Naïve method, KMP algorithm, Robin-Karp algorithm, Boyer Moore algorithm, Suffix array **[2 Labs]** 5. Backtracking: N-queen problem, Subset sum, Graph m-coloring problem. **[2 Labs]**	
Course Outcome (CO): CO1: To implement various algorithmic paradigms such as incremental approach, divide-and-conquer and backtracking algorithms. CO2: To implement greedy and dynamic programming to solve real life problems and analyze the efficiency. CO3: To implement and analyze the solutions based on the randomized algorithms. CO4: Analyze the performance of various graph algorithms to find the shortest route, minimum spanning tree and other operations. CO5: To implement the approximation algorithm to solve NP-Hard problems.	
References: 1. Thomas H. Cormen, et al. Introduction to Algorithms, Latest Edition, MIT Press 2. Narasimha Karumanchi, Data Structures and Algorithms Made Easy, Latest Edition, Career Monk Publication 3. Jon Kleinberg and Eva Tardos, Algorithm Design, Latest Edition, Pearson 4. Robert Sedgewick and Kevin Wayne, Algorithms, Latest Edition, Addison Wesley.	

Course Code: CSTXXX	**Course Credit: 3**
Course Name: Cyber Physical Systems	**L-T-P: 3-0-0**
Course Prerequisite: Basic knowledge of programming	

Course Syllabus:

Cyber-Physical Systems (CPS) in the real world, Industry 4.0, AutoSAR, IIOT implications, Continuous Dynamics, Feedback Control, Discrete Systems, Hybrid Systems, Composition of State Machines, Concurrent Models of Computation, Building Automation, Medical CPS and mathematical modeling. **[7 Lectures]**

Design and Implementation: Sensors and Actuators, Embedded Processors, Memory Architectures, Input and Output Interface, Multitasking, Scheduling. **[5 Lectures]**

Dynamical Systems and Stability, Controller Design Techniques, Performance under Packet drop and Noise. **[5 Lectures]**

Intelligent CPS: Safe Reinforcement Learning (Robot motion control, Autonomous Vehicle control), Gaussian Process Learning(Smart Grid Demand Response, Building Automation). **[6 Lectures]**

Analysis and Verification: Invariants and Temporal Logic, Equivalence and Refinement, Reachability Analysis, Model Checking, Timing Analysis. **[5 Lectures]**

CPS Control: Event triggered Control, Receding Horizon Control, Anytime Control. **[5 Lectures]**

Secure Deployment of CPS: Secure Task mapping and Partitioning, State estimation for attack detection, Automotive Case study : Vehicle ABS hacking, Power Distribution Case study : Attacks on Smart Grids. **[7 Lectures]**

Course Outcome (CO):

CO1: Implement the basic concepts of cyber physical systems
CO2: System modelling, real-time scheduling and real-time resource utilization.
CO3: Verify and validate a model mathematically.

References:

1. Edward A. Lee and Sanjit A. Seshia, Introduction to Embedded Systems, A Cyber-Physical Systems Approach, Second Edition, http://LeeSeshia.org, ISBN 978-1-312-42740-2, 2015.
2. Rajeev Alur. Principles of Cyber-Physical Systems. MIT Press. 2015.
3. K. J. Astrom and R. M. Murray. Feedback Systems: An Introduction for Scientists and Engineers. Prince- ton University Press, 2009.
http://www.cds.caltech.edu/~murray/amwiki/index.php/Main_Page.
4. Relevant research papers.

Course Code: CSPXXX	Course Credit: 1
Course Name: Cyber Physical Systems Lab	**L-T-P: 0-0-2**
Course Prerequisite: Basic knowledge of programming	
Course Syllabus: 1. Dynamic Modeling -- Disease spreading models, Cruise Control, rocket and aircraft dynamics, Water & waste management, Agriculture, MPC **[3 Labs]** 2. Smart Energy System-- Smart Grid, Smart buildings, Smart Cities, Energy Plus- HCV **[3 Labs]** 3. Medical CPS: Model verification using UPPAAL- Heart, Pacemaker, drugs and tissues model and verification **[3 Labs]** 4. CPS for Automotives- Application ---demo --Introduction to driverless car. **[3 Labs]**	
Course Outcome (CO): CO1: Implement the basic concepts of cyber physical systems. CO2: System modelling, real-time scheduling and real-time resource utilization. CO3: Verify and validate a model mathematically.	
References: 1. Edward A. Lee and Sanjit A. Seshia, Introduction to Embedded Systems, A Cyber-Physical Systems Approach, Second Edition, http://LeeSeshia.org, ISBN 978-1-312-42740-2, 2015. 2. Rajeev Alur. Principles of Cyber-Physical Systems. MIT Press. 2015. 3. K. J. Astrom and R. M. Murray. Feedback Systems: An Introduction for Scientists and Engineers. Prince- ton University Press, 2009. http://www.cds.caltech.edu/~murray/amwiki/index.php/Main_Page. 4. Relevant research papers.	

Course Code: CSTXXX	Course Credit: 3
Course Name: Operating Systems	**L-T-P: 3-0-0**
Course Prerequisite: Basic knowledge of computer systems	

Course Syllabus:

Introduction and Process Management: Need of operating system, types of OS, operating system as resource manager, OS services, kernel, system calls, firmware, bootloader, process model, creation, termination, states and transitions, context switching, process control block, system calls in Linux and Windows, processes versus threads, kernel and user level threads and multi-threading. **[6 Lectures]**

Process Scheduling: Process scheduling - concepts, CPU and I/O bound, CPU scheduler - short, medium, long-term dispatcher. Scheduling - preemptive and non-preemptive, Priority, Scheduling algorithms - FCFS, SJFS, Shortest Remaining Time, round robin, priority scheduling, multilevel queue scheduling, multilevel feedback queue scheduling, fair share scheduling. **[8 Lectures]**

Inter-Process Communication: Message passing, race condition, critical section problem, mutual exclusion with busy waiting, Peterson's solution, Semaphore, Classical IPC problems, Deadlock problem, detection, prevention, avoidance, recovery from deadlock. **[10 Lectures]**

Memory Management: Memory management - concepts, logical and physical address space, address binding, degree of multiprogramming, swapping. Memory allocation schemes, Free space management, memory protection and sharing, relocation and address translation, Virtual Memory-concept, paging, segmentation, segmentation with paging, demand paging, thrashing. Page replacement algorithms - optimal, MRU, FIFO, LRU, Belady's anomaly, design issues for paging system. Page size, TLB. Inverted page table. Basic idea of MM in Linux. **[10 Lectures]**

File System and Storage: File System - concepts, operations, types. File organization and access (Sequential, Direct, Index and Sequential) methods. Memory mapped files, directory structures, file system mounting, file sharing. Overview of file system in Linux, Input/output subsystems- concepts, input/output devices, disk structure, disk storage capacity. Disk scheduling algorithm - FCFS, SSTF, Scan scheduling, C-scan schedule, Look and C-Look schedule. **[6 Lectures]**

Course Outcome (CO):

CO1: Students will be able to describe the general architecture of computers
CO2: Students will be able to describe, contrast and compare differing structures of operating systems
CO3: Students will understand and analyse theory and implementation of: processes, resource control (concurrency etc.), physical and virtual memory, scheduling, I/O and files.

