Academic Programme Guide

of

Bachelor of Engineering
Electronics and Communication Engineering

Based on Choice Based Credit System (CBCS)/Elective Course System(ECS)

CHITKARA UNIVERSITY
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NAAC ACCREDITED

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1. General Information

Bachelor of Engineering Programme in Electronics and Communication Engineering prepares the students for the ever expanding field of Electronics and Communication Engineering. The curriculum is directed towards the major applications such as wireless communications, embedded systems and Internet of things (IoT), Robotics, and Very large scale Integration (VLSI). We believe that, many creative opportunities exist at the boundaries of Computer Science engineering and Electronics and Communication Engineering, so accordingly cross-training schedule for the students across disciplinary boundaries is planned. The normal duration of course is four years. Initially in the curriculum of Electronics and Communication Engineering few courses are in common with the other engineering programs. Thereafter, for 3rd and 4thyear the programme is structured into different verticals to allow customization by individual students based on their own personal perspectives. The Programme Educational Objectives (PEOs) and Programme Outcomes of Electronics and Communication Engineering are summarized as below:

1.1 Programme Educational Objectives (PEOs):

PEO1: The graduating students would be able to make choice to go for a professional career in core technical domain or to pursue higher studies in the field of Electronics and Communication Engineering and other related areas and succeed in their academic and research careers.
PEO2: The graduating students would be able to solve socially relevant engineering problems by designing/developing the products with the help of acquired multidisciplinary knowledge.
PEO3: The graduating students would exhibit a good command over interpersonal communication skills, leadership and team work, and possess ethical values in their chosen professional careers.
PEO4: The graduating students would be ready to serve the society at local, national and international level with the help of life-long learning accomplished for professional development through practical training, courses by international faculty and specialized certifications.

1.2 Programme Outcomes (POs):

The graduating students would be able to

PO1: Possess an ability to apply the knowledge of mathematics science, engineering fundamentals, and engineering specialization to the solution of complex engineering problems.
PO2: Possess an ability to identify, formulate, review research literature, and analyze complex engineering problems using first principles of mathematics, natural sciences, and engineering sciences.
PO3: Possess an ability to design solutions for complex engineering problems and design system components or processes to meet the specific needs with appropriate consideration of the public health and safety, the cultural, societal, and environmental sustainability.

PO4: Possess an ability to use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions
PO5: Possess an ability to create, elect, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6: Possess an ability to apply reasoning informed by the contextual knowledge of societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practices.
PO7: To understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge and need for sustainable development.
PO8: Possess an ability to apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9: Possess an ability to function effectively as an individual and as a member or leader in diverse teams and in multidisciplinary settings**.**
PO10: Possess an ability to communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11: Possess an ability to demonstrate knowledge and understanding of the engineering, management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12: Possess an ability to recognize the need and have ability to engage in independent and lifelong learning in the broadest context of technological change.

1.3 PEOs - Mission mapping

University Vision:
To be a globally recognized organization promoting academic excellence through interdisciplinary applied research and to expand realms of knowledge through innovation.

University Mission:

M1: To carry out the academic processes in accordance with global standards through active teacher-student-industry participation.
M2: To promote research, innovation and entrepreneurship in collaboration with industry, research laboratories and academic institutions of global repute.
M3: To inculcate high moral, ethical and professional values amongst our students, faculty & staff.
M4: To contribute in building skillful society.

In B.E. Electronics and Computer Engineering Programme, the programme educational objectives (PEOs) are well-designed on the mission of providing the graduating students with knowledge and expertise required for professional practices in engineering and the necessary technical skills for working in corporate industries.

The graduating students are prepared for participation in a global environment, where number of opportunities exists for students to connect with one another across the world. Each year, professors from different universities across the globe visits Chitkara University to provide international exposure to students. During the Global Week (GW), cross-cultural competence and knowledge sharing between the students and faculties on both sides are infused, which also facilitates the social cultural immersion programs, helping students in their international careers. Engineering Projects in Community Service–(EPICS) course is offered to students which involves service learning, and reflecting upon an organized activity to benefit their communities, in order to deepen their knowledge of a topic or perspective they have learned about in the classroom. Aiming at developing student's personality through community service, NSS activities are offered to students to instill the idea of social welfare and to provide service to society without bias. To enrich student's interpersonal skills, variety of extracurricular activities have been inculcated in the course curriculum in the form of national level technical and cultural festivals such as EXPLORE and Rangrez respectively on a yearly basis. A vital role is played by the department for overall grooming of the student through organizing industrial visits, workshops and technical quizzes/debates and project showcase competitions by technical societies (IETE, and IEI) and department cultural club (E-Buzz). The students are offered to participate or organize such events. These value-added activities have been designed taken into account various Programme Objectives (POs) such as **PO3, PO4, PO7, PO8, PO9,** and **PO10**, and have been in accordance with all the mentioned Programme Educational Objectives (PEOs). By offering sports related activities, the overall purpose of service-learning is achieved with an emphasis on good health and well-being.

The programme also aims at achieving the sustainable development goals set up by the United Nations. **PO5, and PO10** promote development for sustainable society**,** which depends on three aspects: Economic Forces, Public policy changes, Changes in Life-style. An engineer can contribute to sustainable development; as the role of technology in the transition to a sustainable society is a central one. Present day technologies include Cloud Computing, Internet of Things (IoT), Artificial Intelligence, Augmented Reality (AR), Virtual Reality (VR), and Robotic Process Automation. The Programme of Electronics and Computer Engineering is designed to build innovators, entrepreneurs, leaders and responsible citizens with the above-mentioned skills and knowledge that will help them contribute to achieving the UN 2030 agenda.

PEOs and POs are designed and oriented to meet the mission of university. The PEOs ensure that the graduating students are well equipped with technical knowledge, command over communication skills, leadership qualities, accomplishment of life-long learning to apply for solving the relevant engineering problems in community at local, national and international level, thereby helping establish a balanced social and professional environment. Thus, the objective of the programme is to produce high quality analytic and creative minded electronics engineers to transform the society into knowledgeable, avant-grade and sustainable society.

1.4 Programme Constitution:

- The courses offered in first year are applied basic engineering subjects.
- Programme in second year have core and elective electronics subjects and is structured keeping in mind the requirements of exams like GATE, UPSC, and IES.
- In year 3 and 4, the programme is structured in form of specialization track. Verticals are offered in the specialization track that allows students to customize their preferences for subjects, based on individual interest and carrier options. The verticals include Robotics and Automation, VLSI Design and Verification, and Core Full Stack. These help the students to gain deeper knowledge and skills in the selected area.
- We follow outcome based education and programme outcomes are mapped with course outcomes. For details see the appendix A of mapping report.

1.5 Placement Opportunities:

Electronics and Communication Graduates have tremendous employment opportunities in design, development, research, marketing, Customer support, Sales and testing areas in industries of:
Optical, Mobile, Wireless communication, Satellite, Computing, Bio medical instrumentation, Health engineering, Embedded System design, VLSI design, Software development and testing, Hardware design and testing.

2. Eligibility for Admission

The student seeking admission in BE programme should have minimum 60% marks in 12th grade or equivalent exam as declared by JEE, with Mathematics, and Physics as compulsory subjects. He / She should have appeared in JEE. The admission is based purely on merit. During admission process, the university follows reservation policy as decided by the State.

3.Programme Duration

The duration of the BE programme is four years - divided into 8 semesters. The maximum duration permissible for completion of B.E. programme is shown in table 1:

Table 1: Duration of the Programme

Normal duration of the degree programme	Maximum time allowed for completion of programme
4 years	4 + 2 years

4.Pedagogical Aspects

The structural layout of the programme and its courses requires that each course be divided in lecture, tutorial and practical sessions. Duration of each session of the course is 55minutes.
Lecture sessions: Lectures are delivered by traditional – Chalk& Talk method, supplemented by modern Information Communication Technology (ICT) methods. The students are encouraged to ask questions and involve in group discussion to the extent allowed by the faculty. In some subjects where case study based methodology is adopted, the lectures are supplemented by discussions on case studies.
Tutorial Sessions: The tutorial sessions are small groups of students interacting with the faculty, solving application oriented and analytical problems. The tutorial sessions are very interactive and inculcate problem solving skills in the students.
Lab / Practical Sessions: During lab / practical sessions, the students work on prescribed list of experiments and do what they have learnt in the Lecture / Tutorial sessions.
Projects: The students identify their team mates (maximum 4 students per team) and work on a unique project allotted to them by faculty / group of faculty members. The projects are allotted to them either at the start of semester or at a later stage (but not later than Sessional test I). Projects are designed by considering real world challenges. Thus, the project statements are made in such a way that the students while working on these projects apply the concepts learned so far and the deliverables are multi-faceted.

5.Programme Structure

The various courses of Electronics and Communication Engineering programme are categorized in terms of their academic affinity or their functional objectivesas Basic Science course (BSC), Engineering Science course (ESC) Programme Core Courses (PCC), Programme Elective Course (PEC) Open elective course (OEC), Mandatory course (MC), and Project work (PW), Generic course (GC) Specialization Courses, and Special Courses. PCC are compulsory set of courses.There are specified number of elective courses classified as PEC or OEC.The students are offered a pool of different elective courses (Based on different verticals) out of which they will choose the course/courses as per their interest.

Special Courses

Special courses comprised of IOHE(Industry Oriented Hands on Experience) and also GW(Global Week). Industry Oriented Hands on Experience is a 6 months industrial training which is being offered in the final year of the degree. Student's get the real industry experience through this course. Students are free to choose his/her IOHE with the due approval of the Head of the department while Global Week is a one week programme where student's get the international exposure.

IOHE: IOHE is a real experience at the industry. This may or may not be in a specific skill set. Dean of the Department and the Office of External affairs (optional) has the authority to assign IOHEs, at appropriate industries. The students are given freedom to choose his/her own IOHE, but the decision of the Head of the department is final while allotment.

GW: Global week is one week programme where students are provided international exposure. Faculty from different part of world teaches the students for one week as per their expertise.

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Programme Structure of BE Electronics and Communication Engineering

Table 2: Course Scheme

YEAR-01				
SEMESTER-1				
Course category	**Course Code**	**Title of course**	**L-T-P**	**Credits**
BSC	AM101	Engineering Mathematics – I	4-1-0	5
BSC	PH101	Engineering Physics	3-1-0	4
BSC	PH103	Engineering Physics Lab	0-0-2	1
ESC	EC101	Basics of Electronics Engineering	3-1-0	4
ESC	EC102	Basics of Electronics Engineering Lab	0-0-2	1
ESC	ME102	Engineering Graphics	3-1-0	4
ESC	ME153	Engineering Graphics Lab	0-0-2	1
		Total		20
YEAR-01				
SEMESTER-2				
Course category	**Course Code**	**Title of course**	**L-T-P**	**Credits**
BSC	AM102	Engineering Mathematics-II	4-1-0	5
ESC	EE101	Basics of Electrical Engineering	3-1-0	4
ESC	EE102	Basics of Electrical Engineering Lab	0-0-2	1
ESC	CS101	Introduction to C Programming	0-0-10	5
PW	AS101	Engineering Exploration	0-0-6	3
MC	CL101	English-I	2-0-0	2
		Total		20
YEAR-02				
SEMESTER-3				
Course category	**Course Code**	**Title of course**	**L-T-P**	**Credits**
PCC	EC107	Analog Electronics	3-0-0	3
PCC	EC108	Analog Electronics Lab	0-0-2	1
PCC	EC105	Digital Electronics & Logic Design	3-0-0	3
PCC	EC106	Digital Electronics & Logic Design Lab	0-0-2	1
ESC	ME152	Manufacturing Practice	0-0-4	2
PCC	EC120	Control System	3-0-0	3
PCC	EC123	Analog and Digital Communication	3-0-0	3
PCC	EC124	Analog and Digital Communication Lab	0-0-2	1

PCC	EC111	Signals & Systems	3-0-0	3
PCC	ES101	Environmental Sciences	2-0-0	2
MC	GW	Global Week		2
PCC	EC113	Measurement & Virtual Instrumentation Lab	0-0-2	1
	CS201	Engineering Exploration	0-0-4	2
		Total		27

YEAR-02

SEMESTER-4

Course category	**Course Code**	**Title of course**	**L-T-P**	**Credits**
PCC	EC114	Microelectronic Circuits	3-0-0	3
PCC	EC115	Microelectronic Circuits Lab	0-0-2	1
PCC	EC116	Linear Integrated Circuits	3-0-0	3
PCC	EC117	Linear Integrated Circuits Lab	0-0-2	1
PCC	EC118	Digital Signal Processing	3-0-0	3
PCC	EC119	Digital Signal Processing Lab	0-0-2	1
PCC	EC109	Microprocessor &Microcontroller	3-0-0	3
PCC	EC110	Microprocessor & Microcontroller lab	0-0-2	1
PCC	EC112	Network Analysis & Synthesis	3-0-0	3
MC	CS501	Cyber Security	3-0-0	3
		Total		22

YEAR-03

Courses are being offered according to Specialization Tracks starting from Fifth Semester for Batch 2019

SEMESTER-5

Course category	**Course Code**	**Title of course**		**L-T-P**	**Credits**
PCC	EC125	Digital VLSI Design		3-0-0	3
PCC	EC126	Digital VLSI Design lab		0-0-2	1
PCC	EC127	Electromagnetic waves and Antenna		3-0-0	3
ESC	EC129	Application Development using Python		0-0-8	4
OEC		Open Elective-1		0-0-8	4
PEC		PE 1	(As per specialization track)	3-0-0	3
PEC		PE 1 Lab		0-0-2	1
		Total			19

YEAR-03					
SEMESTER-6					
Course category	**Course Code**	**Title of course**		**L-T-P**	**Credits**
OEC		Open Elective-2		0-0-8	4
PEC		PE-3		0-0-8	4
PCC	CL601	Life Skills		4-0-0	4
PW	EC131	Major Project		4-0-0	4
PEC		PE-2	(As per specialization track)	3-1-0	4
PEC		PE-4		4-0-0	4
		Total			24

Scheme-I
YEAR-04
For the students doing semester track
Year IV: In the final year of BE(ECE) programme, the student has the option of doing Co-op track or semester track. In the co-op track, the student take up a yearlong co-op project at a designated industry, while in the semester track, the student takes regular courses at campus and in the other semester takes up internship at a designated industry.

SEMESTER-7					
Course category	**Course Code**	**Title of course**		**L-T-P**	**Credits**
PCC	EC128	Wireless and mobile communication		3-0-0	3
PW	EC132	Seminar		2-0-0	2
PEC		PE-5	(As per specialization track)	3-1-0	4
PEC		PE-5 lab		0-0-4	2
PEC		PE-6		4-0-0	4
		Total			15

YEAR-04				
SEMESTER-8				
Course category	**Course Code**	**Title of course**	**L-T-P**	**Credits**
PW	EC133	Industry Oriented Hands on Experience (Six Month Industrial Training)	24 weeks	15
GC		Generic Course Offered by the University		Max credits to be earned 6***

Scheme -II				
YEAR-04				
For students doing Co-op Track				
SEMESTER-7				
Course category	**Course Code**	**Title of course**	**L-T-P**	**Credits**
PW	EC134	Co-op Project at Industry: Module I	24 weeks	15
		Total	24 weeks	15
YEAR-04				
For students doing Co-op Track				
SEMESTER- 8				
Course category	**Course Code**	**Title of course**	**L-T-P**	**Credits**
PW	EC136	Co-op Project at Industry: Module II	24 weeks	15
GC		Generic Course Offered by the University		Max credits to be earned 6***
Entrepreneurial Skill development / Start-up Activity				
Course Code	**Title of course**		**L-T-P**	**Credits**
ER101	CEED Acceleration Program(CAP) Cohort-II-Module I		0-0-4	3 credits
ER102	CEED Acceleration Program(CAP) Cohort-II-Module II		0-0-4	2 credits

* The student have a choice to opt for PE-4 (4 credits) and seminar (2 credit) or to choose entrepreneurial skill development /startup activity (5 credits).

** L-T-P can be changed as per the teaching methodology used for the conduct of the subject

*** GC This is applicable to the students who opt for generic courses NSS/NCC as per UGC.

Table 3: List of Electives

Track⟶ Names		**Robotics &Automation**		**VLSI**		**IOT &Embedded**		**Core Full Stack**		**Credits**
PE	PE1	EC202	Robotics Lab-1	*EC220*	Low Power VLSI System Design	EC237	Sensor and Communication Protocol	EC204	Digital Image Processing	4
		EC210	Robotics system modeling and control	*EC221*	Low Power VLSI System Design lab			EC205	Digital Image Processing Lab	
								EC262	Machine learning	4
	PE2	EC209	Introduction to Robotic sensor	*EC224*	Mixed Signal Circuit Design	EC249	IoT application development	EC203	Bio-medical electronics	4
								EC233	Speech and Audio processing	4
	PE3	EC225	Aerial and Mobile Robotics	*EC211*	High Speed VLSI Design Circuits	EC139	Introduction to CCNA routing and switching	EC208	Electronic System design	4
		EC229	Robotics lab -2	*EC212*	High Speed VLSI Design Circuits lab					
	PE4	EC216	Biomedical Robotics	EC201	Analog Layout Design	EC217	IOT and Industrial Application	EC206	Digital system Design	4
								EC207	Digital System Design Lab	
								EC266	Cloud Computing & Virtualization	4
	PE5	EC231	Machine Vision	*EC234*	VLSI design and Verification	EC241	Cloud Computing for IoT	EC214	Introduction to MEMs	4
		EC2	Robotics Lab-3	*EC235*	VLSI Design and			EC121	Embedded system design	4

		32			Verification lab			EC122	Embedded system design Lab	
	PE6	EC269	Artificial Intelligence & expert system	EC244	IC Fabrication & Technology	EC236	Wearable technology and reality	EC213	Information Theory and Coding	4
								EC215	Introduction to mobile technology	4
								EC222	Microwave and Satellite communication	4
								EC223	Microwave and Satellite communication lab	
								EC226	Optical communication system	4
								EC239	Advance Wireless Communication	4
								EC243	Wireless Sensor Network	4
	OE1	EC252		Scientific computing						4
		EC273		Computer system Architecture						4
		EC270		Computer Networks						4
		CS115		Operating Systems						4
		EC251		Database Management System						4
		EC271		Object Oriented Software Engineering						4
		EC272		Advanced Programming Concepts						4
		CS114		Data Structures						4
		AM104		Numerical Methods and Statistical Techniques						4
	OE2	GI101		Numerical Ability & logical reasoning						4
		EC275		Essentials of Information Technology						4
		EC227		Probability Theory and Random Processes						4
		EC228		Project Management						4

		EC259	Data Analytics	4
		GW2001	G-Visions	NC

6. Assessment and Evaluation

The internal evaluation will be continuous and in order to map the entire range of thinking skills of students from low to high. The weightage of internal and external evaluation would be selected as per the type for various courses such as: Theory courses, Practical Courses, Integrated Projects, Programming courses and Seminar etc, and is elaborated in the table 4 below.