References:

1. Silberschatz and Galvin: Operating System Principals, Wiley India Pvt. Ltd.
2. Tanenbaum: Modern Operating System, Prentice Hall.
3. OS – Three Easy Step by Remzi (available free online).

Course Code: CSPXXX	Course Credit: 1
Course Name: Operating Systems Lab	**L-T-P: 0-0-2**
Course Prerequisite: C Programming	

Course Syllabus: 1 Lab per experiment unless otherwise mentioned

1. Basics of Unix Commands.
2. Process creation (fork, wait, exec, etc.)
3. Implement Scheduling Algorithms (round robin, fcfs, priority, sjf etc)
4. Implement Semaphores
5. Implement Banker's Algorithm for Deadlock Avoidance
6. Implement an Algorithm for Deadlock Detection
7. Implement concepts of memory management **[2 Labs]**
8. Implement all page replacement algorithms a) FIFO b) LRU c) LFU **[2 Labs]**
9. Implementation concepts of disk scheduling. **[2 Labs]**

Course Outcome (CO):

CO1: At the end of the course, the student should be able to implement deadlock avoidance, and Detection Algorithms
CO2: Students will be able to compare the performance of various CPU Scheduling Algorithm
CO3: Students will be able to critically analyze the performance of the various page replacement algorithms
CO4: Students will be able to create processes and implement IPC.

References:

1. Silberschatz and Galvin: Operating System Principles, Wiley India Pvt. Ltd.
2. Tanenbaum: Modern Operating System, Prentice Hall.
3. OS – Three Easy Step by Remzi (available free online)
4. DM Dhamdhere: Operating Systems – A Concepts Based Approach, Tata McGraw Hill
5. Charles Crowly: Operating System A Design Oriented Approach, Tata McGraw Hill.

Course Code: CSTXXX	**Course Credit: 3**
Course Name: Software Engineering	**L-T-P: 3-0-0**
Course Prerequisite: Basic knowledge of C programing language	

Course Syllabus:

Introduction to Software Engineering – Reasons for software project failure – Similarities and differences between software and other engineering products. Software Components, Software Characteristics, Software Crisis, Software Development Life Cycle (SDLC)– Phases Overview, Water Fall Model, Prototype Model, Spiral Model, Evolutionary Development Models, Iterative Enhancement Models, Choosing a social relevant problem-Summary Team Report. **[8 Lectures]**

Problem partitioning (subdivision) - Power of Abstraction, Concept of functional decomposition , process modeling : DFDs, Concept of data modeling : ER diagrams, Class and component level design : UML diagrams. **[4 Lectures]**

Requirement Engineering Process: Elicitation, Analysis, Documentation, Review and Management of User Needs, Feasibility Study, Assessment: Impact of Requirement Engineering. Decision Tables, SRS Document, IEEE Standards for SRS, Architectural design, component level design, user interface design, WebApp Design, SRS Documentation for Team Project. **[8 Lectures]**

Coding and Testing: Testing Objectives, Unit Testing, Integration Testing, Acceptance Testing, Regression Testing, Testing for Functionality and Testing for Performance, Top-Down and Bottom-Up Testing, Software Testing Strategies - Strategies: Test Drivers and Test Stubs, Structural Testing (White Box Testing), Functional Testing (Black Box Testing), Introduction to secure programming. Types of testing – Specification of test cases – Code review process. **[8 Lectures]**

Software Quality Assurance (SQA): Quality concepts, Review techniques, Verification and Validation, SQA Plans, Software Quality Frameworks. Assessment: Framing SQA Plan. ISO 9000 Models, SEI-CMM Model and their relevance to project Management-other emerging models like People CMM. **[6 Lectures]**

Software Configuration Management (SCM): versioning, Reusable components, Mathematical methods of risk assessment and management, Methods of software licensing and introduction to free software. Software Maintenance: Maintenance Characteristics, Maintainability, Maintenance tasks and side effects. Risk Management, Maintenance and Reengineering. Risk Assessment: Preparation of Risk mitigation plan. **[6 Lectures]**

Course Outcome (CO):

CO1: Learn basic SW engineering methods and practices, and understanding of software process models.
CO2: Learn software requirements and the SRS documentation, software design process and principles.
CO3: Understand implementation issues i.e., modularity, coding standards and software testing approaches.
CO4: Learn planning, scheduling, risk management, ethical and professional issues of software engineers.

References:

1. Pressman R.S: Software Engineering: A Practitioner approach, McGraw Hill.
2. Sommerville I: Software Engineering, Addison Wesley
3. Ghezzi C. Jazayeri M and Mandrioli: Fundamentals of Software Engg., PHI
4. Pankaj Jalote, Software Engineering: A Precise Approach (1/e), Wiley India, 2010.

Course Code: CSPXXX	Course Credit: 1
Course Name: Software Engineering Lab	**L-T-P: 0-0-2**
Course Prerequisite: Software Engineering	
Course Syllabus: 1 Lab per experiment 1. Do requirement analysis and develop Software Requirement Specification Sheet (SRS) for taken project. 2. Develop Flow-Charts to understand basic problem solving technique by the help of Raptor tool. 3. Perform the function oriented diagram: Data Flow Diagram (DFD) and Structured chart. 4. To perform the user‘s view analysis for the suggested system: Use case diagram 5. To draw the structural view diagram for the system: Class diagram, object diagram. 6. To draw the behavioral view diagram : State-chart diagram, Activity diagram. 7. To perform the behavioral view diagram for the suggested system : Sequence diagram, Collaboration diagram. 8. To perform the implementation view diagram: Component diagram for the system. 9. To perform the environmental view diagram: Deployment diagram for the system. 10. To perform various testing using the testing tool Junit. 11. Project management using Gantt Project. 12. Version control using Subversion.	
Course Outcome (CO):	
References: 1. Design Patterns: Elements of Reusable Object-Oriented Software (Addison-Wesley Professional Computing Series), Erich Gamma, Richard Helm 2. Software Engineering: A Practitioner's Approach by Roger S. Pressman 3. Object-oriented Software Engineering: A Use Case Driven Approach by Ivar Jacobson 4. Complete UML Training Course, The Book by Grady Booch, Ivar Jacobson, and James Rumbaugh 5. Object-Oriented Analysis and Design with Applications, Bobbi J. Young, Robert A. Maksimchuk, Grady Booch, Michael W. Engel	

Course Code: MATXXX	**Course Credit: 3**
Course Name: Applied statistical Analysis	**L-T-P: 3-0-0**
Course Prerequisite: None	

Course Syllabus:

The Role of Statistics in Engineering: The Engineering Method and Statistical Thinking - Collecting Engineering Data - Basic Principles - Retrospective Study - Observational Study - Designed Experiments -Observing Processes Over Time - Mechanistic and Empirical Models **[3 Lecture]**
Data Description and Representation: Collection of data- Classification and Tabulation of data - Stem-and-Leaf Diagrams - Frequency Distributions and Histograms - Box Plots - Time Sequence Plots - Probability Plots . **[4 Lecture]**
Descriptive Statistics: Measures of central Tendency-Measures of Dispersion Skewness and Kurtosis. Correlation and Regression: Scatter Diagram – Types of Correlation – Karl Pearsons Coefficient of Correlation and Spearmen's Rank Correlations- Method of Least Squares – Linear Regression **[7 Lecture]**
Sampling: Different types of sampling - Sampling Distributions - Sampling Distribution of Mean. **Point Estimation of Parameters**: General Concepts of Point Estimation - Unbiased Estimators -Variance of a Point Estimator - Standard Error- Methods of Point Estimation (Method of Moments - Method of Maximum Likelihood). **[4 Lecture]**
Statistical Intervals for a Single Sample: Confidence Interval on the Mean of a Normal Distribution with Variance Known - Confidence Interval on the Mean of a Normal Distribution with Variance Unknown - Confidence Interval on the Variance and Standard Deviation of a Normal Distribution - A Large-Sample Confidence Interval for a Population Proportion. **[4 Lecture]**
Tests of Hypotheses for a Single Sample: Tests of Statistical Hypotheses - General Procedure for Hypothesis Testing –Tests on the Mean of a Normal Distribution with Variance Known - Tests on the Mean of a Normal Distribution with Variance Unknown - Tests on the Variance and Standard Deviation **[6 Lecture]**
Statistical Inference for Two Samples: Inference For a Difference in Means of Two Normal Distributions with Variances Known - Inference For a Difference in Means of Two Normal Distributions with Variances Unknown -Inference on the Variances of Two Normal Distributions – Inference on Two Population Proportions. **[4 Lecture]**
The Analysis of Variance: Concept-Assumptions-One way classification and two-way classifications. **Designing Engineering Experiments** –Concept of Randomization, Replication and local control - Completely Randomized Design -Randomized Block Design – Latin square Design. **[8 Lecture]**

Course Outcome (CO):

CO1: Discuss the different methods that engineers use to collect data interpret & visual displays
CO2: Compute correlation coefficient and, use simple linear regression model to engineering data.
CO3: Compute and explain point estimators and interval estimators for mean, variance and proportion
CO4: Hypothesis tests, use z-test, t-test, chi-square and Ftest to test and making decisions in hypothesis tests, explain and use the relationship between confidence interval and hypothesis tests.
CO5: How the analysis of variance (one-way and two- way) is used to analyze the data from engineering experiments and apply CRD, RBD and CSD in Engineering problems.

References:

1. Douglas C. Montgomery and George C. Runger. Applied Statistics and Probability for Engineers, (3rdEdn), John Wiley and Sons, Inc., New York, 2003.
2. Richard A. Johnson and C.B. Gupta, Probability and Statistics for Engineers, (7thEdn.), Pearson Education, Indian Impression 2006.
3. Sheldon M. Ross, Introduction to Probability and Statistics, (3rdEdn), Elsevier Science and Technology Books, New York, 2004

Course Code: MATXXX	**Course Credit: 3**
Course Name: Complex Analysis	**L-T-P: 3-0-0**
Course Prerequisite: Calculus	

Course Syllabus:

Fundamental concepts: Field of complex numbers, complex plane, polar representation, stereographic projection. **[4 Lectures]**

Analytic Functions; Functions of complex variable, limits and continuity, differentiability, Cauchy – Riemann equations, analytic function, harmonic functions, Milne's Thompson's method, conjugate functions. **[6 Lectures]**

Conformal Mappings: Mappings or transformations, conformal mapping, necessary and sufficient conditions for w=f(z) to represent conformal mapping, linear, bilinear and some important transformations, cross ratio, Schwarz – Christoffel transformations. **[6 Lectures]**

Complex Integration: Line integral, Cauchy fundamental theorem, Cauchy-Goursat theorem, Cauchy integral formula, Cauchy derivative formula, Morera's theorem. **[6 Lectures]**

Expansion of analytic function: Expansion of analytic function as power series, Taylor and Laurent series, zeros and poles, isolated singularities. **[6 Lectures]**

Calculus of Residues: Residue at simple pole, residue at a pole of order greater than unity, the Cauchy's residue theorem, Evaluation of real integrals using residue theorem. **[6 Lectures]**

Applications of residues: Argument principle, improper integrals, Rouches theorem, Poisson integral formula **[6 Lectures]**

Course Outcome (CO):

CO1: Represent complex numbers algebraically and geometrically.
CO2: Define and analyze limits and continuity for complex functions.
CO3: Apply the concept and consequences of analyticity and the Cauchy-Riemann equations, harmonic and entire functions.
CO4: Analyze sequences and series of analytic functions and types of convergence.
CO5: Evaluate complex contour integrals directly and by the fundamental theorem, apply the Cauchy integral theorem in its various versions, and the Cauchy integral formula, and represent functions as Taylor and Laurent series,
CO6: Classify singularities and poles, find residues and evaluate complex integrals using the residue theorem.

References:

1. Zill D G. and Shanahan P. D., Complex Analysis, Jones & Bartlett; Third edition, 2015.
2. Kreyszig E., Advanced Engineering Mathematics, 10ed., John Wiley, 2015.
3. Brown J. W. and Churchill R. V., Complex variables and applications, Eight Edition,
4. Ponnusamy S., Foundation of Complex Analysis, Narosa Publisher.

Course Code: MATXXX	**Course Credit: 3**
Course Name: Discrete Mathematical Structures	**L-T-P: 3-0-0**
Course Prerequisite:	

Course Syllabus:

Set theory: Definition of Sets, Venn Diagrams, complements, Cartesian products, power sets, counting principle, cardinality and countability, proofs of some general identities on sets. **[4 Lectures]**

Relation and Functions: Definition, types of relation, composition of relations, domain and range of a relation, pictorial representation of relation, properties of relation, equivalence relation partial ordering relation. Function: Definition and types of function, composition of functions), pigeonhole principle. **[5 Lectures]**

Propositional logic: Proposition logic, basic logic, logical connectives, truth tables, tautologies, contradiction, converse, inverse, contrapositive, negation, and contradiction. Deduction, Resolution, Predicates and Quantifiers, Mathematical Proofs. **[10 Lectures]**

Combinatorics: Mathematical induction, recursive mathematical definitions, basics of counting, permutations, combinations, inclusion-exclusion, recurrence relations (nth order recurrence relation with constant coefficients, Homogeneous recurrence relations, and Inhomogeneous recurrence relation), and generating function (closed form expression, properties of G.F., solution of recurrence relation using G.F, solution of combinatorial problem using G.F.) **[8 Lectures]**

Algebraic Structure: Binary composition and its properties definition of algebraic structure; Semi group, Monoid Groups, Abelian Group, properties of groups, Homomorphism, isomorphism, Permutation Groups, Sub Group, Cyclic Group, Rings and Fields (definition and standard results). **[6 Lectures]**

Graph Theory: Graph terminology, types of graph connected graphs, components of graph, Euler graph, Hamiltonian path and circuits, Graph coloring, Chromatic number. Tree: Definition, types of tree (rooted, binary), properties of trees, binary search tree, tree traversing (preorder, inorder, postorder). **[7 Lectures]**

Course Outcome (CO):

CO1: To enable the students to think logically and mathematically.
CO2: To apply mathematical reasoning in which mathematical problems could be solved.
CO3: To see the practical aspects of mathematical reasoning, combinatorial analysis, discrete structures, and mathematical modeling.
CO4: To observe the real life problems where the concepts of logic, set theory, counting, probability theory, graph theory, trees, Boolean algebra, and modeling computation can be applied.