Table 4: Evaluation components for various Courses

Sr. No.		Internal Evaluation (% weightage)	External Evaluation (% weightage)	Total Weightage of the course
1	Theory	40	60	100%
3	Lab	60	40	
5	Industry	100	0	

There are Sessional Tests (STs) for all theory papers, the average of best is considered. The policy on the evaluation component – 'Quizzes / Tutorials / Assignments' is decided by the course coordinator and Dean and is announced separately for each course. The End Term examination for practical courses includes conduct of experiment and an oral examination (viva voce). The components for practical based courses comprise of lab performances, file work, internal and external viva-voce. The project-based courses evaluate the performance of students through presentation of their work in the form of demonstration of the prototype and project report. The medium of examination is English.

Criteria to Pass Examination: Based on the marks obtained by the student in a particular course as described in tables above, the grade in that course is obtained, in accordance with the table 5.

7. Rules for Attendance

Students are expected to be regular in attending the classes. 75% attendance (of all held sessions – lectures, tutorials, lab) is compulsory in a course in order to be eligible for appearing in end term comprehensive examination. 10% concession in this mandatory requirement is possible only in extreme circumstances and at the sole discretion of the Vice Chancellor. 5% concession is possible only in case of extreme circumstances and at the sole discretion of the Head of the Department. Students are encouraged for participating in co-curricular activities conducted by prestigious institutions at national/International level. Such students would be eligible for grant of special Duty Leaves (limited by a cap decided by the Vice Chancellor) to make up for the attendance, in case any class work is missed during this period. This privilege extended to the students will not be termed as right and is limited to just the attendance benefit. *There is no weightage for attendance in evaluation criteria.*

8. Grading System

The list of letter and non-letter grades, their applicability and connotation are given below:
Letter Grades

Table 5: Grading scheme

% Marks Range of Total	Grade	Qualitative Meaning	Grade Point
80 – 100	O	Outstanding	10
70 – 79	A+	Excellent	9
60 – 69	A	Very Good	8
55 – 59	B+	Good	7
50 – 54	B	Above Average	6
45 – 49	C	Average	5
40 – 44	P	Pass	4
0 – 39	F	Fail	0
	I	Incomplete	0

If a student obtains grade P or above, he is declared pass in that subject. The grade F is equivalent to being fail in that subject, in the latter case, the student has to reappear in the end term examination of that subject, whenever its exam is conducted again with the regular examination, after payment of appropriate examination fee.
If the student is detained from appearing in the end term examination because of shortage of attendance in the regular semester or is absent in the end term exam, his grade in that subject is 'I', till he/she appears again in the end term examination and obtains a new grade.

The grade I (Incomplete) may be awarded in the following conditions:

(i) Where a case of unfair means is pending, a 'Grade I' is awarded till the case is finalized.
(ii) Where a case of indiscipline is pending, a 'Grade I' is awarded till the case is finalized.
(iii) In cases of unfair means and indiscipline where the results for a particular examination are declared can be declared as null and void.
(iv) In cases, where the student does not complete his course work because of some reason viz, shortage of attendance / is absent in the end term examination.

In case the grades are not received by the University as per the time schedule the, the Dean of department may make a specific authorization for the Course coordinator to report GA (Grade Awaited). The dean of department will also simultaneously advise Dean Examination about the estimated time by which the grades will be received. Whenever the report GA appears in the grade sheet, permission for further registration of such a student will be decided by Dean of School.
The Cumulative Grade Point Average (CGPA) denotes the overall performance of a student

in all courses in which he is awarded letter grades. It is the weighted average of the grade points of all the letter grades received by the student from the time of his entry into the University.

Calculation of CGPA:

The CGPA (calculated on a 10-point scale) would be used to describe the overall performance of a student (from the semester of admission till the point of reckoning) in all courses for which LETTER GRADES will be awarded. SGPA will indicate the performance of student for any particular semester. Formulas for calculation of SGPA and CGPA have been provided as below:

$$SGPA_i = \frac{\sum_{j=1}^{n} C_{ij} G_j}{\sum_{j=1}^{n} C_{ij}} \qquad CGPA = \frac{\sum_{i=1}^{N}\left(GPA_i * \sum_{j=1}^{n} C_{ij}\right)}{\sum_{i=1}^{N}\left(\sum_{j=1}^{n} C_{ij}\right)}$$

Where n = number of subjects in the semester; N = number of semesters; GPA_i = GPA for the ith semester; C_{ij} = number of credits for the jth course in ith semester; and G_j = Grade point corresponding to the grade obtained in the jth course.

Example to Understand the Calculation of SGPA

Suppose a student is registered in four courses 'W', 'X', 'Y' and 'Z' in a particular semester as mentioned below in the Column - I of the table. Column - II in the table 8 depicts the number of credits, which those courses carried. At the end of the semester, student was awarded with the grades as mentioned in Column – III in the table given below. Column – IV indicates the corresponding grade weight. Column – V and Column – VI indicate essentially the Credit value and Grade Points for every course completed by a student in that particular semester.

Table 6: Number of Credits and Courses

Courses in which student registered (Col. I)	Credits (Col. II)	Letter Grade (Col. III)	Grade Value (Col. IV)	Credit Value (Col. V)	Grade Points (Col. VI)
Course W	3	B	6	3 x 6	18
Course X	3	A	8	3 x 8	24
Course Y	3	O	10	3 x 10	30
Course Z	2	O	10	2 x 10	20
Total	11			Total	92

Thus, the total GPA of the student would be =

$$SGPA = \frac{Total\ grade\ pts.}{Total\ no.of\ credits} = \frac{92}{11} = 8.36$$

Suppose the GPA of the student in two successive terms is 7.0 and 8.0 with respective course credits being 12 and 11, then the

$$CGPA = \frac{7x12 + 8x11}{12 + 11} = \frac{84 + 88}{23} = 7.48$$

9. Promotion and Registration

Any bonafide student, who appears for the examination conducted by the University, shall be promoted to the next higher semester and shall carry forward all course(s) / subject(s) in which he/she is declared fail. The student shall have to pass all papers within stipulated maximum duration to qualify for the award of degree.

All students are eligible to register for next semester irrespective of number of backlogs unless if:

1) He/She has dues outstanding to the University, hostel, or any recognized authority or body of the University.
2) His/Her grade sheet in his immediately preceding term is withheld.
3) He/She has been specifically debarred or asked to stay away from that term.

Late registration may be granted in case a student fails to register on the stipulated date. Student failing to register on the specified day of registration will be allowed to register only after permission from Dean of the Department and after paying the stipulated late fee. Any student who has not registered will not be allowed to attend classes. The registration of the student may be cancelled, if at the later stage, it is found that the student is not eligible for registration due to following reasons:

a) If the registration of a student in a course is not found to be in accordance with the regulations, his/her registration in that course will be cancelled and the grade obtained, if any, will be rejected.
b) The registration of a student in a course or complete set of courses in a term can be cancelled by the concerned authority when he is found guilty in cases of unfair means, breach of discipline, etc. or when he/she persistently and deliberately does not pay his dues.
c) Absence for a period of four or more weeks at a stretch during a term shall result in automatic cancellation of the registration of a student from all the courses in that term.

10. Migration/Credit Transfer Policy

The following procedures will be followed for credit transfer for student under migration, studied in other Universities in India and Abroad:

"The credits earned by the student from the other universities in India or abroad shall be transferred as such.The Degree shall only be awarded to candidate subject to the condition that student earned the minimum no. of credit defined by Academic Regulation/APG of the Programme run by the Chitkara University."

In case a student undergoes international exchange programme or internship for 1 semester/ 1 year, then the courses, credits and grades earned by the student in abroad during that period should be reflected on the grade card issued by the Chitkara University. The courses will be marked as (*) on the grade card/transcript. The description of the (*) will be "credits and grades as adopted university/institute name . . . . . during international exchange programme.

11. Eligibility to Award the Degree

A student is deemed to have fulfilled the requirement of graduation for a degree or a higher level degree when he has:

(i) Cleared all Courses prescribed for the programme
(ii) Earned the minimum credits required for the programme as described in the "APG"
(iii) Obtained the minimum CGPA 4.5 for the award of degree in the UG programmes
(iv) Satisfied all requirements of these regulations.
The minimum credits to be earned are given in table 7

Table 7: Minimum Credits to be Earned for Award of Degree in BE

Course / Year	BE in Electronics and Communication Engineering
Year I	40
Year II	49
Year III	43
Year IV	30
Total	**162**

It is mandatory for the student to earn minimum 162credits by clearing mandatory course and elective courses. The student can choose electives of his interest from the list of electives attached in the scheme. The student can earn more credits if he avails opportunity offered by university in the form of Generic Courses*** (GC) that falls in category of extracurricular activities/NCC/NSS/vocational courses/sports etc.

A student is deemed to have become eligible for the degree if, in addition to satisfying the above requirements, he has:

(i) Satisfied all rules of evaluation

(ii) No case of indiscipline or unfair means is pending against him.

However, in case of a student having outstanding dues against him to be paid to the University, Hostel or any other recognized organ of the University, his degree will be withheld until the said dues are cleared. Under extreme circumstances where gross violation of graduation is detected at a later stage, the Academic Council may recommend the Governing Body to recall the degree already awarded.

* Generic Courses (as in Table 8) are not mandatory to opt.
** Scheme I is 6 months Training track and Scheme II is Co-op Track

12. Programme Overview

Table 8: Break up of Semester

Course Category	Category	Credits											
		I	II	III	IV	V	VI	VII		VIII		Total	
								Scheme I**	Scheme II**	Scheme I**	Scheme II**	Scheme I**	Scheme II**
BSC	Basic Science Course	10	5	-	-	-	-	-	-	-	-	15	15
ESC	Engineering Science Course	10	10	2	-	4	-	-	-	-	-	26	26
PCC	Programme Core Course	-	-	21	19	7	4	3	-	-	-	54	51
PEC	Programme elective Course	-	-	-	-	4	12	10	-	-	-	26	16
OEC	Open Elective Course	-	-	-	-	4	4	-	-	-	-	8	8
MC	Mandatory course	-	2	2	3	-	-	-		-	-	7	7
PW	Project work	-	3	2	-	-	4	2	15	15	15	26	39
GC	Generic Course*	-	-	-	-	-	-	-	-	6*	6*	-	-
Total												162	162

* Generic Courses (as in Table 8) are not mandatory to opt.
** Scheme I is 6 months Training track and Scheme II is Co-op Track

YEAR-01
SEMESTER-1

Course Code	Course Name	L-T-P	Credits
AM101	Engineering Mathematics- I	(4-1-0)	5

Course Learning Outcomes (CLO):

CLO1: Use the matrices to present mathematical solutions in a concise and informative manner to the problems related to linear equations.

CLO2: Solve problems related to local extreme values of functions of several variables, related application problems using Lagrange multipliers and examine the conditions for the existence of absolute extreme values.

CLO3: Skill for applying the principles of Integral Calculus to solve a variety of practical problems in Engineering and applied Sciences.

CLO4: Skill to employ appropriate regression models in determining statistical relationships through interpretation with the help of probability & distributions and hypothesis testing for means, variances and proportions of large as well as small data.

Review of matrices and determinants, Elementary operations, rank, Inverse of matrix (using rank), Normal form, Cayley Hamilton theorem (without proof), Solution of a system of linear equations by using rank, Characteristics equations, Eigen values and vectors, Diagonalization, Canonical form, Quadratic form. Curve Tracing: curve tracing (Cartesian and polar curves)- Cissoid, cardiod, Leminscate, Folium of Descartes, Three/Four Leaved Rose, Limacon. Introduction to Partial Derivatives: Function of several variables, Limit and continuity Partial Differentiation, Euler's Theorem, Total derivatives, Error & Approximation, Tangent and Normal. Partial Derivative of Composite Functions, Implicit Functions, Jacobians, Taylor's Series Expansion, Maclaurin's Series (one and two variables). Application: Maxima and Minima of functions of two and three variables, Lagrange's method of Undetermined Multipliers. Curve tracing, Introduction to Double Integration using Cartesian & polar coordinate, Change of order in double integration, Introduction to Triple Integration, Change of variables in Polar, Cylindrical and Spherical Coordinates, Applications of multiple integral to find Area enclosed by Plane curves, Applications of multiple integral to find Volume, Moment of Inertia, Centroid, Center of Gravity, Improper integrals of first and second kind, Special Functions: Beta and Gamma functions. Vector Function (Derivative and integral), tangent to the curve, Unit tangent, Scalar and Vector Field, Gradient and its Physical Interpretations, Directional Derivatives. Divergence and its Physical Interpretations, Curl and its Physical Interpretations, Properties of Gradient, Divergence and Curl, Line Integrals, Surface & Volume Integral, Green's Theorem in the Plane (without proof) and applications, Stoke's Theorem (without proof) and applications, Gauss Divergence Theorem (without proof) and applications.

Recommended Books:

1. "Advanced Engineering Mathematics", Erwin Kreyszig, Wiley India Pvt. Ltd.
2. "Engineering Mathematics", Srimanta Pal & Subodh C. Bhunia, Edition 2015, Oxford University Press.

3. “The Engineering Mathematics”, 2nd Edition, Chitkara University Publication, Vol. I.
4. “Higher Engineering Mathematics”, B.V. Ramana, Tata McGraw-Hill Education.
5. “Advanced Engineering Mathematics”, R.K. Jain and S.R.K. Iyengar, Alpha Science International Ltd.
6. “Higher Engineering Mathematics”, B.S. Grewal, Khanna Publications.
7. “A text book of Engineering Mathematics”, N. P. Bali and Manish Goyal, Laxmi Publications.
8. “Vector Analysis with applications”, by MD. Ali Ashraf, MD. Abdul Khaleq Hazra, Published by New Age International (New Delhi).
9. “Calculus”, by Howard Anton, Irl Bivens Stephens Davis.
10. “Advanced Engineering Mathematics”, H.C. Taneja,I.K. International, Vol I..

Course Code	Course Name	L-T-P	Credits
PH101	Engineering Physics	(3-1-0)	4

Course Learning Outcomes (CLO):

CLO1: Apply the knowledge of physics through fundamental concepts together with analytical tools in everyday life.

CLO2: Analyze a physical problem, and suggest appropriate possible solution based on the physics concepts.

CLO3: Explore physical systems by setting up experiments, collecting and analyzing data, identifying sources of uncertainty, and interpreting their results in terms of the fundamental principles and concepts of physics

CLO4: Evaluate and analyze scientific measurement and error analysis.

CLO5: Skill to apply the fundamental concepts of physics to related engineering problems.

Vector and scalar fields, Gradient, divergence, curl and their physical interpretation, Gauss's theorem and Stokes theorem (Statement only), Equation of continuity, Maxwell's equations (Integral & differential form), Maxwell's equations in free space, Propagation of electromagnetic waves in free space. Energy bands in solids, Metals, Semiconductors, Insulators, Intrinsic and extrinsic semiconductors, Free electron theory, fermi energy, carrier concentration of semiconductors, drift current density, Mobility effects, Conductivity, V-I characteristics, Diffusion Current Density, Total Current Density, Hall Effect (Qualitative Idea) Introduction, Laser characteristics such as coherence, monochromaticity, collimated and angular divergence, laser action, stimulated absorption, spontaneous emission, stimulated emission, Population inversion and pumping. Derivation of Einstein's coefficient relation, Various level lasers, two level, three level, four level, Ruby laser, Helium-Neon laser, Semiconductor laser, concepts of Holography, LASER Applications in engineering. Basic principle of optical fiber, step index and graded index fibers, Parameters of optical fibers, acceptance angle, acceptance cone, numerical aperture, normalized frequency, No. of modes, Attenuation in optical fibers, intermodal and intramodal dispersion (no derivation), optical fibers in communication, Applications of optical fibers in engineering. Terminology and classification, Derivation of Magnetic moments of an atom, Ferromagnetism and related phenomena, Ferrites, The domain structure, The hysteresis loop, Types of magnetic materials, soft magnetic materials, hard magnetic materials, applications of magnetic materials in engineering. Introduction, Meissner effect, critical field, critical current, Isotope effect, Types of superconductors: type I superconductors, type II superconductors, London equations, Penetration depth, Cooper pair and BCS theory (Qualitative only), high temperature superconductors. Applications of superconductivity. Introduction to Quantum Mechanics, Group velocity and phase velocity (No relation), de-Broglie waves, Uncertainty principle (statement only), Wave function and its significance, Normalized wave function, Time

Independent Schrodinger wave equations, Time dependent Schrodinger wave equations, Particle in one dimensional box.