References:

1. J.P. Tremblay and R. Manohar, "Discrete Mathematical Structures with Applications to Computer Science", McGraw Hill.
2. Kenneth H. Rosen, "Discrete Mathematics and its Applications'', McGraw Hill, 2002.
3. Grimaldi, R.P. "Discrete and Combinatorial Mathematics", Pearson Education, 2002
4. C.L. Liu, Elements of Discrete Mathematics, McGraw-Hill Book

Course Code: MATXXX	**Course Credit: 3**
Course Name: Graph Theory	**L-T-P: 3-0-0**
Course Prerequisite: None	

Course Syllabus:

Fundamental concepts:
Graphs, subgraphs, isomorphism, representation of graphs, degrees and graphical sequences, walks, trails, paths, cycles, connectivity, bipartite graphs. **[6 Lectures]**

Trees and distance:
Characterizations of trees, minimum-spanning-trees, number of trees, Cayley's formula, shortest path algorithms, cut-sets, Characterization of blocks. **[8 Lectures]**

Eulerian and Hamiltonian graphs:
Characterizations, Necessary/sufficient conditions. Coverings and independent sets: Basic relations, matchings in bipartite graphs, Matchings, maximal and maximum matchings, M-augmenting path, Tutte's Perfect matching theorem and consequences. **[6 Lectures]**

Graph Colorings:
Edge-colorings of bipartite graphs, Gupta Vizing's theorem, greedy algorithm for vertex-colorings, Brook's theorem, clique-number and vertex chromatic number. **[8 Lectures]**

Planar graphs:
Euler's formula and its consequences, Kuratowski's Characterization. **[6 Lectures]**

Directed graphs: Out-degree, in-degree, connectivity, orientation, Eulerian directed graphs, Hamilton directed graphs, tournaments. **[6 Lectures]**

Course Outcome (CO):

CO1: Understand the fundamentals of graph theory.
CO2: Understand the principle of shortest path.
CO3: To apply graph theory based tools in solving practical problems.
CO4: Be able to formulate and prove central theorems about trees, matching, connectivity, colouring and planar graphs.
CO5: Learn to describe and apply some basic algorithms for graphs;
CO6: Learn to use graph theory as a modelling tool

References:

1. D.B.West: Introduction to Graph Theory, Prentice-Hall of India/Pearson, 2009.
2. N. Deo , Graph Theory with Applications to Engineering and Computer Sciences, PHI learning, 2009.
3. J.A. Bondy and U.S.R Murthy, Graph Theory with Applications, Macmillan, 1976.

Course Code: MATXXX	**Course Credit: 3**
Course Name: Information Theory and Coding	**L-T-P: 3-0-0**
Course Prerequisite: None	

Course Syllabus:

Information and Entropy – Mathematical foundation of information theory in communication systems. Measures of Information – self information, Shannon's theory, joint and conditional entropies, mutual information and their properties. **[8 Lectures]**

Discrete Memoryless Channels and Source coding – Classification of channels, Calculation of channel capacity, Unique decipherable codes, Condition of instantaneous codes, Average code word length, Kraft inequality. Shannon's noiseless coding theorem. **[8 Lectures]**

Construction of codes – Shannon Fano, Shannon Binary and Huffman codes. Higher extension codes. Decoding scheme – the ideal observer decision scheme. Applications. **[12 Lectures]**

Channel Coding and Error Correcting Codes – Minimum distance principles. Relation between distance and error correcting properties of codes, The Hamming bound. Construction of Linear block codes, Parity check coding and syndrome decoding. Applications. **[12 Lectures]**

Course Outcome (CO):

CO1: Introduce the principles and applications of information theory.
CO2: To teach how information is measured in terms of probability and entropy, and the relationships among conditional and joint entropies.
CO3: To teach coding schemes, including error correcting codes.

References:

1. Robert G. Gallager, "Information Theory and Reliable Communication", Springer-Verlag Wien GMBH.
2. Robert B. Ash, "Information Theory", Dover Publications Inc.
3. Fazlollah M. Reza, "An Introduction to Information Theory", Dover Publications Inc.
4. W. Wesley Peterson, E.J. Weldon Jr., "Error Correcting Codes", 2nd edition, The Massachusetts Institute of Technology.
5. Robert J. McEliece, "The Theory of Information and Coding", Cambridge University Press

Course Code: MATXXX	**Course Credit: 3**
Course Name: Linear Algebra	**L-T-P: 3-0-0**
Course Prerequisite: Engineering Mathematics	
Course Syllabus: Review of vector spaces over arbitrary fields and linear transformation. Characteristic and minimal polynomials. Diagonalization of linear transformations, the primary decomposition theorem, the rational and Jordan canonical forms and some applications. **[17 Lectures]** Linear functional and dual spaces. Bilinear, Quadratic and Hermitian forms. Best approximation, Cauchy –Schwarz inequality, structure theory for normal operators: adjoint, self-adjoint, normal, unity and positive definite operator and their properties. **[15 Lectures]** Modules: motivation, modules, submodules, quotient modules and cyclic modules. Homomorphism, fundamental homomorphism theorem, Simple modules, direct sum and product of modules. The module associated with linear operator. **[8 Lectures]**	
Course Outcome (CO):	
References: 1. Linear Algebra by Kenneth Hoffman, Ray Kunze, PHI learning 2. Linear Algebra & Its Applications by Gilbert Strang 3. Linear Algebra, Schum's outline series. 4. Advanced Linear Algebra, Steven Roman, Third edition, Springer.	

Course Code: MATXXX	**Course Credit: 3**
Course Name: Mathematical Methods	**L-T-P: 3-0-0**
Course Prerequisite: Engineering Mathematics I	
Course Syllabus: Fourier transform, Laplace transform, Solution of differential equations by Laplace and Fourier transform methods, Applications of Laplace and Fourier transforms to Boundary value problems arising in Engineering Sciences. **(12 Lectures)** Hankel transform, Applications. **(4 Lectures)** Solutions of Laplace, Wave and Heat Conduction Equations. **(4 Lectures)** Basic ideas of Discrete Fourier transform (DFT) and Finite Fourier transform (FFT), Z-transform, and Applications. **(8 Lectures)** Ordinary Differential Equations: Power series and Frobenius methods, Hermite functions, Bessel functions, Modified Bessel functions, Applications. Legendre polynomials, Associated Legendre polynomials, Rodrigues formula, Orthogonality of Legendre polynomials, Hermite functions and Bessel functions, Sturm-Liouville problem. **(8 Lectures)** Concept and calculation of Green's function, Approximate Green's function, Green's function method for differential equations. **(4 Lectures)**	
Course Outcome (CO):	
References: 1. G. S. Rao and K. K. Reddy, Mathematical Methods, I.K. International Pvt. Ltd., 2009. 2. W.W. Bell, Special functions for scientists and engineers, D. VanNostrand Company Ltd., London, 1968. 3. O. Scherzer (Ed.), Handbook of Mathematical Methods in Imaging, Springer, 2011. 4. G. N. Watson, A Treatise on the Theory of Bessel Functions, Cambridge University Press, 1944. 5. G. F. Roach, Green's Functions, Cambridge University Press, 1995. 6. D. Poularikas, The Transforms and Applications Handbook, CRC Press, 1996.	

Course Code: MATXXX	**Course Credit: 3**
Course Name: Mathematical Modelling	**L-T-P: 3-0-0**
Course Prerequisite: Engineering Mathematics I &II, Probability & Statistics	

Course Syllabus:

Mathematical modelling concepts: Concepts of mathematical modelling; open and closed systems; limitations of mathematical modelling; properties of mathematical modelling; needs and techniques used; areas of applications; discussion on non-uniqueness of models. **[3 lectures]**

Classification of Mathematical modelling: Classification of mathematical models in terms of areas of application; Classification in terms of the types of mathematics used: Graphical models, models using algebra, models using differential equations (ordinary and partial both); models using difference equations; models using calculus of variations and dynamic programming, etc. **[3 lectures]**

Procedure and techniques of Mathematical modelling: Real problems, identification of parameters, significant parameters, parameters of importance, reduction of an open problem to a closed form, conversion of a real problem into a mathematical problem; identification of problem to be modelled; quest for a mathematical technique for solution; importance of numerical techniques; computer simulation; physical interpretation; illustrations. **[4 lectures]**

Mathematical models in different fields Classical and continuous models, Deterministic, probabilistic and stochastic models; Case studies in problems of physics, chemistry, engineering, biological sciences, genetics, economics, defence, meteorology, music, languages and literature, chaos, synchronization, sports etc. [**20 lectures]**

Simulation Barterning model, Basic optimization, Basic probability, Monte-Carlo simulation, Approaches to differential equation: Heun method, Local stability theory: Bernoulli Trials, General techniques for simulating continuous random variables, simulation from Normal and Gamma distributions, simulation from discrete probability distributions, simulating a non – homogeneous Poisson Process and queuing system. **[10 lectures]**

Course Outcome (CO):

References:

1. J. N. Kapoor, Mathematical Modelling, Wiley Eastern Limited.
2. J. N. Kapoor, Mathematical Modelling in biology and medicine, Affiliated East-West Press Pvt. Ltd.
3. Edward A. Bender., An Introduction to Mathematical Modelling.
4. S.M. Ross, Simulation, India Elsevier Publication.
5. C. Fowler. Mathematical Models in Applied Sciences, Cambridge University Press.
6. A.M. Law and W.D. Kelton.. Simulation Modeling and Analysis, T.M.H. Edition.

Course Code: MATXXX	**Course Credit: 3**
Course Name: Numerical Computation	**L-T-P: 3-0-0**
Course Prerequisite: Mathematics-I and II	

Course Syllabus:

Computational errors: Error definition, Absolute and relative errors, Truncation errors, Round off errors with examples and implementation in MATLAB. Solutions of system of linear equations: LU decomposition method, Gauss-Seidal method. Roots of non-linear equations: Bisection method vs Regula-Falsi method, geometrical interpretations, Newton-Raphson method vs Modified Newton-Raphson method, geometrical interpretations and MATLAB implementations. [**10 lectures]**

Finite Differences: operators, forward and backward differences, central differences. Relation between them. Use MATLAB to compute numerically. Interpolation: Newton-Gregory formula for forward interpolation with error, Newton-Gregory formula for backward interpolation with error, Stirling's formula for central interpolation. Lagrange's interpolation formula, Relationship among various interpolation formulae. Use MATLAB for computation. [**10 lectures]**

Numerical integration with MATLAB implementation: General quadrature formula, Trapezoidal rule with geometrical interpretation and error, Simpson's 1/3rd and 3/8th rules with errors. [**10 lectures]**

Numerical solution of Ordinary differential equations of first order: Picard's method for successive approximations, Euler's method with its geometrical interpretations, Modified Euler's method with error analysis, Runge-Kutta IV order method. Use MATLAB to execute the above methods. [**10 lectures]**

Course Outcome (CO):

CO1: To understand the numerical methods of solving the non-linear equations, interpolation, differentiation, and integration.
CO2: To improve the student's skills in numerical methods by using the numerical analysis software and computer facilities.
CO3: To provide a basic understanding of the derivation, analysis, and use of these numerical methods.

References:

1. M.K. Jain, S.R.K Iyenger and R.K. Jain; Numerical methods for scientific and engineering computation, New age international publishers
2. L. N. Trefethen and D. Bau III, Numerical Linear Algebra, SIAM, Philadelphia, 1997.
3. J. H. Mathews and K.D. Fink, Numerical methods using MATLAB, Pearson Education.
4. Balagurusamy: Numerical Methods, Scitech.
5. Baburam: Numerical Methods, Pearson Education.

Course Code: MATXXX	**Course Credit: 3**
Course Name: Operations Research	**L-T-P: 3-0-0**
Course Prerequisite: None	

Course Syllabus:

Linear Programming Problems **[10 Lectures]**
Basic LPP and Applications, LP Problem Formulation, Simultaneous Equations and Graphical Method, Simplex Method, Big-M Method, Duality Theory, Transportation Problems and Assignment Problem.

Network Analysis **[8 Lectures]**
Shortest Path; Floyd Algorithm, Maximal Flow Problem (Ford-Fulkerson); PERT-CPM (Cost Analysis, Crashing, Resource Allocation excluded).

Dynamic Theory **[5 Lectures]**
Dynamic programming problems and their characteristics; Bellman's principle of optimality; solving (i) Stage coach problem, (ii) Knapsack problem.

Game Theory **[5 Lectures]**
Introduction; 2-Person Zero-sum Game; Saddle Point; Mini – Max and Maxi – Min Theorems (statement only) and problems; Games without Saddle Point; Graphical Method; Principle of Dominance.

Queuing Theory **[12 Lectures]**
Introduction of Stochastic process, Introduction, Axiomatic Derivation of the Arrival & Departure (Poisson Queue).Poisson Queue Models: (M/M/1:∞/FIFO) and (M/M/1:N/FIFO). (M/M/S:∞/FIFO) and (M/M/S:N/FIFO).