Recommended Books

1. H. K. Malik and A. K. Singh, Engineering Physics, Mc Graw Hill Education.
2. Engineering Physics by Chitkara Publication 2nd Edition.
3. Donald A Neamen and Dhrubes Biswas, Semiconductor Physics and devices, Mc Graw Hill Education.
4. Avadhanulu, M.N., 2008. A textbook of engineering physics. S. Chand Publishing.

Course Code	Course Name	L-T-P	Credits
PH103	Engineering Physics Lab	(0-0-2)	1

Course Learning Outcomes (CLO):

CLO1: Students would be able to correlate practical knowledge of physics with the theoretical concepts.

CLO2: Students would achieve perfectness in experimental skills related to physics fundamentals.

CLO3: The study of practical applications will bring more confidence.

CLO4: Ability among the students to design, perform, document and analyze advanced experiments in physics to enhance their skills.

Electrical Properties of Materials: To determine the ionization potential of mercury using a gas filled diode. To determine the e/m ratio of electron using Thomson method. Find out the polarizability of a dielectric substance by using dielectric constant kit. To study the Hall effect in a semiconductor. Quantum Mechanics: To determine Planck's constant by using light emitting diodes. Magnetic Materials: To find out the Susceptibility of FeCl3 by Quinke's Method. Study the variation of magnetic field with distance along axis of a circular coil carrying current. To draw the B-H curve of a given magnetic material. Lasers and Optics: To determine the wavelength of light using Michelson's Interferometer. To determine the resolving power of a plane transmission grating. To measure the specific rotation of cane sugar solution using Laurent's half shade polarimeter. Study of Diffraction using Laser beam and thus to determine the wavelength/grating element. To study the laser beam characteristics like wave length, aperture & divergence etc. Fibre Optics: Determination of Numerical aperture of an optical fibre. To determine attenuation & propagation losses in optical fibres.

Recommended Books

1. Squirres, Practical physics, Cambridge University press.
2. H. K. Malik and A. K. Singh, Engineering Physics, Mc Graw Hill Education.
3. Engineering Physics by Chitkara Publication 2nd Edition.
4. Avadhanulu, M.N., 2008. A textbook of engineering physics. S. Chand Publishing.

Course Code	Course Name	L-T-P	Credits
EC101	Basics of Electronics Engineering	(3-1-0)	4

Course Learning Outcomes (CLO):

CLO1: Students would know the basics of electronics elements, their functionality and applications. They would be able to perceive the concept of logic gates and integrated circuits in electronics.

CLO2: Skilled to interpret the characteristics of various types of diodes and transistors to describe the operation of related circuits for evolving engineering solutions.

CLO3: Students would be able to apply fundamental principles of electronics together with analytic tools to evaluate and describe physical situations appropriate to address a scientific problem.

CLO4: Students would possess a skill to explore physical systems by setting up experiments, collecting and analysing data, identifying sources of uncertainty, and interpreting their results in terms of the fundamental principles and concepts of electronics.

CLO5: Skilled to apply fundamental principles of electronics together with analytic tools

Semiconductor Theory (Energy Band Structure, Classification of Semiconductors, Doping). Theory of PN junction diode, V-I Characteristics of a pn junction diode under forward and reverse bias. Zener diode, Breakdown in Zener diode (Avalanche and Zener), V-I Characteristics of Zener diode. Varactor diode and its characteristics. Opto-Electronic Devices: Photodiode, Light Emitting Diode (LED). PN diode applications, Diode as a Switch, Zener Diode as Voltage Regulator, Use of Diodes in Rectifiers, Half Wave, Full Wave Centre-tap and Bridge Rectifier (Circuit diagram , Waveforms), Derivation of average and rms value of voltage, ripple factor, Peak Inverse Voltage, dc power, Efficiency, Comparison of different rectifiers, Diode Clippers: Positive and Negative Clippers. Introduction of Bipolar Junction Transistor (BJT), Construction of BJT, BJT Biasing, Operation of NPN and PNP BJT, Types of Transistor Amplifier Configurations: Common Base (CB), Common Emitter (CE), Common Collector (CC); Transistor Characteristics: Input and Output Characteristics of CB and CE Configurations. Transistor Parameters (Input Impedance, Output Admittance, forward current gain, reverse voltage gain), Comparison of CB, CE and CC Configurations (Why is CE Configuration widely used in amplifier circuits?). Number Systems : Decimal, Binary, Octal and Hexadecimal ; Conversion from one number system to another, Binary Arithmetic (Addition, Subtraction, Multiplication, Division), 1's and 2's Complement, 1's complement and 2's complement subtraction, Logic Gates (OR, AND, NOT, NAND, NOR, Ex-OR, Ex-NOR), DeMorgan's Theorems, Realization of basic gates using Universal gates; Realization of logic expressions using basic gates. Introduction to Combinational and Sequential Logic, Latch and RS Flip Flop

as memory element: Circuit Diagram and Truth Table. IC 555 Timer, Functional Block diagram of 555, Modes of operation of IC 555: Astable, Monostable and Bistable, Voltage Regulator IC 7805.

Recommended Books

1. R. Muthusubramanian, S. Sahlivahanan 'Basic Electrical and Electronics Engineering', by McGraw Hill, First Edition, 2010.
2. N. N Bhargava, D. C Kulshreshtha, S. C Gupta; 'Basic Electronics and Linear Circuits', McGraw Hill Publications, Second Edition, 2013.
3. D. P. Kothari, I. J. Nagrath, 'Basic Electronics', McGraw Hill, Second Edition, 2014.
4. D. K. Bhattacharya, Rajnish Sharma, 'Solid State Electronic Devices', Oxford University Press, Second Edition, 2013.
5. Albert Malvino, David J. Bates, 'Electronic Principles", Mcgraw Hill Education, Seventh Edition, 2007.

Course Code	Course Name	L-T-P	Credits
EC102	Basics of Electronics Engineering Lab	(0-0-2)	1

Course Learning Outcomes (CLO):

CLO1: After completing the course, students would know the basics of electronics elements, their functionality and applications and would be able to design basic electronics projects.

CLO2: They would be able to analyze and characterize the electronic circuits and have basic understanding for their implementation.

CLO3: They would possess a skill to perceive the concept of logic gates like XOR and X-NOR and integrated circuits in electronics.

CLO4 Skill of explaining the basics of electronics fundamentals

CLO5: Development of hands on training skill.

Familiarization with basic electronic components and Identification of linear and non-linear elements based on VI characteristics. Plot and analyze the forward and reverse characteristics of PN junction Si and Ge diodes and determine their knee and breakdown voltages. Analyze Zener diode as voltage regulator and observe the output voltage with variable input voltage and fixed load resistance for Zener diodes with different breakdown voltages. Study and observe the output waveform of half-wave and full wave rectifiers on CRO and calculate the average and rms values of output voltage and current. Analyze the NPN/PNP transistors in common emitter configuration and plot their input and output characteristics. Analyze the truth tables of various logic gates and Implement 2-input XOR gate and 2-input X-NOR gate using basic gates. Study the operation of astable, monostable and bistable multivibrators using 555 timer. Plot and analyze the V-I characteristics of Light Emitting Diode (LED) in forward biasing. Plot and analyze the V-I characteristics of Avalanche photo diode. To test the varactor diode by applying reverse voltage and see the corresponding change in capacitance across PN junction. Plot the graph between applied reverse voltage (Vr) versus capacitance (C).

Recommended Books

1. R. Muthusubramanian, S. Sahlivahanan ‘Basic Electrical and Electronics Engineering’, by McGraw Hill, First Edition, 2010.
2. N. N Bhargava, D. C Kulshreshtha, S. C Gupta; ‘Basic Electronics and Linear Circuits’, McGraw Hill Publications, Second Edition, 2013.
3. D. P. Kothari, I. J. Nagrath, ‘Basic Electronics’, McGraw Hill, Second Edition, 2014.
4. D. K. Bhattacharya, Rajnish Sharma, ‘Solid State Electronic Devices’, Oxford University Press, Second Edition, 2013.
5. Albert Malvino, David J. Bates, ‘Electronic Principles”, Mcgraw Hill Education, Seventh Edition, 2007.

Course Code	Course Name	L-T-P	Credits
ME102	Engineering Graphics	(3-1-0)	4

Course Learning Outcomes (CLO):

CLO1: Improve the technical writing, basic sketching and drawing.

CLO2: Use engineering scale effectively

CLO3: Use dimensioning effectively.

CLO4: Use development of surfaces.

CLO5: Skilled to Communicate through Engineering Graphics.

Introduction of Engineering Drawing & Drawing Instruments: Classifications of Drawing, Drawing Instruments, Use of Drawing Materials, Drawing Sheet and its Sizes. LETTERING: Single Stroke Vertical Gothic Lettering, its sizes and dimensioning, Inclined Italic Gothic Lettering (Ratio of 7:5) and freehand writing practice. Conventions: for lines, Various Materials and breaks. Dimensioning: Different types of dimensioning, their symbols, notations and placement. SCALES: Types of scales, Plain scale, Diagonal scale. PROJECTION OF POINTS: Introduction, concept of horizontal and vertical planes, first and third angle projections; conventional representation of points & its projection in all the four quadrants Projection of Lines-1: Introduction, projection of lines parallel & angular to principal planes, true lengths of lines and their horizontal and vertical traces (inclination to one reference plane)Projection of lines-2: projection of lines,, true length of lines and their horizontal and vertical traces(inclination to both reference plane), Projections of Planes: Introduction, Projection of planes parallel and angular to principal planes and their traces . Projection of solids-1: Projection of right solids; solids of rotation and polyhedrons etc. (inclination to one reference plane). Projection of solids-2: projection of right solids, solids of rotation and polyhedrons etc.(inclination to both reference plane). Sectioning of Solids: Principles of sectioning, types of sectioning, and their practice on projection of solids, sectioning by auxiliary planes. Development of surfaces: Development of surfaces of cylinders, cones, pyramids and prisms. Orthographic Projection: practice in orthographic projections. Isometric projection: concept of isometric views; isometric scales and exercises on isometric views.

Recommended Books:

1. P.S. Gill; **"**Engineering DrawingEleventh edition, S.K. Kataria & Sons.
2. R. K. Dhawan; "Engineering Drawing2014 Edition, S. Chand and Company.
3. Gupta, B.V.R., 2008. *Engineering Drawing*. IK International Pvt Ltd.
4. Pal, S. and Bhattacharyya, M., 2005. *Engineering Drawing*. Viva Books.

Course Code	Course Name	L-T-P	Credits
ME153	Engineering Graphics Lab	(0-0-2)	1

Course Learning Outcomes (CLO):

CLO1: Students would know the basics commands of the AutoCAD and their practical application.

CLO2: Skilled to use various draw and modify commands to achieve practical industrial drawings.

CLO3: They would be able to understand the usage of various drawing aids to achieve required drawings.

Introduction of the CAD (computer aided drafting) software and its utilities in the engineering software. Study of the various toolbar options and exercises to familiarize all the drawing tools. Study the basic initial setting and viewing of the drafting software interfaces. Use of basic entities in 2D. Uses of various modify commands of the drafting software. Dimensioning in 2D and 3D entries. Study and implementation of coordinate systems.

Recommended Books:

1. George Omura, Mastering Autocad 2011 and Autocad LT 2011, Wiley Pub, India
2. Shah Rana; 'Engineering Drawing Second addition ,Pearson Publication.
3. Dhananjay A Jhole 'Engineering Drawing with introduction to Auto CAD';First Addition;Mc Graw Hill.
4. Bhatt ND; Tulsi sadan Anand. 'Engineering Drawing Charotar Book stall, 49th Addition;

YEAR-01
SEMESTER-2

Course Code	Course Name	L-T-P	Credits
AM102	Engineering Mathematics- II	(4-1-0)	5

Course Learning Outcomes (CLO):

CLO1: Develop skill to analyze and correlate many real life problems mathematically and thus find the appropriate solution for them using Fourier series and Transforms (Fourier and Laplace transform).

CLO2: Use ordinary differential equations student will be able to solve various practical problems in Science and Engineering.

CLO3: Skill to recognize and find families of solutions for most real physical processes such as heat transfer, elasticity, quantum mechanics, water flow and others, which are governed by partial differential equations subject to boundary conditions.

CLO4: Recognize functions of complex variables, techniques of complex integrals and compute integrals over complex surfaces to provide solution for relevant physical processes.

Fourier Series: Introduction, Fourier Series on Arbitrary Intervals, Half-range cosine and sine series, Fourier Transform with properties: Fourier Transform Linearity property. Fourier Transform of derivative, shifting and scaling, Convolution. Fourier Cosine and Sine transforms and properties: Fourier Cosine and Sine Transform. Linearity, Shifting and Scaling, Fourier Cosine and Sine transforms of Derivatives, Parseval's Identity. Ordinary Differential Equations: Differential equations of first order and first degree – linear and Bernoulli, equations. Exact differential equations. Equation solvable for p, y and x, Clairaut's equation. Application to orthogonal trajectories. Second and higher order ordinary linear differential equations with constant coefficients –Complementary function - Particular integrals (standard types), Differential Operator Method, Variation of parameters, Method of Undetermined Coefficients. Cauchy-Euler differential equation. Simultaneous linear differential equations (two variables) with constant coefficients, Application to RLC circuit, etc. Laplace transform, inverse transforms properties, Transforms of derivatives and integrals, Unit step functions. Dirac's delta functions, Applications to differential equations. Partial Differential Equations: Formation of partial differential equations - Equations of first Order - Lagrange's linear equation - Charpit's method - Standard types of first order non-linear partial differential equations. Solution of second order linear partial differential equations in two variables with constant coefficients by finding complementary function and particular integral. Classification of PDE of second order - parabolic, elliptic and hyperbolic equations - Solution by separation of variables. Solutions of one-dimensional heat and wave equations and two-dimensional Laplace equation using Fourier series. Functions of Complex Variables: Limits, Continuity, Derivative of Complex Functions, Analytic Function, Cauchy Riemann Equation, Harmonic Functions,

Conformal Mapping, Complex Integration, Cauchy's Theorem, Cauchy Integral formula, Taylors and Laurent's Expansion.

Recommended Books:

1. "The Engineering Mathematics", 1st Edition, Chitkara University Publication, Vol. II.
2. "Higher Engineering Mathematics", B V Ramana, Edition 2009, McGraw Hill.
3. "Advanced Engineering Mathematics" (Vol. I & Vol. II), Dr. H. C. Taneja, I. K. International.
4. Dr. H. C. Taneja, "Advanced Engineering Mathematics" (Vol. I & Vol. II), I. K. International

Course Code	Course Name	L-T-P	Credits
EE101	Basics of Electrical Engineering	(3-1-0)	4

Course Learning Outcomes (CLO):

CLO1: Students would know the basics of DC circuits, Series and parallel connections, Kirchhoff's current and voltage laws, mesh and nodal analysis. They would be able to compute various electrical engineering concepts based on real time applications.

CLO2: Students would possess an ability to analyze and characterize the RL, RC & RLC circuits and have basic understanding of their implementation and also able to compute parameters related to these circuits like impedance and power. They would also learn phenomenon like resonance

CLO3: Students would be skilled to apply and clarify fundamental principles of magnetic effects, magnetism and their functionality for electrical equipment's.

CLO4: Students would possess the skill to conduct experiments, understand the principle, construction and working of Transformers, DC motors and Induction motors.

DC Circuits: Introduction to DC Circuits and related terminology, Series and Parallel combination of resistances, Kirchhoff's Laws: KVL and KCL, Mesh or loop Analysis and Nodal Analysis. Magnetic Circuits**:** Definitions of Magnetic quantities, Magnetic Circuit, Comparison between Electric and Magnetic Circuits Magnetic Effect of Electric Current, Current carrying conductor in magnetic field, Law of EMI, Induced EMF: self-inductance, 0mutual inductance, Coupling Coefficient between two magnetically coupled circuits.AC circuits**:** Generation of Alternating EMF, Terminology, Concept of 3phase EMF generation, RMS value, Average value, Phasor representation of alternating quantities, Analysis of AC circuits: Single phase AC circuits: Representation of alternating quantities in rectangular and polar forms, RL, RC, RLC series circuits and its Power calculations. Resonance in series AC circuits. Three Phase AC circuits: Star Connections, Delta connections. Measurements of power in 3 phase circuits**.** Electrical Machines Transformer: Principle, Construction, Working. DC Motor: Principle, Construction, Working. Three Phase Induction Motors: Principle, Construction, Working. Electrical measuring instruments and transducers**:** Electrical Measuring instruments: Classification of instruments, Basic principles of indicating instruments. Electrical Transducers Introduction, Types of transducer: LVDT, RTD. Thermocouple, Thermistor, Piezoelectric transducer, Photoelectric transducer.

Recommended Books

1. R. Muthusubramanian, S Salivahanan, 'Basic Electrical and Electronics

Engineering', McGraw Hill,2009
2. B.R. Patil, 'Basic Electrical and Electronics Engineering' Oxford Higher Education Revised Second Edition, 2013.
3. T.K Nagsarkar & M.S Sukhija, 'Basic Electrical Engineering', Oxford2017.
4. D.C, Kulshreshtha, 'Basic Electrical Engineering' TMH, 2014

Course Code	Course Name	L-T-P	Credits
EE102	Basics of Electrical Engineering Lab	(0-0-2)	1

Course Learning Outcomes (CLO):

CLO1: After completing the course, students would know the basic components of electrical elements, equipment's and their functionality with applications. With the knowledge of the basic components, students would be able to make basic electrical projects

CLO2: They would possess an ability to analyze and characterize the electrical equipment's and instrument's basics for their implementation.