Course Outcome (CO):

CO1: Formulate and solve mathematical model (linear programming problem) for a physical situations like production, distribution of goods and economics.
CO2: Understanding the Net-work Analysis.
CO3: learning the Dynamic programming problems and their characteristics
CO4 : Learning the Game theory and Principle of Dominance
CO5:Introduction of Stochastic process and queue models

References

1. H.A. Taha, "Operations Research", Pearson
2. P. M. Karak –"Linear Programming and Theory of Games", ABS Publishing House
3. Kanti Swaroop— "Operations Research", Sultan Chand & Sons
4. Rathindra P. Sen—"Operations Research: Algorithms and Applications", PHI
5. R. Panneerselvam- "Operations Research", PHI.
6. A.M. Natarajan, P. Balasubramani and A. Tamilarasi- "Operations Research", Pearson

Course Code: HSTXXX	**Course Credit: 3**
Course Name: Digital Innovation and Transformation	**L-T-P: 3-0-0**
Course Prerequisite: None	

Course Syllabus:

Foundation Concepts & Key Drivers- Framing of the context, Exponential evolution of technology, Critical role of technology-based, digital innovations, Understand digital innovation drivers. **[8 Lectures]**

The economics of digital innovation- Using Technology as Innovation, Integration and Interconnection of economies, Economic theories – network economics; transaction costs theory; pricing theory. **[12 Lectures]**

Development trends- Deconstruction of the value chain, Gig Economy, Platforms and ecosystems. **[10 Lectures]**

Digital Innovations environment- Value creation in the networked economy, innovation in price dynamics, organisational, legal, ethical and security issues. **[10 Lectures]**

Course Outcome (CO):

CO1: Understand the fundamentals of digital innovation and transformation.
CO2: Understand the economics of digital innovation.
CO3: Learn the key drivers of Digital innovation.
CO4: Learn the organizational, legal, ethical and security issues.

References:

1. Chaffey, D., *e-Business and e-Commerce Management,* (Sixth Edition) Harlow, England: Pearson Education, (2014)
2. Kenney, Martin, and John Zysman. "The rise of the platform economy." Issues in science and technology 32, no. 3 (2016): 61.
3. Larsson, Anthony, and Robin Teigland. 2019. The Digital Transformation of Labor: Automation, the Gig Economy and Welfare. Routledge.
4. Overby, Harald, and Jan Arild Audestad. Digital Economics: How Information and Communication Technology is Shaping Markets, Businesses, and Innovation. Sp, 2018.
5. Śledziewska, Katarzyna, Taylor & Francis Group, and Renata Wloch. 2021. The Economics of Digital Transformation: The Disruption of Markets, Production, Consumption and Work. Taylor & Francis Group.

Course Code: HSTXXX	**Course Credit: 3**
Course Name: Engineering Economics	**L-T-P: 2-1-0**
Course Prerequisite: None	

Course Syllabus:

Introduction: *Why study Economics?* Microeconomics & Macroeconomics. The Economic Problem: Scarcity, Choice and opportunity Cost; Production Possibility Frontier; Economic Systems and the Role of Government: Command Economies, laissez-faire Economies-The Free market, Mixed Economies. **[5 Lectures]**

Basic Microeconomics and Applications: How Market Works; Market forces of Demand and Supply, Elasticity and its applications; Consumer Behaviour: Utility theory, Indifference Curves Approach, Optimum Choice. **[8 Lectures]**

Production Analysis: Short-run and long-run production functions, Law of Variable Proportions, Iso-quants, Returns to Scale; Cost of Production: Short-run and long-run cost curves, Revenue-cost-output relationship, Profit maximization. **[8 Lectures]**

Market Structures: Perfect Competition, Monopoly, Monopolistic Competition, Oligopoly. **[4 Lectures]**

Economic Appraisal Techniques: Payback period, NPV, IRR, Cost-benefit ratio. **[2 Lectures]**

Introduction to Macroeconomics: National Income: Circular Flow of Income, Measures of national income, GDP as a measure of Economic Well-Being. **[5 Tutorial Hours]**

Macroeconomic Issues: Growth and Development, Inflation, and Unemployment. **[4 Tutorial Hours]**

Introduction to Policy Framework: Business cycles, Fiscal and Monetary Policies, Balance of Payments and Foreign Trade. **[4 Tutorial Hours]**

Course Outcome (CO):

CO1: Comprehend the fundamental questions that economics in general addresses affecting the choice making process in practical and professional world.
CO2: Identify and analyze the basic determinants of consumer behavior and market.
CO3: Understand and comprehend the tools and techniques of economics at the micro level for optimal choices, decisions and behavior of the producers.
CO4: Learn and become familiar with the macroeconomic issues.
CO5: Enhance the career opportunities of the graduates in management/professional field and at the same time develop entrepreneurial skills among students.

References:

1. N. Gregory Mankiw. “Principles of Microeconomics", South western Cengage Learning.
2. Paul A Samuelson, William D Nordhaus. "Economics", Tata Mc Graw Hill, Special Indian Edition (Indian Adaptation by Sudip Chaudhari and Anindya Sen).
3. Karl E Case, Ray C Fair & Sharon M Oster. “Principles of Macroeconomics", Prentice Hall, Pearson.
4. H.C. Peterson, W. Cris Lewis & S.K. Jain." Managerial Economics", Prentice Hall.

Course Code: HSTXXX	Course Credit: 3
Course Name: Human Resource Development	**L-T-P: 3-0-0**
Course Prerequisite: None	

Course Syllabus:

Introduction to HRD: Concept, Functions, roles, skills competencies, HRD-definition, goals and challenges. **[4 Lectures]**

The changing environment of HRM: Globalization, cultural environment, technological advances, workforce diversity, corporate downsizing, changing skill requirement, HRM support for improvement programs, Work life balance, HR role in strategy formulation & gaining competitive advantage. **[6 Lectures]**

Human Resource Planning & Information System: Process, Forecasting demand & supply, Skill inventories. (HRIS) succession planning, Job analysis – Uses, methods, Job description & Job specifications. HR accounting and audit concept. **[6 Lectures]**

Human Resource Development & Training: Recruitment, Selection & Orientation: internal & external sources, e- recruitment, selection process, orientation process. Training: Concept, Needs, Systematic approach to training, Methods of training. **[6 Lectures]**

Performance management: Performance management methods, factors that distort appraisal, appraisal interview. Career planning: career anchors, career life stages. **[6 Lectures]**

Compensation & components of pay structure: Steps of determining compensation, job evaluation. Components of pay structure, factors influencing compensation levels, wage differentials & incentives. **[6 Lectures]**

Profit sharing & Social security: Profit sharing, gain sharing, employees' stock option plans. Brief introduction of social security, health, retirement & other benefits. **[6 Lectures]**

Course Outcome (CO):

CO1: Understand the basic concepts, functions and processes of human resource development.
CO2: Understand the role, functions and functioning of human resource department of the organizations.
CO3: Design and formulate various HRM processes such as Recruitment, Selection, Training, Development, Performance appraisals and Reward Systems, Compensation Plans and Ethical Behaviour.
CO4: Develop ways in which human resources management might diagnose a business strategy and then facilitate the internal change necessary to accomplish the strategy.
CO5: Evaluate the developing role of human resources in the global arena.

References:

1. De Cenzo, D.A. & Robbins. "Fundamentals of Human Resource Management", New York: John Wiley & Sons.
2. Dessler, G. "Human Resource Management", Pearson.
3. Monappa & Saiyaddin. "Personnel Management", Tata McGraw Hill.
4. Rao, V.S.P.: Human Resource Management- Text and Cases, Excel Books.

Course Code: HSTXXX	Course Credit: 3
Course Name: Indian Economy: Contemporary Perspectives	**L-T-P: 3-0-0**

Course Prerequisite: The learner should have interest and aptitude towards understanding some fundamental issues and perspectives of the Indian Economy.

Course Syllabus:

History of Indian economy since independence, Analysis of the pre- and post-reform periods of India's economic growth and development. **[8 Lectures]**

Assessment of agriculture sector reforms, Industrial reforms in a mixed economic set-up and tracing the contours of liberalization and self-reliance. **[6 Lectures]**

Poverty and Inequality, Unemployment, Rural-Urban divide, Infrastructure Problems, Inflation, Gender Gap. **[8 Lectures]**

Structural shocks and review of recent policy initiatives like Digitalization, Energy Policy, New Education Policy etc. Pandemic and its impact on growth and development. **[9 Lectures]**

Financial sector reforms and financial inclusion, Tax Reforms, Global institutions, Indian banking sector crisis and recent developments. **[9 Lectures]**

Course Outcome (CO):

CO1: Understand the fundamentals of Indian economy
CO2: Understand the economic reforms.
CO3. Sensitize students with the nature and magnitude of the main contemporary issues in Indian Economy
CO4: Acquaint them with the contemporary Indian development challenges

References:

1. Datta and Sundaram. (2019). Indian Economy. 72nd Edition, S. Chand Publication.
2. Puri V.K., Misra S.K., Indian Economy (2020), 38th Edition, Himalaya Publishing House.
3. Uma Kapila, Indian Economy (2019). 20th Edition, Academic Foundation Publication.

Course Code: HSTXXX	Course Credit: 3
Course Name: Intellectual Property Rights and Laws	**L-T-P: 3-0-0**
Course Prerequisite: None	

Course Syllabus:

Overview of IPR: Introduction to Intellectual Property Rights, Kinds of Intellectual Property Rights, Industrial property, need for intellectual property rights, rationale for protection of IPR, Intellectual Property – Policy Consideration – National and International, Some important examples of IPR. **[6 Lectures]**

Patent process: Definition, types of inventions protected by patent, Patentable and non-patentable inventions, process and product patent, Legal requirements for patents, granting of patent, Patent application process: Searching a patent, drafting of a patent, Filing of a patent, Types of patent applications, patent document: specification and claims **[8 Lectures]**

Trademarks & Copyrights: Rights of trademark, Types of signs used as trademarks, purpose and functions of trademark, trademark protection, trademark registration, acquisition of trade mark rights, selecting and evaluating trademark, trademark registration processes. Rights and protection covered by copyright, law of copy rights: Fundamental of copy right law, originality of material, copy right ownership issues, notice of copy right. **[10 Lectures]**

Geogrophical Indication of Goods: Types, why and How GI need protection and GI Laws, Indian GI act, Industrial Designs: Protection, kind of protection is provided by industrial designs, Trade Secrets: Trade secrete law, determination of trade secrete status, liability for misappropriations of trade secrets, protections for submission, trade secret litigation **[8 Lectures]**

Technological and legal Developments in IP: Computer program: Brief history of protection of computer programs, protection of computer programs under patent or under copyright, International norms concerning copyright protection of computer programs, An overview of Indian copyright software, database, data protection law in respect to information technology enables services, cyber security, strategies-IT law, cybersquatting. **[8 Lectures]**

Course Outcome (CO):

CO1: Understand the fundamentals IPR.
CO2: Student able to learn on Trademarks, Trade secrets and cyber law
CO 3: Student get an insight on Copyrights, Patents and Software patents which are instrumental for further advancements.
CO 4: IPR Laws and patents pave the way for innovative ideas which are instrumental for inventions to seek Patents
CO5: Students able to understand the Technological and legal Developments in IP

References:

1. Fundamentals of IP for Engineers, K. Bansal and P. Bansal
2. Ajit Parulekar and Sarita D' Souza, Indian Patents Law – Legal & Business Implications; Macmillan India ltd , 2006
3. B.L.Wadehra; Law Relating to Patents, Trade Marks, Copyright, Designs & Geographical Indications; Universal law Publishing Pvt. Ltd., India 2000
4. P. Narayanan; Law of Copyright and Industrial Designs; Eastern law House, Delhi , 2010
5. Intellectual property right, Deborah, E. Bouchoux, cengage learning.
6. Intellectual property right - Unleashing the knowledge economy, prabuddha ganguli, Tata Mc Graw Hill Publishing Company Ltd.

Course Code: HSTXXX	**Course Credit: 3**
Course Name: Introduction to International Relations and World Politics	**L-T-P: 3-0-0**

Course Prerequisite: Learner should have understanding of the fundamental concepts of social science and international relations.

Course Syllabus:

Core Ideas - National Interest and Balance of Power,
What is Westphalian world? Bipolarity, Unipolarity, Multipolarity. **[7 lectures]**

United Nations and its institutions, the Cold War, Non Aligned Movement, disintegration of USSR, Universal Declaration of Human Rights. **[8 lectures]**

Nuclear non-proliferation, transnational terrorism, health security, energy security, maritime security. **[7 lectures]**

Bretton Woods institutions, globalization, Non-state actors in global politics, democratic peace theory, regional trade agreements & recent trends toward de-globalization. **[8 lectures]**

Role of major powers in contemporary world politics: USA, Russia, China, India, Japan and EU; geopolitics in the Indo-Pacific. **[10 lectures]**

Course Outcome (CO):

CO1: Students will become familiarized with the key issues of International Relation.
CO2: Students will understand the key developments in global politics.

References:

1. Jon C. W. Pevehouse and Joshua S. Goldstein (2017), International Studies, Pearson Education.
2. Robert Jackson and Georg Sørensen (2016), Introduction to International Relations: Theories and Approaches, Oxford University Press.
3. John Baylis, Steve Smith, and Patricia Owens (2019), The Globalization of World Politics: An Introduction to International Relations, Oxford University Press.
4. Richard W. Mansbach and Kirsten L. Taylor (2017), Introduction to Global Politics, Routledge.
5. Paul R. Viotti and Mark V. Kauppi (2007), International Relations and World Politics: Security, Economy, Identity, Pearson.
6. Rumki Basu, (2012) International Politics: Concepts, Theories and Issues, New Delhi: Sage Publications.
7. Andrew Heywood (2014), Global Politics, New York: Palgrave MacMillan.

Course Code: HSTXXX	**Course Credit: 3**
Course Name: Mindfulness for Wellbeing	**L-T-P: 2-1-0**
Course Prerequisite: None	

Course Syllabus:

Self-Management: Developing sense of Purpose, Building Psychological Capital, Managing Emotions, Practicing Mindfulness, Managing Stress, Pursuing Happiness and Maximizing Life-Satisfaction. **[10 Lectures + Tutorials]**

Cognitive-Development: Critical and Creative Thinking, Enhancing Conceptual Skills, Design thinking and Problem-solving, Decision-Making. **[10 Lectures + Tutorials]**

Social Intelligence: Improving Assertiveness, Managing Interpersonal Relationships, Cultivating Leadership, Developing Citizenship. **[10 Lectures + Tutorials]**

Career Management: Understanding Career and its Context, Knowing Self, Exploring Options, Making Informed Career Decisions, Impression Management (Resume writing, Facing Group Discussions, and Interviews), Managing career Resources. **[10 Lectures + Tutorials]**

Course Outcome (CO):

CO1: Develop insights to lead a meaningful, happy, and prosperous life.
CO2: Improve their mental abilities leading to effective decision-making in diverse situations.
CO3: Enhance thinking skills, emotional management, and social intelligence
CO4: Gain insights about their vocational personalities, acquire skills for career decision making, impression management and career development.