CLO3: They would be skilled to measure power and power factor of ac circuits and understand three-phase star and delta connections with and without applying loads to calculate 3-phase power.

CLO4: Possess skill to perceive the concept of Fuse/MCB characteristics for different fault currents. Students will be familiarized with appearance and functioning of the MCB and fuse used in their homes.

CLO5: Skilled to conduct experiments, understand the principle, construction and working of electrical devices

To study the use of multi-meter and testing of various components. , Verification of Kirchhoff's Laws i.e KCL and KVL in DC circuits. Analysis of AC circuits: To find voltage, current relationship and power factor in single phase series R-L-C circuits. Measurement of power in single phase series R-L-C circuits. To verify the relation between line and phase quantities in three phase circuits. Measurement of self-inductance, mutual inductance and coupling coefficient of windings. To perform open- circuit and short circuit test on a transformer and determine Efficiency, Voltage ratio. To study speed control of the D.C. shunt motor by Armature control method and Field control method, to Connect; reverse the direction of rotation of a 3- phase induction motor, Measurement of temperature using RTD, Measurement of displacement using LVDT. to study the current – time characteristics of MCBs / Fuse.

Recommended Books:

1. R. Muthusubramanian, S Salivahanan, 'Basic Electrical and Electronics Engineering', McGraw Hill,2009
2. B.R. Patil, 'Basic Electrical and Electronics Engineering' Oxford Higher Education Revised Second Edition, 2013.
3. T.K Nagsarkar & M.S Sukhija, 'Basic Electrical Engineering', Oxford2017.
4. D.C, Kulshreshtha, 'Basic Electrical Engineering' TMH, 2014

Course Code	Course Name	L-T-P	Credits
CS101	Introduction to C Programming	(0-0-10)	5

Course Learning Outcomes (CLO):

CLO1: Choose the appropriate C programming constructs to solve the problems.

CLO2: Demonstrate the advantages and disadvantages of specific techniques to be used.

CLO3: Skilled to differentiate between efficient and inefficient way of programming.

CLO4: Determine and demonstrate bugs in a program and recognize needed basic operations.

CLO5: Formulate new solutions for programming problems or improve existing code to program effectively

Structure of a c program, Compilation, Linking & Execution, Comments in C ,Identifiers: Nomenclature of an Identifier, Variables, Constants, Reserved Keywords , Pre-processor directives: #define , #include, Data Types: Introduction Initialization and Declaration of Data Type, Expressions, Statements, Symbolic Constants, Type, Memory representation of integer, character and float data types. Conversion / Type Casting, Input Output in C: Introduction, scanf(), printf( ), getchar(), putchar(), Operators: Arithmetic, Relational, Logical, Assignment, Conditional, bitwise, sizeof, Precedence of operators and their associativity, Iteration control Statements:: while, do – while, for, Nested loops, Continue, break, Functions: User defined functions, Built-in functions , Pointers: Introduction to pointer, Pointer expression and pointer Arithmetic, Assignment, Value finding (dereferencing),Taking a pointer address, Adding an integer to a pointer, null pointer, generic pointer, void pointer. Function parameter passing mechanisms: call by value, call by reference, call by address, Recursion, Storage classes: auto, register, static, extern, Types of Arrays, 1-D Arrays: Introduction, Need & Importance, Initialization of arrays, inputting values, assigning Values, Passing 1-D to Function, Multi-Dimensional Arrays: Declaration of 2-D Array, Initialization of 2-D Array, passing 2-D array to function, Representing 1-D arrays as pointer, Arrays of pointers, pointer to an array, Representing 2-D arrays as pointer, Dynamic memory Allocation in C, Strings: Introduction, Reading and writing strings, String functions, (Predefined): isalpha(), isdigit(), isspace(), strcat(), strncat(),s trcpy(), strncpy(), strlen(), strlwr(), strupr(), strchr(), strcmp(), strstr(), Pointers and Strings, Passing string to a function, Array of Strings, User defined data types in C, Using typedef keyword, Enumerated data types in C, Structure –Declaring Structure, Accessing members of Structure, Copying Structure, Accessing Structure elements, Nested Structure, Array of structure, passing structure elements to a function individually, Passing entire structure to a function, Pointer to structure, Passing pointer of structure to function, Union.

Recommended Books:

1. Reema Thareja, Programming in C, 2nd Edition, Oxford University Press
2. Vikas Gupta, Computer concepts and C programming, 1st edition, DreamTech Press
3. Dennis Ritchie and Brian. W. Kernighan, The C Programming Language, 2nd edition, Prentice Hall.
4. Yashavant Kanetkar, Let Us C, 17th edition by bpb publishers.

Course Code	Course Name	L-T-P	Credits
AS101	Engineering Exploration	0-0-6	3

Course Learning Outcomes (CLO):

CLO1: Skilled to identify community problems and engineering solutions helps in entrepreneurship.

CLO2: Analyze a given problem using process of engineering problem analysis

CLO3: Build simple systems using engineering design process helps to increase their employability and in entrepreneurship.

CLO4: Ability to communicate efficiently and effectively.

CLO5: Ability to understands the problem.

Introduction to engineering exploration, what is community? Basics of team formation, field visit to community area, understanding the importance of need, engineering design fundamentals, basics of design process, PUGG chart, black box representation, glass box representation. Introduction to mechanisms, different type of mechanisms, crank-shaft mechanism, chain mechanism, rack-pinion mechanism, pulley mechanism, belt mechanism, chain-sprocket mechanism, concept of gears and teeth, gear ratio, relation between speed and torque. Degree of freedom and movements. Introduction to Arduino embedded platform, understanding the different components of platform board, basic programming on Arduino platform, interfacing of peripherals, introduction to sensor, interfacing of Infrared-sensor, ultrasonic sensor, PIR sensor, LDR sensor, interfacing of DC motors, concept of pulse width modulation, speed control of DC motors, H-bridge concept, integrating peripherals to an application. Aspects of project management, allocation of team plan, technical report writing, project execution plan. Developing of working prototype of the solution.

YEAR-02
SEMESTER-3

Course Code	Course Name	L-T-P	Credits
EC107	Analog Electronics	(3-0-0)	3

Course Learning Outcomes (CLO):

CLO1: Develop the ability to understand the design and working of BJT amplifiers

CLO2: Skill to design BJT based circuits and observe the amplitude and frequency responses of common amplifiers.

CLO3: Skill to design and develop the audio and power amplifiers using re and hybrid equivalent models.

CLO4: Develop the skill to build, and troubleshoot analog circuits.

CLO5: Skill to build, and troubleshoot analog circuits in their job

BJT introduction and operation, Common Base Configuration, Common Emitter Configuration DC bias; The Hybrid equivalent model, Approximate Hybrid Equivalent Circuit- Fixed bias, Voltage divider, Emitter follower configuration;. BJT transistor modeling and small signal ac equivalent circuit. Two stage RC- Coupled BJT amplifier to calculate voltage gain, input impedance and output impedance. Introduction to Hybrid Equivalent model. Approximate Hybrid equivalent circuit for Common Base configuration Complete Hybrid circuit to find current gain, voltage gain, input impedance and output impedance. Introduction-Definition and Amplifier Types Series-fed and Transformer-coupled class A Amplifiers Class B Amplifier Operation and Circuits, Amplifier Distortion Class C and D Amplifiers. General Frequency Consideration, Normalization Process, Low Frequency Response BJT Amplifier High Frequency Response. Construction and characteristics of JFET, Transfer characteristics and important relations with BJT, Introduction to Depletion type MOSFET.

Recommended Books

1. Robert L.Boylestad and Louis Nashelsky, 'Electronic Devices and Circuit Theory' by Pearson Publication, 10thEdition, 2009.
2. Albert Malvino 'ELECTRONIC PRINCIPLES' by, McGraw Hill, 7thEdition, 2006
3. Millman- Halkias 'Electronic Devices & Circuits' by, Tata Mcgraw Hill
4. J.D. Ryder, 'Electronic Fundamentals & Application', by, PHI. Electronic Devices, by Floyd, Pearson Education.

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Course Code	Course Name	L-T-P	Credits
EC108	Analog Electronics lab	(0-0-2)	1

Course Learning Outcomes (CLO):

CLO1: To be able to read and interpret electronic datasheets and diagrams.

CLO2: To be able to measure the electronics & electrical parameters of an amplifier like voltage gain, input & output impedance.

CLO3: Skill to design, construct and troubleshoot transistor based amplifier complex electronic circuits

Familiarization with Cathode Ray Oscilloscope, Function Generator and Power Supply. Study and analysis of Fixed base biasing With & without Emitter Resistor and collector to Base Biasing of BJT. Study and analysis of Fixed Bias/Self Bias Circuit and Voltage Divider Bias of BJT. To plot the frequency response of Single stage Common Emitter (CE) Amplifier and calculate its gain and bandwidth. To plot the frequency response of Single stage CB (Common Base) Amplifier and calculate its gain and bandwidth. To plot the frequency response of Single stage CC (Common Collector) Amplifier and calculate its gain and bandwidth. To Calculate the gain and bandwidth of CE amplifier with feedback and without feedback BJT Class A power amplifier-To simulate and verify the efficiency of BJT Class A Power amplifier circuit. BJT Class B Push pull Power amplifier -To simulate and verify the efficiency of Transistor Class B Push pull Power amplifier. BJT Class AB power amplifier- To simulate and verify the efficiency of class AB power amplifier. BJT Class C power amplifier - To simulate and verify the efficiency of class C power amplifier. BJT Complementary Symmetry Push pull power amplifier - To simulate and verify the efficiency of Transistor Complementary Symmetry Push pull power amplifier. BJT Two stage RC Coupled Amplifier - To plot the frequency response of Two stage RC Coupled Amplifier and calculate its gain and bandwidth. To Study VI characteristics of Field Effect Transistor (FET). To Study VI characteristics of Metal Oxide Semiconductor Field Effect Transistor (MOSFET).

Recommended Books

1. Robert L.Boylestad and Louis Nashelsky, 'Electronic Devices and Circuit Theory' by Pearson Publication, 10thEdition, 2009.
2. Albert Malvino 'ELECTRONIC PRINCIPLES' by, McGraw Hill, 7thEdition, 2006
3. Millman- Halkias 'Electronic Devices & Circuits' by, Tata Mcgraw Hill
4. J.D. Ryder, 'Electronic Fundamentals & Application', by, PHI. Electronic Devices, by Floyd, Pearson Education.

Course Code	Course Name	L-T-P	Credits
EC105	Digital Electronics and Logic Design	3-0-0	3

Course Learning Outcomes (CLO):

CLO1: Understand the basics of difference between analog and digital circuits and their applications.

CLO2: Skill to implement simple logical operations required for the designing of digital circuits and understand common forms of number representation.

CLO3: Reduction of Boolean expressions for the designing of minimized logical circuits.

CLO4: Skill to design and implementation of combinational circuits.

CLO5: Skill to design and implementation of sequential circuits and their application.

Introduction to Digital Concepts: Digital and Analog systems, logic levels using the waveform. Logic Gates, symbols and truth table And Gate, OR Gate, Not gate, Universal Gates, Exclusive–OR gate, Exclusive-NOR gate. Number systems: Decimal number system, Binary number system. Representation of signed numbers. Octal number system, Hexadecimal number system. Binary codes: Classification of binary codes. 8421 BCD code, Excess three code, Gray code. Introduction to Error detecting code and Error correcting codes. Boolean algebra: Laws of Boolean algebra. Boolean Functions and their representation: Sum of Product (SOP), Product of Sum (POS), canonical forms. Karnaugh map upto 4 variable. Q-M method of minimization Digital IC families (DTL, TTL, ECL, MOS and CMOS): Comparison in terms of threshold voltage, Propagation delay, power dissipation, Fan in, Fan out, voltage and current parameters, Noise margin, operating temperature and speed power product. Logic families. Combinational circuit: Arithmetic circuits Binary Adders & Subtractors (half, Full, parallel), Magnitude Comparator: Multiplexer and Demultiplexer, Encoder, Priority encoder, Decoder and Code Converters. Sequential circuits: Classification of sequential circuits, Flip flops SR, JK, T, D. Excitation table, Conversion of flip flops. Shift Registers: SIPO, SISO, PISO and PIPO. Counters: Asynchronous counters, design of asynchronous counters, synchronous counters. Shift register counter: Ring counter and Johnson counter. D/A Converter and A/D converters: Introduction, Digital to analog conversion, R-2R DAC, weighted resistor DAC, A/D Converter: Analog to digital conversion using Successive approximation method, Dual slope method. Semiconductor Memories: program and data memory, memory types and terminology, SRAM and DRAM. Programmable Logic Devices: ROM, PAL, PLA, PROM.

Recommended Books:

1. A. Anand Kumar, Fundamentals of digital circuits, 3rd Edition, PHI.
2. Thomas L. Floyd, 10th Edition, Digital Fundamentals, Pearson Publications.
3. M. Morris Mano, Digital Design, 4.ed., Prentice Hall of India Pvt. Ltd., New Delhi,

Sixth impression /Pearson Education (Singapore) Pvt. Ltd., New Delhi.

4. Donald P.Leach and Albert Paul Malvino, Digital Principles and Applications, 5th Edition, Tata McGraw Hill Publishing Company Limited, New Delhi, 2003.

Course Code	Course Name	L-T-P	Credits
EC106	Digital Electronics & Logic Design Lab	(0-0-2)	1

Course Learning Outcomes (CLO):

CLO1: To understand the digital logic and create various systems by using these logics.

CLO2: Develop a skill to understand the design and simulation of digital logic circuits.

CLO3: To get a basic understanding of layout of electronic circuits.

CLO4: Skill to use the Multisim tool for design and simulation.

CLO5: Skill to design and implementation of sequential circuits and their application.

Logic gate is a basic building block of a digital circuit. So verify the truth tables of all the logic gates on trainer kit using TTL ICs. Also verify them using multisim. Mr. Vivek wants to add two numbers in computer but computer only understands the binary numbers i.e. 0&1. So design a circuit that adds binary equivalent of two decimal numbers. Suppose there are two binary numbers as input and subtract one binary number input from other binary number input. Design the circuit using universal gates. Considering two numbers (each two bit), Design a circuit which produces the output that compares whether the number is greater than, less than or equal to the second number. A code represents each number in the sequence of integers {0...2^N-1} as a binary string of length N in an order such that adjacent integers have code representations that differ in only one-bit position. Design a convertor that has above property. Design and verify the methods using which one bit of information can be stored in computers. In digital logic and computing, a counter is a device which stores the number of times a particular event or process has occurred in relationship to a clock signal. Design such a counter which uses a circulating shift register in which last flip flop shifts its value into the first flip flop. Also design a counter in which the inverted output of the last flip flop is connected to the input of first flip flop.

Recommended Books:

1. Anand Kumar, Fundamentals of digital circuits, 3rd Edition, PHI.
2. Thomas L. Floyd, 10th Edition, Digital Fundamentals, Pearson Publications.
3. M. Morris Mano, Digital Design, 4.ed., Prentice Hall of India Pvt. Ltd., New Delhi, Sixth impression /Pearson Education (Singapore) Pvt. Ltd., New Delhi.
4. Donald P.Leach and Albert Paul Malvino, Digital Principles and Applications, 5th Edition, Tata McGraw Hill Publishing Company Limited, New Delhi, 2003.

Course Code	Course Name	L-T-P	Credits
EC120	Control System	(3-0-0)	3

Course Learning Outcomes (CLO):

CLO1: The students would be able to understand operation of basic control systems employed in industries.

CLO2: The students would be able to propose automation solutions to real world problems

CLO3: The students would attain skill to carry out time domain and frequency domain analysis of a designed control system.

CLO4: Skilled to solve automation solutions to real world problems

CLO5: Skilled to carry out analysis of a designed control system.

The control System, Introduction to Open loop control system and closed loop systems. Transfer function of Mechanical, rotational, electrical system, control system components potentiometer, synchro, tachometer, linear SISO systems. Linearisation of nonlinear systems. Responses for some basic systems. Poles and zeros. Block diagram Algebra, transfer function of Signal flow graphs from block diagram , Introduction to State variable approach. Proportional (P-)control. Integral (I-) control explained in the time domain. Classification or time responses, system time response, analysis of steady state error , Type of input and steady state error , Analysis of first order system, second order system, effect of damping ratio on second order system, time response specifications, Concept of stability ,Routh-Hurwitz criterion, Routh's stability criterion. Root locus concepts, construction root locii, and Frequency response, Methods in frequency response, Advantages and disadvantages in frequency response. Polar plots, Bode plots, Nyquist stability criterion, Nyquist analysis. Realization of basic compensators (lead) with advantages and disadvantages, Introduction to basic actions of controllers, Proportional controllel and Integral controller. Computer control of systems (discrete control).

Recommended Books:

1. Samarjit Ghosh, 'Control Systems' by 1st edition, Pearson Education, ISBN-81-317-0828-4.
2. K. Ogata, 'Modern Control Engineering' by 4th edition, Pearson, ISBN-81-7808-579-8.
3. B.C.Kuo, 'Automatic Control Systems' by 7th edition, PHI, ISBN-81-203-0968-5.
4. Goodwin, G.C., Graebe, S.F. and Salgado, M.E., 2001. *Control system design* (Vol. 240). New Jersey: Prentice Hall.