References:

1. Linley, A. (2008). Average to A+: Realising Strengths in Yourself and Others. CAPP Press.
2. Peterson, C. & Seligman, M. (2004). Character Strengths and Virtues: A Handbook and Classification. New York: Oxford University Press.
3. Salgado, B. (2016). Real World Mindfulness for Beginners: Navigate Daily Life One Practice at A Time. Sonoma Press.
4. Lau, J. Y. F. (2011). An Introduction to Critical Thinking and Creativity: Think More, Think Better. Wiley.
5. Elkin, A. (1999). Stress Management for Dummies. New York, NY: Wiley.
6. Hirschi, A. (2012). The career resources model: An integrative framework for career counsellors. British Journal of Guidance & Counselling, 40(4), 369-383
7. Kumar, A. (2007). Personal, Academic and Career Development in Higher Education: Soaring to Success, Routledge, London and New York, NY.
8. Paterson, R. J. (2000). The assertiveness workbook: How to express your ideas and stand up for yourself at work and in relationships. Oakland, USA: New Harbinger Publications.
9. Watts, A. G. (2006). Career development learning and employability. York: Higher Education Academy.

Course Code: HSTXXX	**Course Credit: 3**
Course Name: Product Design – Planning and Management	**L-T-P: 3-0-0**
Course Prerequisite: None	

Course Syllabus:

Introduction to product design, **[3 Lectures]**

History of product design in Global and National Contexts **[5Lectures]**

Design concepts and methodologies applicable in product design and innovation **[4 Lectures]**

User Study and Design Thinking paradigm **[4 Lectures]**

Market Surveys, Market Study Analysis and Market Research Methods **[4 Lectures]**

Product Ideation and Product planning **[6 Lectures]**

Design Economics, introduction to various manufacturing processes and materials. **[5 Lectures]**

Trends and case studies of Product design across scales and genres **[5 Lectures]**

Product Deployment, Placement, branding, user feedback and Management **[4 Lectures]**

Course Outcome (CO):

CO1: Understand the fundamentals of product design
CO2: Understand the principles of user research in product design
CO3: Learn product ideation and concept development process
CO4: Learn the product design methodology and design thinking process
CO5: Learn product planning, manufacturing, branding and marketing strategies

References:

1. Rowe, P. G. (1987). Design thinking. MIT press.
2. Norman, D. (2013). The design of everyday things: Revised and expanded edition. Basic books.
3. Alexander, C. (1964). Notes on the Synthesis of Form (Vol. 5). Harvard University Press.
4. Lawson, B. (2006). How designers think: The design process demystified. Routledge.
5. Cross, N., & Roy, R. (1978). Design Methods Manual: Prepared for the {Open University, Man-Made Futures; Design and Technology} Course Team. Open UP.

Course Code: HSTXXX	Course Credit: 3
Course Name: Quality Control and Reliability	**L-T-P: 3-0-0**
Course Prerequisite: None	

Course Syllabus:

Evolution of quality control, Quality assurance, Total quality systems, Quality cost, Deming's philosophy, Crosby's philosophy, Juran's philosophy, Management commitment, QFD, Tools for continuous improvement. **[5 Lectures]**

Frequency distributions and Histograms, Run charts, Stem-and-leaf plots, Pareto diagram, Cause-and-effect diagram, Normal probability plot, Scatter diagrams, Multivariable charts, Selection of characteristics for investigation. **[5 Lectures]**

Descriptive statistics, Probability distributions, Inferential statistics, Concepts in sampling. Causes of variation, Statistical basis for control charts, Selection of rational samples, Analysis of patterns. **[12 Lectures]**

Control chart for mean and range, Charts for proportion nonconforming, Charts for number of nonconformities, Chart for number of nonconformities per unit, Chart for demerits per unit, Process capability analysis, Types of sampling plan, OC curve, Evaluating sampling plans. **[12 Lectures]**

Reliability definition, Types of reliability systems, Reliability distributions, Bath tub curve, Reliability estimation, System reliability. **[6 Lectures]**

Course Outcome (CO):

CO1: Understand the fundamentals of quality control and quality assurance.
CO2: Understand the principles and techniques for quality control, based on statistical methods.
CO3: Learn concepts of reliability and methods to improve product and systems reliability.
CO4: Learn the tools for quality engineering and quality management.

References:

1. Mitra A., Fundamentals of Quality Control and Improvement, Pearson Education
2. Gryna, F. M., Chua, R. C. H. and Defeo, J. A., Juran's Quality Planning and Analysis for Enterprise Quality, Tata McGraw Hill, 5th Edition, 2007.
3. Montgomery, D. C., Introduction to Statistical Quality Control, John Wiley & Sons, 4th Edition, 2003.
4. Kapur, K. and Lamberson, L., Introduction to Reliability Engineering, John Wiley & Sons, 2nd Edition, 1989.
5. Montgomery, D.C., Design and Analysis of Experiments, John Wiley & Sons, 3rd Edition, 2000.
6. Mathews, P., Design of Experiments with Minitab, Pearson Education, 1st Edition, 2005.

Course Code: HSTXXX	Course Credit: 3
Course Name: Supply Chain Management	**L-T-P: 3-0-0**
Course Prerequisite: None	

Course Syllabus:

Supply chain strategy, cycle view, push-pull view, strategic fit, efficiency and responsiveness spectrum; Supply chain drivers: Inventory, information technology, pricing, transportation, facilities, sourcing **[8 Lectures]**

Distribution network design: selection of facility, cost computations, types of distribution network designs, distribution network design strategies in uncertain environment **[7 Lectures]**

Demand forecasting and aggregate planning in supply chain: **[5 Lectures]**

Planning Supply and Demand in a Supply Chain: Managing Predictable Variability, Inventory management in supply chain: cycle inventory and safety inventory **[6 lectures]**

Pricing and revenue management in supply chain **[3 Lectures]**

Transportation in supply chain management **[3 Lectures]**

Supply chain Coordination and the role of bullwhip effect **[3 Lectures]**

Role of Digital technologies in Supply chain management such as blockchain technology, enterprise resource planning, use of internet of things in warehousing etc. **[5 Lectures]**

Course Outcome (CO):

CO1: Understand the fundamentals of Supply chain management.
CO2: Understand the components of supply chain.
CO3: Understand risk and uncertainty in managing a supply chain
CO4: Learn about various digital technology intervention in managing supply chains

References:

1. Supply Chain Management: Strategy, Planning, and Operations (5th Edition) by Sunil Chopra and Peter Meindl. Prentice Hall, 2012.
2. Martin Christopher, Logishes & Supply chain Management
3. Mohanty. R. P, Deshmukh. S. G., Supply chain Management, Phoenix publishing

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