Course Code	Course Name	L-T-P	Credits
EC123	Analog and Digital Communication	(3-0-0)	3

Course Learning Outcomes (CLO):

CLO1: The students would understand various modulation concepts and distinguish between various modulation schemes on the basis of advantages, disadvantages and applications as used in analog and digital wireless communication systems.

CLO2: The students would be skilled to analyze design aspects of generation and detection techniques of AM and FM signals as used in broadcast radio and TV transmissions.

CLO3: The students would be able to select appropriate method to convert an analog signal to digital signal with suitable line coding technique for baseband transmission systems.

CLO4: They would possess an ability to apply knowledge of various digital modulation schemes to improve performance of advanced digital cellular communication systems during employment.

CLO5: Skill of various schemes to improve performance of communication systems.

Historical Perspective; Electromagnetic Frequency Spectrum; Elements of Electronic Communications System; Analog and Digital Transmission; Modulation - Need and Types; Concept of Frequency Translation; Types of Analog Modulation; Principles of Amplitude Modulation; AM for a Complex Modulating Signal; AM Power and Current Distribution; Limitation of AM; Comparison of AM, DSBSC, SSB and VSB; Applications of AM; Principles of Angle Modulation; Theory of FM – Basic Concepts; Spectrum Analysis of FM Wave; Narrowband and Wideband FM; Relationship between FM and PM; Advantages and Disadvantages of Angle Modulation; Comparison of AM, FM and PM; Applications of FM and PM; AM Radio Transmitters – Low level and High level; AM Radio Receivers – AM Super heterodyne Receiver; Receiver Characteristics; FM Modulators and Transmitters – Methods of FM Generation; FM Receivers and Demodulators – FM Super heterodyne Receiver, Amplitude Limiter, Pre-emphasis and De-emphasis, FM Demodulators – Types; Digital versus Analog Transmissions, Sampling Theorem, Practical Aspects of Sampling, Classification of Pulse Modulation Techniques, Pulse Amplitude Modulation, Pulse Code Modulation – PCM System Block Diagram, PCM Encoding and Efficiency, Transmission Bandwidth of PCM, Quantization of Signals, Delta Modulation, Slope Overload and Granular Noise, Comparison of PCM and DM Techniques; Need and Properties of Line Codes, Line Encoding Techniques, Multiplexing in Telecommunication Networks – Fundamentals of TDM System, Synchronous and Asynchronous TDM, Comparison of TDM and FDM; Types of Digital Modulation, ASK, FSK and PSK; QPSK and Offset QPSK, Gaussian Minimum Shift Keying (GMSK).

Recommended books:

1. T. L. Singal, 'Analog and Digital Communications' by ISBN: 978-0-07-107269-4, McGraw Hill Education Publications, First Edition Copyright @ 2012, Fifth Reprint 2015.
2. T. L. Singal, 'Electronic Communications' by ISBN: 978-93-82782-16-2, Chitkara University Publications, First edition Copyright @ 2014.
3. B. P. Lathi and Zhi Ding `Modern Digital and Analog Communication Systems' by, Oxford University Press, International 4th Edition Copyright @ 2010.
4. T. L. Singal. Digital Communication' by, ISBN: 978-93-392-1952-9, McGraw Hill Education Publications, First Edition Copyright @ 2015.

Course Code	Course Name	L-T-P	Credits
EC124	Analog and Digital Communication Lab	(0-0-2)	1

Course Learning Outcomes (CLO):

CLO1: The students would have a good understanding of both time and frequency domain representations of information and modulated signals used in analog, pulse and digital communication systems

CLO2: They would be able to evolve functional blocks of Tx and Rx for AM/FM broadcast radio, baseband PCM transmission and digital wireless communication applications.

CLO3: The students would be skilled to evaluate binary and M-ary shift keying digital modulation and demodulation techniques for digital cellular applications

CLO4: They would possess an ability to apply knowledge of various digital modulation schemes to improve performance of advanced digital cellular communication systems.

CLO5: Skill of various schemes to improve performance of communication systems.

The lab work focuses on providing practical knowledge of fundamental concepts of different types of analog, pulse and digital modulation and demodulation techniques used in analog and digital communication systems. The students are also familiarized with MATLAB software tool to simulate amplitude and frequency modulation process. Various experiments to be performed include the following: To generate and demodulate the amplitude modulation signal and plot the waveforms in time-domain and frequency-domain. To generate and demodulate the frequency modulation signal and plot the waveforms in time-domain and frequency-domain. To generate and plot natural sampling. Flat top sampling and sample & hold (PAM) waveforms. To study pulse code modulation (PCM) technique and observe analog signal to digital code conversion procedure. To study delta modulation (DM) techniques and observe the DM noise. To study and obtain modulated and demodulated waveforms of amplitude shift keying (ASK) technique. To study and obtain modulated and demodulated waveforms of frequency shift keying (FSK) technique. To study and obtain modulated and demodulated waveforms of phase shift keying (PSK) technique. To study and obtain Modulated and Demodulated waveforms of Quadrature Phase Shift Keying (QPSK) technique. To study GMSK modulation and demodulation process and observe the process. To execute various AT commands and observe their functions in GSM mobile handset. To study voice communication protocols and procedure using AT commands in GSM mobile handset. To generate voice call records and contacts using GSM mobile handset trainer. To simulate various analog and digital modulation schemes using MATLAB/LABVIEW simulation software.

Recommended books:

1. T. L. Singal, 'Analog and Digital Communications' by ISBN: 978-0-07-107269-4, McGraw Hill Education Publications, First Edition Copyright @ 2012, Fifth Reprint 2015.
2. T. L. Singal, 'Electronic Communications' by ISBN: 978-93-82782-16-2, Chitkara University Publications, First edition Copyright @ 2014.
3. B. P. Lathi and Zhi Ding `Modern Digital and Analog Communication Systems' by, Oxford University Press, International 4th Edition Copyright @ 2010.
4. T. L. Singal. Digital Communication' by, ISBN: 978-93-392-1952-9, McGraw Hill Education Publications, First Edition Copyright @ 2015.

Course Code	Course Name	L-T-P	Credits
EC111	Signals and Systems	(3-0-0)	3

Course Learning Outcomes (CLO):

CLO1: Categorize various types of signals and systems as continuous/ discrete.

CLO2: Apply various transforms in analysis of systems with different input signals.

CLO3: Skill to interpret the behaviour of Linear time invariant systems (Continuous & Discrete) in terms of system stability and response.

CLO4: Skilled for evaluation of several transforms in analysis of systems with different input signals

CLO5: Skilled to design Linear time invariant systems in terms of system stability and response.

Introduction to Signals and Systems:Introduction to Signal –Continuous Time, Discrete Time; Introduction to System–Continuous and Discrete Time, Introduction to frequency domain analysis of Continuous Time and discrete time signals and systems, importance of signals and systems, Continuous Time Signals: standard continuous time signals , Classification of continuous time signals, Mathematical Operations on CT , Mathematical equation governing CT system, block diagram representation of CT system, Classifications of Continuous Time System, Response of LTI systems in CT in time domain, Convolution of CT, Discrete Time Signals: Sampling of Continuous Time Signals, standard discrete time signals , Classification of discrete time signals, Mathematical Operations on DT , Mathematical equation governing DT system, block diagram representation of DT system, Classifications of Discrete Time System, Response of LTI systems in DT in time domain, Convolution of DT, Correlation, Cross-correlation and Autocorrelation. Review of Laplace transform with properties for analysis of CT systems, Pole zero analysis in Laplace transform, Review of Fourier series and Fourier transform for analysis of CT systems, Fourier transform of some important signals, Z-Transform : Introduction, ROC, Summary of Properties of Z-transform, Poles and zeros of rational function of Z-Transform, Inverse Z-transform.

Recommended Books:

1. A Nagoor Kani ‘Signals and Systems’ by, ISBN: 978-0-07-015139-0, McGraw Hill Education, First Edition, Copyright © 2010.
2. Tarun Kumar Rawat, Signals and Systems’ by Oxford University Press, First Edition, Copyright © 2010.
3. B. P. Lathi `Principles of Linear Systems and Signals’ by, ISBN: 978-0-19-806227-1, Oxford University Press, First Edition, Copyright © 2009.
4. S Salivahanan, C Gnanapriya, ‘Digital Signal Processing’ by 2nd edition, Tata McGraw-Hill, ISBN:9780070669246, 2, 2013.

Course Code	Course Name	L-T-P	Credits
ES101	Environmental Sciences	2-0-0	2

Course Learning Outcomes (CLO):

CLO1: Understanding the concepts about natural resources, ecosystems, biodiversity, energy resources, environmental pollution and waste management which are required to understand the interrelationships of the natural world.

CLO2: Identification and analysis of environmental problems both natural (disasters such as floods and earthquakes) and man-made (industrial pollution and global warming).

CLO3: Skilled to understand the societal and environmental impacts of energy and examine alternative solutions for meeting the growing energy needs

Introduction to environmental studies: Multidisciplinary nature of environmental studies; Scope and importance; Concept of sustainability and sustainable development. Ecosystems: Structure and function of an ecosystem. Producers, consumers and decomposers, energy flow in the ecosystem, food chains, food webs and ecological succession, Introduction, types, characteristic features, and case study of the following ecosystems: Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries), Natural Resources: Renewable and non-renewable resources, Land resources and Land use change; land degradation, soil erosion and desertification, Deforestation: Causes and Impacts due to mining, dams building on environment, on forest , biodiversity and tribal populations. Water resources: Use and over exploitation of surface and ground water, floods, drought, conflicts over water (international and inter-state). Energy resources: renewable and non-renewable energy sources use of alternate energy sources, Growing energy needs, Case studies. Biodiversity and Conservation: Definition, Levels of biological diversity: genetic, species and ecosystem diversity. Bio-geographical classification of India; biodiversity patterns and global biodiversity Hot-sports. India as a mega-biodiversity nation; Endangered and endemic species of India. Threats to biodiversity: Habitat loss, poaching of wildlife, man wildlife conflicts, biological invasions; Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity. Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and informational values. Environmental Pollution: Definition, types, Causes, effects and control measures of Air, Water, Soil, and Noise pollution. Nuclear hazards and human health risks. Solid waste Management: control measures of urban and industrial wastes, Pollution case studies. Environmental Policies & Practices: Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture. Environment Laws; Environment Protection Act; Air(Prevention and control of Pollution)Act; Water (Prevention and control of Pollution)Act; Wildlife Protection Act ; Forest Conservation Act. International agreements; Montreal and Kyoto protocols and Conservation on Biological Diversity (CBD). Nature reserves, Tribal Populations and rights, and human wildlife conflicts in Indian context. Human Communities and the Environment: Human Population growth: Impacts on environment, human health and welfare. Resettlement and rehabilitation of project affected persons; case studies. Disaster management; floods, earthquake, cyclones and landslides. Environmental movements; Chipko, silent valley, Bishnois of Rajasthan.

Environmental ethics: Role of Indian and other religions and cultures in environmental conservation. Environmental communication and public awareness, case studies (CNG vehicles in Delhi). Field Work.

Recommended Books:

1. Erach Bharucha, Textbook of Environmental Studies for Undergraduate Courses' First Edition, University Grants Commission, Universities Press (India) Private Limited.
2. Clark, J.S. and Gelfand, A.E. eds., 2006. Hierarchical modelling for the environmental sciences: statistical methods and applications. OUP Oxford.
3. Middleton, G.V. and Wilcock, P.R., 1994. Mechanics in the earth and environmental sciences. Cambridge University Press.
4. Manish Randhawa 'The Basics of Environmental Sciences', First edition, Chitkara University publications.

Course Code	Course Name	L-T-P	Credits
GW2001	G-Visions	2-0-0	2

Course Learning Outcomes (CLO):

CLO1: Understand complex dimension of diversity, equity, and inclusion around the world, including language, culture and identity.

CLO2: Synthesizes knowledge and meaning from multiple sources to enhance decision - making in diverse contexts.

CLO3: Skilled to use technology, human and natural capital, information resources, and diverse ways to solve problems

Evolution of mobile technologies, Conspiracy theories, Why 5G, why millimetre waves, ionizing and non-ionizing radiations, frequency spectrum of electromagnetic radiations, health concerns related to microwaves and mm-waves, Overview of 5G and its applications, Technical enablers, Roles of communication engineer, Machine learning for mm-wave, Hybrid BF using deep learning neural nets, Overview of IoT, what is antenna, green antenna, examples of antenna, Reconfigurable antenna, Design for future wireless, 5G mm-wave system and cognitive radio, introduction to radio astronomy, Neutral hydrogen distribution, Radio astronomy distribution, Radio telescope, Radio telescope array, Beamforming, Radio telescope, Astronomical observation, Astrometry, photometry, spectroscopy, Radio signal sources.

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Course Code	Course Name	L-T-P	Credits
EC113	Measurement and Virtual Instrumentation lab	(0-0-2)	1

Course Learning Outcomes (CLO):

CLO1: The students will be skilled to design any instrumentation-based project in employment

CLO2: The students will be skilled to simulate any type of signals and check performance of any circuit based on these simulated signals.

CLO3: Skill of using Elvis instrument and perform experiment on it

CLO4: Skilled to work on interfacing hardware with software.

CLO5: Skilled for the creation of new projects.

Introduction to LabVIEW software: LabVIEW components, function palette, control pallet, loops and structures, waveform graphs, SubVI, Debugging techniques, Icon editor, formula node. Virtual Instrumentation: Creating a virtual instrument using LabVIEW. Different types of Waveform generation and analyze the signals by measuring amplitude, frequency and phase variations using soft front panel instruments (CRO, FGEN, DMM), introduction to ELVIS-II. Measurement of instantaneous, peak to peak and average value of voltage, period and phase angle using oscilloscope and Lissajous pattern using LabVIEW. Sources of error in measurements and its statistical analysis: Measurement of resistances of resistors of same color coded values using DMM SFP and investigates errors (Gross error, systematic error and random error) in measurements and statistical analysis using waveform graph. Introduction to control system toolbox of LabVIEW: Stability test of series parallel circuit using LabVIEW, generation of Bode plot, Nyquist plot, Root locus plot of the given transfer function. Obtain the responses of the systems i.e. proportional (P), the integral (I), and the derivative (D), PID control system. Potentiometers: Designing of input- output characteristics of a potentiometer and use two potentiometers as an error detector by a comparison of the reference and the output that will perform the crucial task of comparing the reference and output signals. Synchro set and servo system: Implementation of transmitter- receiver characteristics of a synchro set. and obtain effects of supply voltage and system parameter on its transient response.

Recommended Books:

1. S. Sumathi and P. Surekha , LabVIEW based advanced instrumentation system by, springer.
2. Jerome, J., 2010. Virtual instrumentation using LabVIEW. PHI Learning Pvt. Ltd..
3. Klaassen, K.B., 1996. Electronic measurement and instrumentation. Cambridge University Press.
4. Oliver, B.M. ed., 1971. *Electronic measurements and instrumentation* (Vol. 12). Tata McGraw-Hill Education.

YEAR-02
SEMESTER-4

Course Code	Course Name	L-T-P	Credits
EC114	Microelectronic Circuits	(3-0-0)	3

Course Learning Outcomes (CLO):

CLO1: After completion of the course, students will be able to construct and apply physical model to determine the electrical characteristic and operation principle of microelectronic devices.

CLO2: Skill of designing digital as well as analog circuits using CMOS technology

CLO3: Students will apply the concept of IC fabrication to create layouts of digital circuits at entrepreneur level.

CLO4: Able to design both circuits using CMOS technology used in industry.

CLO5: Execute the concept of IC fabrication to create layouts of digital circuits during their employment

MOS Theory-Evolution of MOS, MOS structure without and with external bias, Structure and Operation of MOS Transistor, Threshold voltage, Gradual channel approximation, channel length modulation, MOSFET Capacitances. Circuit designing: Introduction to circuit designing, CMOS Inverter: representation, CMOS working, DC-characteristics, Logic gates designing using CMOS logic and Pseudo nMOS logic, CMOS transmission gates and complementary pass transistor logic, SR Latch circuit, SR flip-flop designing, D Flip Flop designing using CMOS and AOI logic, CMOS dynamic circuits, Domino logic, NP domino logic, Zipper domino logic. Introduction to memory design, Operation of one Transistor DRAM Cell, Operation of 6-T SRAM cell, Overview of power consumption. Introduction, Fabrication Process Flow: Basic steps, Fabrication of nMOS transistor, Layout Design Rules, Full custom mask layout design:, silicon on Insulator, floating body voltage, SOI advantages and disadvantages,. Analog Integrated Circuit Design Techniques: Small signal model for the MOS Transistor, Common source, Common drain and Common Gate Amplifiers, Introduction to Current mirror circuit, DC Analysis of MOS Transistor Current Mirror, Changing MOS mirror ratio.

Recommended Books:

1. Sung-Mo Kang and Yusuf Leblebici, “CMOS Digital Integrated Circuits Analysis and Design”, Tata McGraw Hill, 3rd Edition, 2005.
2. Richard C. Jaeger, Travis N. Blalock, “Microelectronic Circuit Design”, McGraw-Hill, 4th edition, 2011.
3. Donald A Neamen, “Semiconductor Physics and Devices”, Mc Graw- Hill, 4th edition,2011

4. Neil H. E. Weste and Kamran Eshraghian, “Principles of CMOS VLSI design”, Pearson, 3rd edition, 2005.

Course Code	Course Name	L-T-P	Credits
EC115	Microelectronic Circuits Lab	(0-0-2)	1

Course Learning Outcomes (CLO):

CLO1: Students will acquire hands on experience of industry oriented circuit designing tools

CLO2: Students will be skilled to design different digital and analog circuits and verify the same through simulation on cadence design tool.

CLO3: Capable of designing layouts of the designed circuit in accordance with layout design rules during employment

CLO4: Skill of using simulator.

CLO5: Skill of interfacing hardware with software.

Introduction to VLSI design techniques and VLSI design flow for Digital and Analog IC designing. Introduction to Cadence design flow. Analysis of NMOS and PMOS transistors, Schematic and Layout Designing and Analysis (Transient, DC) of CMOS inverter. Schematic Designing and Analysis (Transient) of Pseduo n-mos inverter. Schematic and Layout Designing and Analysis (Transient) of Digital gates with CMOS logic. Schematic and Layout Designing and Analysis of SR and D- Flip Flops. Designing and Analysis Differential Amplifier with MOS Logic. Designing and Analysis MOS Mirror circuit with MOS Logic. Design Analysis of MOS based Amplifiers (Common Source, Common Drain, and Common Gate).Design Analysis of MOS based Analog Multiplier.

Recommended Books

1. Sung-Mo Kang and Yusuf Leblebici, "CMOS Digital Integrated Circuits Analysis and Design", Tata McGraw Hill, 3rd Edition, 2005.
2. Richard C. Jaeger, Travis N. Blalock, "Microelectronic Circuit Design", McGraw-Hill, 4th edition, 2011.
3. Donald A Neamen, "Semiconductor Physics and Devices", Mc Graw- Hill, 4th edition,2011
4. Neil H. E. Weste and Kamran Eshraghian, "Principles of CMOS VLSI design", Pearson, 3rd edition, 2005.

Course Code	Course Name	L-T-P	Credits
EC116	Linear Integrated Circuits	(3-0-0)	3

Course Learning Outcomes (CLO):

CLO1: Skilled to design Op-amp based circuit to give specified gain.

CLO2: To compute component values to design different Op-amp based applications such as arithmetic building blocks, filters, waveform generators.

CLO3: Develop practical skills for building and testing circuits using analog ICs during employment.

CLO4: Able to compute component values to design different Op-amp based applications in their employment

CLO5: Skilled in practical skills for building and testing circuits using analog ICs in their employment.

Unit-1: Introduction and basic Fundamentals of Op-Amp: Operational Amplifier, Block Diagram. Schematic symbol, introduction to Integrated Circuit, Ideal Op Amp, equivalent circuit, open loop Op Amp configurations: differential, inverting and non- inverting. Unit-2: Op-Amp ideal circuits: Block Diagram, Voltage Series Feedback Amplifier: closed loop voltage gain, difference input voltage ideally zero, input and output resistance Bandwidth, total output offset voltage, voltage follower. Voltage Shunt Feedback Amplifier: closed loop voltage gain, inverting input terminal at virtual ground, Input and output resistance Bandwidth, total output offset voltage.. Linear applications : DC and AC Amplifiers, Summing, Scaling and averaging amplifier, instrumentation Amplifier, Integrator Circuit, Differentiator Circuit, Introduction to Voltage to current converter with floating load and grounded load. Unit-3: Non-idealities and frequency response: Practical Op Amp: Input offset voltage, input bias current, Input offset current, common mode rejection ratio, Frequency response: compensating networks, frequency response of internally compensated and non-compensated op amps, high frequency op amp equivalent circuit, open loop voltage gain as a function of frequency, close loop frequency response, circuit stability, slew rate: Causes of slew rate, slew rate equation. Unit-4: Active filters and Oscillators: Filters: Active filters: First order LP Butterworth filter, Second order LP Butterworth filter, First order HP Butterworth filter, Second order HP Butterworth filter. Phase Shift Oscillator and Wien Bridge Oscillator. Unit-5: Nonlinear circuits: Basic Comparator, Schmitt Trigger, Square wave, Saw tooth Wave and triangular wave generator.

Recommended Books

1. Ramakant A. Gayakwad "Op-AMPS and Linear Integrated Circuits", by, Prentice-Hall, 4th edition, 2008.
2. T.L Singal “Linear Integrated Circuits”, by, PBS Education, 1st edition, 2015.
3. S. Salivahanan, V S Kanchanna Bhaaskaran, “Linear Integrated Circuits”, by Tata McGraw-Hill, 1st Edition, 2008.
4. D. Roy Choudhary, Sahil B. Jain. “Linear Integrated Circuits”, by, New Age Techno press, 4th edition, 2010.

Course Code	Course Name	L-T-P	Credits
EC117	Linear Integrated Circuits Lab	(0-0-2)	1

Course Learning Outcomes (CLO):

CLO1: Skilled able to select an appropriate IC for a industrial and domestic applications by interpreting electronic datasheet.

CLO2: Skilled to design an op amp based circuit such as filters, oscillators, generators, converters and can solve problems related to it during employment.

CLO3: Skilled to troubleshoot and replace the defective parts of op amp based electronic circuits during employment.

CLO4: Develop appropriate communication skills, particularly technical reports through the laboratory for student as entrepreneur.

CLO5: Skill of hands-on training of designing linear integrated circuits

To investigate the application of negative feedback Operational Amplifier as Inverting and Non-Inverting configuration. Also verify them using Multisim. To observe the performance parameters of an Operational Amplifier. To observe & study frequency response of an Operational Amplifier. Measurement of Saturation limits of an Operational Amplifier. To design a Differentiator circuit and observe output with different input waveforms using Op-Amp. To design an Integrator circuit and observe output with different input waveforms using Op-Amp. To investigate an application of an OP-Amp as Schmitt trigger. To Calculate the time period and observe the waveform generated of 555 timer using Op-Amp. To observe an application of an Op Amp as sam01umming, scaling and averaging circuit. To understand the concept of differentiator as a building block for designing High pass Butterworth active filters using Op Amp. To understand the concept of an integrator as a building block for designing Low pass Butterworth active filters using Op Amp. To investigate an Op-amp based circuits which can generate Square and Triangular waveforms. To Observe Phase Locked Loop (PLL) Characteristics and its use as a frequency Multiplier.

Recommended Books

1. Ramakant A. Gayakwad "Op-AMPS and Linear Integrated Circuits", by, Prentice-Hall, 4th edition, 2008.
2. T.L Singal “Linear Integrated Circuits”, by, PBS Education, 1st edition, 2015.
3. S. Salivahanan, V S Kanchanna Bhaaskaran, “Linear Integrated Circuits”, by Tata McGraw-Hill, 1st Edition, 2008.
4. D. Roy Choudhary, Sahil B. Jain. “Linear Integrated Circuits”, by, New Age Techno press, 4th edition, 2010.

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Course Code	Course Name	L-T-P	Credits
EC118	Digital Signal Processing	(3-0-0)	3

Course Learning Outcomes (CLO):

CLO1: Identify different types of discrete signals, implement these signals on different systems using z transform, Discrete Fourier Transform and Fast Fourier Transform.

CLO2: Student can apply knowledge to design and filters and implement them for signal processing applications.

CLO3: Apply the knowledge to design and analyse a practical discrete-time signal system, such as a radar, image, speech, audio, bio-medical or wireless system during employment.

CLO4: Implementation of signal processing applications in employment

CLO5: Skilled to design and analyse a practical discrete-time signal system, in their employment.

Discrete and Fast Fourier Transforms: DFT, Relationship between DFT and other transforms DFT, Properties of DFT, Relation between DFT and Z-Transform, Analysis of LTI discrete time system using DFT, DFT as a Linear Transformation, Fast Fourier Transform, Radix-2 (DIT), Fast Fourier Transform, Radix-2 (DIF) Computing an Inverse DFT using FFT. Finite Impulse Response Filters: Magnitude and phase response of a digital filters, Frequency response of linear phase FIR filters (case 1 only), Design Techniques for FIR filters using Window method Design techniques for FIR filters using Frequency Sampling method, Infinite Impulse Response Filters: Introduction, Frequency response of Analog and digital IIR Filter, Infinite Impulse Response Filters: Introduction, Frequency response of Analog and digital IIR Filter IIR filter Design by Impulse Invariant Method, Bilinear Transformation, Butterworth filters, Chebyshev Filters Realization of Digital Filters: Basic Structures for IIR Systems – Direct Form I, Direct Form II, Cascade Structure, Parallel Realization of IIR System,, Basic Structures for FIR system. Effects of Finite Word Length in Digital Filters: Introduction, Rounding and Truncation Errors, Quantization effects in analog to digital conversion of signals Applications of DSP: Introduction, Applications of DSP in Biomedical Signal Processing Radar, Image Processing, and Overview of TMS320 Family DSP Processors.

Recommended Books:

1. Salivahan and Gnanapriya, Digital Signal Processing' by fifth reprint-2013 Tata McGraw- Hill Education private limited.
2. Sanjit K. Mitra, Digital signal processing, 3rd edition by, Tata McGraw Hill, 2001
3. John G. Proakis, Dimitris G. Manoiaias, Digital Signal Processing' by, Prentice Hall of India pvt. Ltd., 4th edition.
4. Bose, T. and Meyer, F., 2003. *Digital signal and image processing*. John Wiley & Sons, Inc.

Course Code	Course Name	L-T-P	Credits
EC119	Digital Signal Processing Lab	(0-0-2)	1

Course Learning Outcomes (CLO):

CLO1: To understand and analyze the different types of signals in time domain and frequency domain.

CLO2: Skill to design and implement the characteristics of the digital filters (FIR and IIR).

CLO3: Can apply skill of programming using MATLAB to develop the computation of Transforms and convolution during employment.

CLO4: Skill of hand-on training on MATLAB programming and simulation.

CLO5: Skill of modeling FIR and IIR filters on MATLAB.

Introduction to MATLAB, write a MATLAB program (a) to generate unit impulse sequence, unit step sequence, ramp sequence and exponential. (b) to generate time shifted signal, time scaled signal, folded signal. (a)Computation of N- point DFT of a discrete time signal and plot the magnitude and phase response using direct approach. (b)Computation of N- point DFT of a discrete time signal and plot the magnitude and phase response using FFT. Compute linear convolution of two discrete time sequences. Compute circular convolution of two discrete time sequences. a) Computation of z transform in factored form. b) Verification of pole zero analysis using transfer function. Design and implementation of FIR filter using rectangular window. Design Butterworth low pass and high pass filter with the given specifications. Find the autocorrelation and cross correlation coefficients of discrete time signals. Program for up sampling a discrete sequence by factor L. Program for down sampling a discrete sequence by factor L.

Recommended Books:

1. Salivahan and Gnanapriya, Digital Signal Processing' by fifth reprint-2013 Tata McGraw- Hill Education private limited.
2. Sanjit K. Mitra, Digital signal processing, 3rd edition by, Tata McGraw Hill, 2001
3. John G. Proakis, Dimitris G. Manoiaias, Digital Signal Processing' by, Prentice Hall of India pvt. Ltd., 4th edition.
4. Bose, T. and Meyer, F., 2003. *Digital signal and image processing*. John Wiley & Sons, Inc.

Course Code	Course Name	L-T-P	Credits
EC109	Microprocessor and Micro-controller	(3-0-0)	3

Course Learning Outcomes (CLO):

CLO1: After completing the course students will be skilled to differentiate between the real time applications of microprocessor and a microcontroller.

CLO2: The student will be able to design a memory and I/O interface aspects for an 8085-based computer systems.

CLO3: Students will develop the knowledge regarding architecture and peripheral configuration of STM32L476.

CLO4: Students will be able to write embedded C code to develop applications using I/O ports, timers and other peripherals of a microcontroller which increases employability.

CLO5: Skilled to develop applications using I/O ports, timers and other peripherals of a microcontroller in their employment

Introduction to a computer system, Central processing unit, Microprocessor and Micro-controller, Pin diagram of 8085 and pin functions, Functional Blocks of 8085 µP and its architecture Programming model, Introduction to instruction set, Addressing modes, Assembly language programming for 8085- decision making and looping, Stack and sub-routines, Timing diagrams for opcode fetch, De-multiplexing address/ data bus, Memory interfacing, Timing diagrams for IN/ OUT instructions, I/O interfacing, Introduction to Interrupt System of 8085, Interrupt process for vectored interrupts, Use of SIM and RIM instructions, Serial Communication with 8085- transmitting and receiving a character under program control, Overview of STM32L4 Series, Block diagram, Introduction to STM32 ARM Core(ARM Cortex-M4), Architecture diagram of STM32L476, STM32 Configuration- Clock Distribution, GPIO Pins, Asynchronous Serial Communication, SPI, I^2C, Programming STM32L4 Timers- PWM Output and Input Capture, Interrupt Programming- Cortex M4 exception model, Enabling interrupts and setting their priority, NVIC configuration, Handling timer interrupts, external interrupts, Configuring Analog-to-digital converter to read analog inputs, Low power modes of operation in STM32.

Recommended Books:

1. Ramesh S. Gaonkar, “Microprocessor Architecture, Programming and Applications with 8085”, Prentice Hall, 2002.
2. Geoffrey Brown, “Discovering the STM32 Microcontroller”, Indiana University, 2016.
3. Joseph Yiu, “The Definitive Guide to ARM Cortex- M3 and Cortex- M4 Processors”, Elsevier, First Edition(2014)
4. Donald Norris, “Programming with STM32: Getting Started with the Nucleo

Board and C/C++", McGraw-Hill Education TAB; 1 edition (21 March 2018).

Course Code	Course Name	L-T-P	Credits
EC110	Microprocessor and Microcontroller Lab	(0-0-2)	1

Course Learning Outcomes (CLO):

CLO1: After the completion of this lab course students will be skilled to handle the technical issues during the programming and also able to evaluate possible causes of discrepancy in practical experimental observations.

CLO2: The students will be able to write a program in assembly language to perform the specific task like arithmetic and logical operations, ON/OFF procedure for an LED pattern etc.

CLO3: Student will be able to understand how to Interface the external devices to the controller

CLO4: Skilled according to the user requirements to create novel products and solutions for the real time problems as entrepreneur

CLO5: Skilled to create innovation through microprocessor circuit designing

8085-based experiments: Study of 8085 Microprocessor kit, Addition and subtraction of two 8-bit/ 16-bit numbers, Detection of Even/ Odd numbers, Multiplication of two 8-bit numbers, Writing subroutines, Using IN/ OUT instructions, Interrupt programming, STM32-based experiments: Introduction to STM32 kit and STM32CUBE software, Blinking LEDs connected to a port, Interfacing a push-button, Writing code for multi-tasking applications, Configure a timer to generate a signal of any given frequency, Generate a PWM signal with a given duration as well as duty cycle, Using interrupt feature on a GPIO pin, Using a timer in interrupt mode, Reading an analog signal and generate a PWM signal of varying duty cycle, Display a message on 16 X 2 LCD display in 8-bit mode, Controlling the backlight of the LCD using a low-power mode.

Recommended Books:

1. Ramesh S. Gaonkar, “Microprocessor Architecture, Programming and Applications with 8085”, Prentice Hall, 2002.
2. Geoffrey Brown, “Discovering the STM32 Microcontroller”, Indiana University, 2016.
3. Joseph Yiu, “The Definitive Guide to ARM Cortex- M3 and Cortex- M4 Processors”, Elsevier, First Edition(2014)
4. Donald Norris, “Programming with STM32: Getting Started with the Nucleo Board and C/C++”, McGraw-Hill Education TAB; 1 edition (21 March 2018).

Course Code	Course Name	L-T-P	Credits
EC112	Network Analysis & Synthesis	(3-0-0)	3

Course Learning Outcomes (CLO):

CLO1: Students will develop sufficient knowledge on circuit analysis techniques.

CLO2: Students will be skilled to perform time domain as well as frequency domain analysis of any electrical circuit.

CLO3: Students will be skilled to synthesize various electrical networks like two port networks and filters circuits.

CLO4: Skilled to execute all domain analysis of any electrical circuit.

CLO5: Skilled to synthesize various electrical networks in practical applications

The circuit, Energy Sources, Introduction to Kirchhoff's laws. Introduction, tree, Co-tree, twigs and links, incidence matrix(A), Incident matrix and KCL, Link currents-Tie set matrix, Cut set and tree branch voltage, Mesh Analysis, Nodal Analysis, State Equation for networks, Source transformation technique, Wye-delta transformation ,Superposition theorem for DC, Thevenin's theorem for DC and AC circuits, Norton's theorem for DC and AC circuits, Maximum Power Transfer theorem for DC and AC circuits, Impedance diagram, phasor diagram, series circuits, parallel circuits, Steady state and Transient response ,DC Response of RL circuit, DC Response of RC circuit, DC Response of RLC circuit, Sinusoidal Response of RL circuit, Sinusoidal Response of RC circuit, Sinusoidal Response of RLC circuit, Laplace transform of some useful functions, Introduction to Frequency Domain analysis of RLC circuit. Two port Network, Open circuit impedance parameters, Short circuit admittance parameters, Transmission parameters, Classification of filters, filter Networks, Equations of Filter Networks (characteristic impedance, propagation constant).

Recommended Books:

1. Sudhakar Sham Mohan, Network Analysis and Synthesis by Tata McGraw Hill Publication Fourth Edition, 2004**.**
2. H Hayt, J E Kemmerly, S M Durbin, Engineering Circuit Analysis' by W Tata McGraw Hill Publication, Seventh Edition, 2006.
3. D.Roy Choudhury; Networks and Systems: New Age International, edition 2nd, 2012.
4. Anderson, B.D. and Vongpanitlerd, S., 2013. Network analysis and synthesis: a modern systems theory approach. Courier Corporation.

Course Code	Course Name	L-T-P	Credits
CS501	Cyber Security	(3-0-0)	3

Course Learning Outcomes (CLO):

CLO1: Acquire Information and risk models including confidentiality, integrity and availability

CLO2: Acquire skill to identify the Threats and attacks and exploit vulnerabilities

CLO3: Gain sufficient knowledge on Cyber security architecture and operations and acquire ability to handle the threats during employment

Introduction to Security: Security principles, threats and attack techniques Basics of Cryptography: Cryptographic mechanisms, Classical Encryption Techniques Symmetric and Asymmetric cryptography (basics) Introduction to cybercrime, cybercrime and information security, Classifications of cybercrimes Cybercrime and the Indian ITA 2000, Cyber offenses: Introduction, how criminals plan the attacks? Botnets- The fuel for cybercrime. Phishing, Password cracking, key loggers and sql injection, attacks on wireless networks. Cost of cybercrimes and IPR issues: lessons for organization, web threats for organization, security and privacy implications from cloud computing, social media marketing: security risks and perils for organizations, social computing and the associated challenges for organizations, protecting people's privacy in the organization, organizational guidelines for internet usage, safe computing guidelines and computer usage policy, incident handling: an essential component of cyber security. Forensics: Best practices for organizations, Media and Asset Protection, Importance of endpoint security in organizations, cybercrime and cyber terrorism: social, political, ethical and psychological dimensions, introduction, intellectual property in the cyberspace, the ethical dimensions of cybercrimes, the Psychology, mindset and skills of hackers and other cybercriminals. Cybercrime: Illustrations, Examples and mini cases, Illustrations of financial frauds in cyber domain, digital signature related crime scenarios.

Recommended Books:

1. Nina Godbole, Sunit Belapure, Cyber Security, Wiley India Pvt. Ltd.; 2011
2. Dieter Gollmann, John Wiley & Sons, ISBN: 470-86293-9; 2006
3. William Stallings, Network Security Essentials, 4th Edition, Pearson Publication
4. Bruce Schneier, Applied Cryptography, Wiley & Sons; Edition 2001

YEAR-03
SEMESTER-5

Course Code	Course Name	L-T-P	Credits
EC125	Digital VLSI Design	(3-0-0)	3

Course Learning Outcomes (CLO):

CLO1: Students will get a clear understanding of VLSI design flow and different types of design styles which are used for integrated circuit design

CLO2: Students will be able to design building blocks of digital IC using different types of modelling styles used in Verilog and perform timing analysis of the blocks

CLO3: Students will acquire skills to identify the faults associated in VLSI circuits and various techniques to test the ICs during employment.

CLO4: Skilled to design building blocks of digital IC using Verilog

CLO5: Skilled to identify the faults associated in VLSI circuits and test the ICs.

Historical Perspectives, Flow of circuit design procedure, VLSI Design Flow, VLSI Design Styles, Design Quality, Introduction to Verilog, Verilog data types, system tasks, compiler directives, Modules definition and Ports declaration, Gate-Level Modeling, Rise, fall, turn-off delays, Min, Max, and typical delays. Dataflow Modeling, Introduction to Behavioural Modelling, Structured Procedures, Timing controls, Conditional Statements, Procedural Assignments, Multiway Branching, Loops, Sequential and Parallel Blocks, Moore and Mealy Machine, Design of FSM in Verilog, Setup/Hold concept, Static timing analysis, Optimizing for Area/Timing, Introduction: Fault Types and Models, Ad Hoc Testable Design Techniques, Scan-Based Techniques, Built-In Self-Test (BIST) Techniques.

Recommended Books:

1. Samir Palnitkar `Verilog HDL Guide' by , Pearson, 2nd Edition, 2001, ISBN 978-81-7758-918-4.
2. Sung-Mo Kang and Yusuf Leblebici,CMOS Digital Integrated Circuits Analysis and Design' by Tata McGraw Hill Publication, 3rd Edition, 2005, ISBN 0- 07-246053-9.
3. Bushnell and Aggarwal, Kluwer `Essentials of Electronics Testing for digital memory & mixed signal VLSI Circuits' by Academic Publishers, 1st Edition, ISBN 0-306-47040-3.
4. J. Bhaskar, 'Verilog HDL synthesis: A Practical Primer' by Star Galaxy Publishing, 2nd edition 1998, ISBN 0-9650391-5-3.

Course Code	Course Name	L-T-P	Credits
EC126	Digital VLSI Design Lab	0-0-2	1

Course Learning Outcomes (CLO):

CLO1: Students will be skilled to use digital design tools such as Xilinx/Vivado for implementing digital circuits

CLO2: Conduct experiments to evaluate the performance of digital circuits with respect to time.

CLO3: Design and simulate the sequential circuits such as registers, counters and state machines using ISE design tool will increase employability.

CLO4: Skilled to design building blocks of digital IC using Verilog

CLO5: Skilled to identify the faults associated in VLSI circuits and test the ICs.

Introduction to VLSI ASIC and VLSI FPGA Design Flow, Introduction to Xilinx ISE/Vivado digital design tool, Verify the truth tables of all the logic gates using Xilinx/Vivado/Cadence digital design tool, An engineer wants to send multiple data signals combined into one over a shared medium. Design and a circuit which shall aid the engineer to do so, Implement the same using Xilinx/Vivado/Cadence digital design tool, For secure transmission of 4-bit of information it is desired that the information is encoded at the transmitter end and then sent over a medium to the receiver side where it is decoded again, Implement such a system using Xilinx/Vivado/Cadence digital design tool, Design a circuit that adds (a)two 1-bit inputs (b)three 1-bit inputs, Design a circuit that subtracts (a)two 1-bit inputs (b)three 1-bit inputs, A code represents each number in the sequence of integers {0...2^N-1} as a binary string of length N in an order such that adjacent integers have code representations that differ in only one bit position, Design such a logic using Xilinx/Vivado/Cadence digital design tool for N = 4, John transmitted 8-bit data i.e. 10101011 over a transmission line, but at the receiver end one bit got changed from 1 to 0, Discuss the method by which John will be able to detect the error. Implement it using Xilinx/Vivado/Cadence digital design tool. A design engineer wants to subtract a number from another number, but during subtraction he found that ALU cannot perform subtraction directly, Implement the logic which will be able to do so using Xilinx/Vivado/ Cadence digital design tool, Design different Flip Flops using sequential constructs using Xilinx/Vivado/Cadence digital design tool, A designer needs to shift 4 bit of data from input to output. Show the transfer of data using SISO and SIPO logic using Xilinx/Vivado/Cadence digital design tool, A record of total number of cars entering and leaving a parking lot which is having a capacity of maximum 15 cars is to be maintained on regular basis, Design a counter which keeps a count of the same using Xilinx/Vivado/Cadence digital design tool.

Recommended Books:

1. Samir Palnitkar `Verilog HDL Guide' by , Pearson, 2nd Edition, 2001, ISBN 978-81-7758-918-4.
2. Sung-Mo Kang and Yusuf Leblebici,CMOS Digital Integrated Circuits Analysis

and Design’ by Tata McGraw Hill Publication, 3rd Edition, 2005, ISBN 0- 07-246053-9.
3. Bushnell and Aggarwal, Kluwer `Essentials of Electronics Testing for digital memory & mixed signal VLSI Circuits’ by Academic Publishers, 1st Edition, ISBN 0-306-47040-3.
4. J. Bhaskar, 'Verilog HDL synthesis: A Practical Primer' by Star Galaxy Publishing, 2nd edition 1998, ISBN 0-9650391-5-3.

Course Code	Course Name	L-T-P	Credits
EC127	Electromagnetic Waves and Antenna	(3-0-0)	3

Course Learning Outcomes (CLO):

CLO1: Develop sufficient knowledge on fundamental of Electromagnetic field theory and its applications such as Vector Calculus and Co-ordinates Systems.

CLO2: Understand Maxwell's equations and apply them to solve practical electromagnetic fields problems.

CLO3: Analyses the behavior of EM Wave through different medium such as Transmission Lines and Waveguides.

CLO4: Skill to solve transmission line impedance mismatching problems in communication and power transmission using stub matching and Smith chart.

CLO5: Understand the basic parameters & properties of Antennas, Antenna Types, and Antenna Arrays for Antenna Gain and Directivity Enhancement.

Co-ordinate Systems and Vector Calculus: Cartesian Co-ordinates, Circular Cylindrical Co-ordinates, Spherical Co-ordinates, Differential Length, Area and Volume Divergence and Curl (Cartesian Co-ordinates): Del Operator , gradient of scalar field, Divergence of vector field, Curl of vector field, Laplacian operator, Gauss and Stokes's Theorem Maxwell's equations: Guass's Law, Ampere's Circuit Law, Magnetic Flux Density Faraday's law, Displacement Current Maxwell's Equations in Differential and Integral Forms Electromagnetic wave propagation: Introduction, Wave Equation, Wave Propagation in Lossy Dielectrics Plane waves in Lossless Dielectrics, Plane waves in Free space, Plane waves in Good Conductors, Skin Depth Power and Poynting Vector Reflection of plane wave at normal incidence, Reflection of plane wave at Oblique incidence Transmission Lines: Introduction, Transmission Line Parameters, Transmission Line Equations, Characteristic impedance, Impedance transformation: Input Impedance, Standing Wave Ratio and Power Smith ChartImpedance matching- Quarter Wave Transformer (Matching), Single-Stub Tuner (Matching), Slotted line (Impedance measurement) Introduction to S parameters Waveguides (Without derivation): Introduction, Rectangular waveguides, Boundary conditions, transverse magnetic modes Transverse electric modes, Basic of Propagation in the waveguide Antennas: Introduction to Antennas and its types (brief discussion) Hertzian dipole, Half Wave dipole antenna Quarter-wave monopole antenna, Small loop antenna Antenna characteristics: Antenna pattern, Radiation Intensity, Directive gain, Power gain Antenna Arrays: Array of two point sources with: Equal amplitude and phase, equal amplitude and opposite phase, unequal amplitude and any phase. Linear array with n isotropic point sources of equal amplitude and spacing, Array Factor Array of n isotropic sources of equal amplitude and spacing (Broadside case) Array of n isotropic sources of equal amplitude and spacing (End-fire

case).

Recommended Books

1. Matthew N.O. Sadiku 'Principles of Electromagnetics' by, Fourth Edition International version, Oxford University Press.
2. Fawwaz T. Ulaby, 'Electromagnetics for Engineers' by Pearson Education, Inc. 2005.
3. Constantine A. Balanis 'Antenna Theory Analysis and Design' by, John Wiley & Sons, Inc., Second Edition.
4. 'Kishore, K., 2013. Antenna and wave propagation. IK International Pvt Ltd.

Course Code	Course Name	L-T-P	Credits
EC129	Application Development using Python	(0-0-8)	4

Course Learning Outcomes (CLO):

CLO1: Choose the appropriate Python programming constructs to solve the problems.

CLO2: Demonstrate the advantages and disadvantages of specific techniques to be used.

CLO3: Skill to differentiate between efficient and inefficient way of programming.

CLO4: Increase employability in demonstrate bugs in a program and recognize needed basic operations.

CLO5: Formulate new solutions for programming problems or improve existing code to program effectively.

Introduction to Python: Python environment setup, identifiers, reserved words, lines and indentation, multiline statements, quotation, comments, Python variable types, assigning values to variables, Multiple assignment, python strings *and* numbers, Python basic operators- arithmetic, comparison, assignment operators, logical operators , Basics of Bitwise operator , Python decision making-if statements, while loop, for loop, Python functions - Calling a function , Python strings- accessing values in strings , updating strings, string special characters, string special operators, triple quotes, built in string methods, Python date & time – Tick, Time Tuple, getting time, getting calendar for a month, time module, calendar module. Python Files I/O and Directories- Input function, opening and closing files, reading and writing files, Directories in python - mkdir() method, chdir() method, getcwd() method, rmdir() method. Exploring Object-Oriented Programming in Python-Introduction, Creating classes, objects, attributes, Introduction to GUI Programming Basics of GUI programming, Role of GUI programming in python, Tkinter programming- Tkinter widgets – Button, canvas, check button, entry, frame, label, list box, menu button, message, scale, scrollbar Tkinter standard attributes – Dimensions, colors, fonts Tkinter geometry management, Basics of Raspberry Pi-Usage of Raspberry Pi with Python.

Recommended Books:

1. Kenneth A. Lambert, The Fundamentals of Python: First Programs, 2011, Cengage Learning, ISBN: 978-1111822705.
2. T.R. Padmanabhan, Programming with Python, Springer, 1st Ed., 2016.
3. Chun, W., 2001. Core python programming (Vol. 1). Prentice Hall Professional.
4. Zelle, J.M., 2004. Python programming: an introduction to computer science. Franklin, Beedle & Associates, Inc..

YEAR-03
SEMESTER-6

Course Code	Course Name	L-T-P	Credits
CL601	Life Skills	(4-0-0)	4

Course Learning Outcomes (CLO):

CLO1: Recognize diverse communication styles (body language, tone of voice) and effectively increase comprehension and build rapport with others.

CLO2: Draw comparison and demonstrate communication in a clear and direct manner. To be able to understand words and language used in formal and casual communication in entrepreneurship.

CLO3: Use creative thinking skills to analyze and evaluate issues and arguments, to solve problems, or to make decisions during their employment and entrepreneurship.

CLO4: Understanding a leader's responsibilities to assess the requirements of a task, identifying the strengths within the team, utilizing the diverse skills of the group to achieve the set objective as an entrepreneur and employee.

Self-awareness, Stages of learning, SWOT analysis, Goal setting, Grooming & Body Language, Power dressing, Work Ethics, Values & Moral, Interpersonal Skills & Empathy, Leadership skills, Presentation Skills, Report writing, Team work, Interview Skills – Acing the Interview, Stress Interviews, Panel Interviews, Cracking Group Discussions, Stress Management, Anger management, Critical Thinking, Time Management, Conflict Resolution, Resume Making.

Recommended Books:

1. Barun K. Mitra, “Personality Development & Soft Skills”, Oxford Publishers, Third impression, 2017.
2. ICT Academy of Kerala, "Life Skills for Engineers", McGraw Hill Education (India) Private Ltd., 2016.
3. The Ace of Soft Skills: Attitude, Communication and Etiquette for Success, Pearson Education; 1 edition, 2013.
4. Shalini Verma, “Development of Life Skills and Professional Practice”; First Edition; Sultan Chand (G/L) & Company, 2014.

Course Code	Course Name	L-T-P	Credits
EC131	Major Project	(0-0-8)	4

Course Learning Outcomes (CLO):

CLO1: To apply multidisciplinary approach in solving engineering problems.

CLO2: Undertake problem identification, formulation and solution as an entrepreneur.

CLO3: Design prototype models for the problems solved through engineering design process as an employee

CLO4: Understanding of design process.

CLO5: Application in solving the societal issues

Final Year Projects represent the culmination of study towards the Bachelor of Engineering degree. Projects offer the opportunity to apply and extend material learned throughout the program. Assessment is by means of a seminar presentation, submission of a thesis, and a public demonstration of work undertaken. Projects are undertaken individually or in small groups that introduces the dimension of workload management into the program to enable completion of a large, relatively unstructured "assignment" over the course of the semester. The projects undertaken span a diverse range of topics, including theoretical, simulation and experimental studies, and vary from year to year. The emphasis is necessarily on facilitating student learning in technical, project management and presentation spheres. Electronics and Communication Engineering involves understanding, designing, controlling, and maintaining electronics equipment. Some of the project areas of the electronics field are embedded systems and IoT, Robotics and Automation, Artificial Intelligence, Data Science and VLSI Design. The latest projects are aimed to build the trending technologies in the field of electronics, communication engineering and incorporate the technological skills that an Electronics Engineering student should possess to improve job prospects.

Year-04

Semester-07(Scheme I)

Course Code	Course Name	L-T-P	Credits
EC128	Wireless and Mobile Communication	(3-0-0)	3

Course Learning Outcomes (CLO):

CLO1: The students would be able to apply the knowledge of mobile communication engineering to solve coverage and call failure problems in cell phones.

CLO2: They would be skilled to implement the cellular concept and antenna system design consideration aspects in optimizing the cellular architecture as per user needs during their employment.

CLO3: The students would possess in-depth knowledge to select and use optimum multiple access technique for interference-free communication.

CLO4: The students would possess an ability and technical skills necessary to understand digital cellular standards and architecture designs.

CLO5: The students would have acquired adequate knowledge about major aspects of 3G/4G digital cellular networks.

Basic Propagation Mechanism, Ground wave Propagation, Space wave Propagation: Free Space and Two Ray Point to Point Propagation Models, Sky wave Propagation: Structural details of the Ionosphere, Ray Path, Critical Frequency, MUF, LUF, OF, Virtual Height and Skip Distance; Cellular Terminology, Cell Structure and Cluster, Frequency Reuse Concept, Cluster Size and System Capacity, Method of Locating Co-channel cells, Frequency Reuse Distance, Design of Omni-directional and Directional Antenna Cellular Systems, System parameters to increase cell coverage and capacity, Cell Splitting. Introduction, Frequency Division Multiple Access, Time Division Multiple Access, Spread Spectrum Multiple Access, Comparison of Multiple Access Techniques. GSM Network Architecture, Identifiers used in GSM system, GSM Channels, Frame Structure for GSM, GSM Call Procedures – Registration, Mobile to Network call, Network to Mobile call. 2.5G TDMA evolution path, GPRS Technology, EDGE Technology, Need of 3G Cellular network, The IMT-2000 Global Standards.

Recommended Books:

1. T. L. Singal, Wireless Communications' by Tata McGraw Hill Publication, 1st edition, 2010.
2. John D Kraus, Ronald J Marhefka and Ahmad S Khan, Antennas and Wave Propagation, Fourth Edition, McGraw Hill Education, 2010.
3. Theodore S Rappaport, Wireless Communication – Principles and Practice, Second Edition, Pearson Education, 2009.
4. William Stallings, Wireless Communications and Networks, Pearson Education, Second Edition, 2005.

Course Code	Course Name	L-T-P	Credits
EC132	Seminar	2-0-0	2

Course Learning Outcomes (CLO):

CLO1: The student would be able to demonstrate the usage of technology in different areas of application.

CLO2: The student will be able to demonstrate the ability to collect, analyze and interpret technical documents as an entrepreneur.

CLO3: The student will be able to represent his/her thoughts and ideas efficiently with an appreciation for complex social and cultural sensibilities.

CLO4: Improvement in skills

CLO5: Potential to identify the problem and its solution

The seminar provides the opportunity to the students to enhance their knowledge through a diverse range of topics, including theoretical, simulation and experimental studies. The students develop the ability to review, prepare and present technological developments happening in the electronics industry and prepare to face placement interviews. During the seminar session each student is expected to prepare and present a topic on engineering/ technology, and assessment is done by means of evaluating their presentations, submission of synopsis and technical report. The emphasis is necessarily on facilitating student learning in technical review and presentation spheres. Electronics and Computer Engineering involves understanding, designing, controlling, and maintaining electronics equipment in addition to software testing and development. The latest seminar topics are aimed to identify and present the trending technologies in the field of electronics, communication, electrical and computer science engineering and incorporate the technological skills that an Engineering student should possess to improve job prospects.

Year-04
Semester-08(Scheme I)

Course Code	Course Name	L-T-P	Credits
EC133	Industry Oriented Hands on Experience (Six Month Industrial Training)	24 weeks	15

Course Learning Outcomes (CLO):

CLO1: Understanding of the importance of sustainability and cost-effectiveness in design and developments of engineering solution as an entrepreneur.

CLO2: Ability to identify, formulate and model problems and find engineering solution based on a systems approach.

CLO3: Capability and enthusiasm for self-improvement through continuous professional development and life-long learning as an employee or entrepreneur.

CLO4: Ability to communicate efficiently and effectively as an entrepreneur**.**

6 Months Training (IOHE) is essential for Electrical Engineering (B.E) students as part of their curriculum/syllabus. This course has been designed to fulfil the need of industrial exposure among the students, where they get an experience of industrial environment in their relevant fields. During the tenure of 6 months training, students are exposed with the actual organizational structure and culture of an environment and also with industrial live projects. Students can learn about the practical aspects of implementation under the guidance and mentorship of industry experts also. The course is implemented with the aim to develop different types of skills leading to achieve following competencies, such as performing many activities/skills and get information pertaining to electrical industry in areas of process, processing equipment's, materials, testing and instruments.

Year-04

Semester-07(Scheme II)

Course Code	Course Name	L-T-P	Credits
EC134	Co-op Project at Industry: Module I	24 weeks	15

Course Learning Outcomes (CLO):

CLO1: Understanding of the importance of sustainability and cost-effectiveness in design and developments of engineering solution.

CLO2: Ability to identify, formulate and model problems and find engineering solution based on a systems approach.

CLO3: Capability and enthusiasm for self-improvement through continuous professional development and life-long learning as an entrepreneur.

CLO4: Ability to communicate efficiently and effectively as an employee or entrepreneur.

CLO5: Ability to understands the problem.

Co-op Training is essential for Electronics and Communication Engineering (B.E) students as part of their curriculum/syllabus. This course has been designed to fulfil the need of industrial exposure among the students, where they get an experience of industrial environment in their relevant fields. During the tenure of training, students are exposed with the actual organizational structure and culture of an environment and also with industrial live projects. Students can learn about the practical aspects of implementation under the guidance and mentorship of industry experts also. The course is implemented with the aim to develop different types of skills leading to achieve following competencies, such as performing many activities/skills and get information pertaining to electronics industry in areas of process, processing equipment's, materials, testing and instruments.

Year-04

Semester-07(Scheme II)

Course Code	Course Name	L-T-P	Credits
EC136	Co-op Project at Industry: Module II	24 weeks	15

Course Learning Outcomes (CLO):

CLO1: Understanding of the importance of sustainability and cost-effectiveness in design and developments of engineering solution.

CLO2: Ability to identify, formulate and model problems and find engineering solution based on a systems approach.

CLO3: Capability and enthusiasm for self-improvement through continuous professional development and life-long learning as an entrepreneur.

CLO4: Ability to communicate efficiently and effectively as an employee or entrepreneur.

Co-op Training is essential for Electronics and Communication Engineering (B.E) students as part of their curriculum/syllabus. This course has been designed to fulfil the need of industrial exposure among the students, where they get an experience of industrial environment in their relevant fields. During the tenure of training, students are exposed with the actual organizational structure and culture of an environment and also with industrial live projects. Students can learn about the practical aspects of implementation under the guidance and mentorship of industry experts also. The course is implemented with the aim to develop different types of skills leading to achieve following competencies, such as performing many activities/skills and get information pertaining to electronics industry in areas of process, processing equipment's, materials, testing and instruments.

Course Code	Course Name	L-T-P	Credits
ER101	CEED Acceleration Program(CAP) Cohort-II-Module I	(0-0-4)	3

Course Learning Outcomes (CLO):

CLO1: Use confidence acquired in oral and visual presentation skills to sell their ideas

CLO2: Implement personal skills for sales and marketing and work under pressure in entrepreneurship.

CLO3: Develop, implement and evaluate strategies for setting up a business idea in entrepreneurship.

CLO4: Implement personal skills in their employment.

CLO5: Design strategies to be an entrepreneur.

Course Introduction: Self Discovery Finding Your Flow, Effectuation – I, Effectuation – II, Case Study, Identify Your Entrepreneurial Style, Master Class - Team Formation, Identifying Problems Worth Solving – I, Entrepreneur Session - Identify Problems Worth Solving – II, Design Thinking, Look for Solutions, Identifying Problems Worth Solving – I, Entrepreneur Session - Identify Problems Worth Solving – II, Design Thinking, Look for Solutions, Present the Problem You Love – I, Present the Problem You Love – II, Customers and Markets, Identify Your Customer Segment and Niche, Identify Jobs, Pains, and Gains, and Early Adopters, Master Class: Craft Your Value Proposition – I, Craft Your Value Proposition – II, Outcome-Driven Innovation (ODI), Present Your Value Proposition Canvas(VPC), Basics of Business Model and Lean Approach, Sketch the Lean Canvas – I, Sketch the Lean Canvas – II, Risks and Assumptions, Class Presentation - Pitch Your Business Model.

Course Code	Course Name	L-T-P	Credits
ER102	CEED Acceleration Program(CAP) Cohort-II-Module II	(0-0-4)	2

Course Learning Outcomes (CLO):

CLO1:	Use confidence acquired in oral and visual presentation skills to sell their ideas
CLO2:	Implement personal skills for sales and marketing and work under pressure in entrepreneurship.
CLO3:	Develop, implement and evaluate strategies for setting up a business idea in entrepreneurship.
CLO4:	Implement personal skills in their employment.
CLO5:	Design strategies to be an entrepreneur.

Validation (Blue Ocean Strategy to refine your value proposition), Validation (Applying the Four Actions Framework), Validation (Build Solution Demo), Validation Problem-Solution Fit, Identify Your MVP and Build It, Build MVP and Conduct MVP Interviews, Prototyping and MVP, Present your MVP, Money (Cost), Money (Revenue & Pricing), Money (Profitability Checks), Money (Bootstrapping & Initial Financing), Money (Practice Pitching), Team (Shared Leadership), Team (Identify Job Roles for Hiring), Team (Practice Pitching), Marketing & Sales (Positioning & Branding), Marketing & Sales (Channels), Marketing & Sales, (Sales Planning), Marketing & Sales (Selling Skills I), Marketing & Sales (Selling Skills II), Support (Project Management), Support (Project Tracking), Support (Basics of Business Regulations), Support (Getting Started with your Venture).

Programme Elective Courses

S. No.	Course Code	Name of the Course	Credits
1	EC209	Introduction to Robotics Sensors	4
2	EC210	Robotic System Modeling and Control	3
3	EC 202	Robotics Lab -1	1
4	EC216	Biomedical Robotics	4
5	EC225	Aerial and Mobile Robotics	3
6	EC229	Robotics Lab - 2	1
7	EC231	Machine Vision	3
8	EC232	Robotics Lab-3	1
9	EC269	Artificial Intelligence & expert system	4
10	EC201	Analog Layout Design	4
11	EC211	High Speed VLSI Design Circuits	3
12	EC212	High Speed VLSI Design Circuits lab	1
13	EC220	Low Power VLSI System Design	3
14	EC221	Low Power VLSI System Design lab	1
15	EC234	VLSI design and Verification	4
16	EC235	VLSI Design and Verification lab	2
17	EC244	IC Fabrication & Technology	4
18	*EC224*	Mixed Signal Circuit Design	4
19	EC237	Sensor and Communication Protocol	4
19	EC249	IoT application development	4
21	EC250	Web Development for Iot	4
22	EC217	IoT and Industrial Application	4
23	EC241	Cloud Computing for IoT	4

24	EC236	Wearable technology and reality	4
25	EC204	Digital Image Processing	3
26	EC205	Digital Image Processing Lab	1
27	EC262	Machine learning	4
28	EC203	Bio-medical electronics	4
29	EC233	Speech and Audio processing	4
30	EC208	Electronic System design	4
31	EC206	Digital system Design	3
32	EC207	Digital System Design Lab	1
33	EC266	Cloud Computing & Virtualization	4
34	EC214	Introduction to MEMs	4
35	EC121	Embedded system design	3
36	EC122	Embedded system design Lab	1
37	EC213	Information Theory and Coding	4
38	EC215	Introduction to mobile technology	4
39	EC222	Microwave and Satellite communication	3
40	EC223	Microwave and Satellite communication lab	1
41	EC226	Optical communication system	4
42	EC239	Advance Wireless Communication	4
43	EC243	Wireless Sensor Network	4

Course Code	Course Name	L-T-P	Credits
EC209	Introduction to Robotics Sensors	(0-0-8)	4

Course Learning Outcomes (CLO):

CLO1: Skill to design and implement the sensor technology and instrumentation in robotics

CLO2: Skill to design and evaluate the performance of a system based on robotic sensors with respect to desired specifications, as well as analyze and interpret data during employment.

CLO3: Define and solve engineering problems to meet certain requirements.

Sensors and Transducers: Classification of sensors based on transduction principle - Primary and secondary, Analog and digital, Active and passive. Primary input physical parameters - Mechanical, electrical, optical, thermal, magnetic, chemical and biological sensors. Characteristics of sensors. Calibration of sensors. Displacement and velocity Sensors: Variable resistance - Linear and angular motion potentiometers, Strain gauges. Variable inductance Electromagnetic and electrodynamic, Variable reluctance and LVDT. Digital transducer - Encoders (Absolute, incremental and tachometer). Force, Pressure, Torque, Sound, Temperature, Touch, Light Sensors and Transducers: Force transducer – load cells. Pneumatic and hydraulic Pressure transducer – elastic pressure transducer-bourdon gauge, bonded strain gauge, piezoelectric transducer, Resistive and capacitive tactile sensors Torque transducer-Absorption type- Block type prony, brake eddy current dynamometer- Transmission type –belt transmission and torsion dynamometer. Temperature transducer-thermistors, Thermocouple and pyroelectric sensor Sound transducers- microphone-piezoelectric and variable capacitor Touch sensor- magnetic, capacitive and resistive. Light sensor- Photo resistive and Photo voltaic. Lidar sensor- Remote sensing. Flow Measurement Sensors: Constant area variable head meters- Venturi, Orifice, Pitot, Constant head variable area meters- Rotameter Variable velocity meters-Anemometer, electromagnetic and ultrasonic sensors.

Recommended Books:

1. Albert D. Helfrick & William D. Modern, “Electronic Instrumentation and Measurement Techniques”, Cooper Publisher: Prentice Hall International Inc., 1992.
2. David. A. Bell, “Electronic Instrumentation and Measurement”, Oxford University Press, 2009.
3. A.K Sawhney , “ Electrical & Electronic Instrumentation and Measurement”, Dhanpat Rai & Co., 2009.
4. Saha, S.K., 2014. Introduction to robotics. Tata McGraw-Hill Education.

Course Code	Course Name	L-T-P	Credits
EC210	Robotic System Modeling and Control	(3-0-0)	3

Course Learning Outcomes (CLO):

CLO1: Skill to identify the problem, design and optimize integrated solutions, adopting new directions.

CLO2: Involve, interact and solve related Instrumentation & control in robotics.

CLO3: Use the techniques to implement movement of robotic joints with microcontrollers.

CLO4: Students can apply techniques for solving problems in areas such like wireless robot control and navigation.

CLO5: They will learn to function effectively as members of multidisciplinary teams for developing and evaluating alternate solutions to real world problems.

Mathematic Modelling of Robots: Symbolic Representation, The Configuration Space, The State Space, The Workspace. Classification of Robotic Manipulators - Articulated manipulator (RRR), Spherical Manipulator (RRP), SCARA Manipulator (RRP), Cylindrical Manipulator (RPP), Cartesian manipulator (PPP), Parallel Manipulator. Modelling of Electrical networks, Translation and Rotational Mechanical systems, Hydraulic, Pneumatic and Thermal System, DC Servo Motors – Field and Armature controlled, Two phase AC Servo Motor. Compensation of Control Systems: Phase-lead, Phase-lag and Phase-lag-lead compensation, Feedback compensation. Set-Point Tracking: PD compensator and its performance, PID Compensator, Saturation, Feedforward Control and computed Torque, Multivariable Control – Robust and adaptive motion control, Force Control – Coordinate Frames and constraints, Impedance Control, Hybrid Impedance Control. Vision-based Control: Different approached, Camera motion and interaction matrix, Image-based Control Laws - Computing Camera Motion, Proportional Control Schemes, The relationship between end effector and camera motions. Robotics Lab-1: Lab experiments, mini projects and case studies related to Robotics sensors and Robotics controls.

Recommended Books

1. Mark W. Spong, Seth Hutchinson, and M. Vidyasagar, Robot Modeling and Control, First Edition, John Wiley & Sons.
2. Samarjit Ghosh, Control Systems: Theory and Applications, Pearson Education India.
3. Saha, S.K., 2014. Introduction to robotics. Tata McGraw-Hill Education.
4. Nenchev, D.N., Konno, A. and Tsujita, T., 2018. Humanoid robots: Modeling and control. Butterworth-Heinemann

Course Code	Course Name	L-T-P	Credits
EC 202	Robotics Lab -1	(0-0-2)	1

Course Learning Outcomes (CLO):

CLO1: Skill to identify the problem, propose robotic solution for specific application and Interface various Servo and hardware components.

CLO2: Skill to identify and evaluate parameters required to control a Robot

CLO3: Develop small automatic/autotropic applications for real world problems and test the robotics circuit at entrepreneurship and employee level.

CLO4: Students can apply techniques for solving problems in areas such like wireless robot control and navigation.

CLO5: They will learn to function effectively as members of multidisciplinary teams for developing and evaluating alternate solutions to real world problems.

To measure the linear and angular displacement using variable resistance potentiometer.

To measure the velocity of a robot car using LVDT.

To measure the strain in a cantilever beams using a strain gauge.

To measure the angular rotation of pulley using optical rotary encoders.

To measure the rpm of the shaft using tachometer.

To measure the pressure exerted during picking the object using capacitive tactile sensor.

To measure the temperature of heated water using thermistors.

To find the change in light intensity in a room using photo resistive sensor.

Recommended Books

1. Mark W. Spong, Seth Hutchinson, and M. Vidyasagar, Robot Modeling and Control, First Edition, John Wiley & Sons.
2. Samarjit Ghosh, Control Systems: Theory and Applications, Pearson Education India.
3. Saha, S.K., 2014. Introduction to robotics. Tata McGraw-Hill Education.
4. Nenchev, D.N., Konno, A. and Tsujita, T., 2018. Humanoid robots: Modeling and control. Butterworth-Heinemann.

Course Code	Course Name	L-T-P	Credits
EC216	Biomedical Robotics	(3-1-0)	4

Course Learning Outcomes (CLO):

CLO1: Skill to identifying the problem, design and optimize integrated solutions for adopting new directions.

CLO2: Skill to identifying identify different types of medical robots and implement the knowledge in kinematics, dynamics, and control

CLO3: Develop the analytical and experimental skills necessary to design and implement robotic assistance for both minimally invasive surgery and image-guided interventions for student as an employee and entrepreneur.

CLO4: Design and implement robotic assistance for both minimally invasive surgery and image-guided interventions

CLO5: Applications in societal problem solving

Introduction: Introduction to medical robotics (applications and paradigms), Basic kinematics concepts (forward, inverse, remote center of motion), Basic control concepts (impedance, admittance), Surgery for engineers, Interventional radiology for engineers. Minimally Invasive Surgery (MIS): Human-machine interfaces, Teleoperation, Cooperative manipulation, Port placement for MIS Robot, design concepts, Video images in MIS, Augmented reality, Minimally invasive surgery training. Image-Guided Interventions: Medical imaging modalities (e.g., MRI, US, X-ray, CT), Robot compatibility with medical imagers, Image segmentation and modelling, Tracking devices, Frames and transformations, Surgical navigation, Calibration, Rigid and non-rigid registration, Radiosurgery, Current topics in medical robotics: Existing clinical applications, controversies, and outcomes, Cardiac, abdominal, and urologic procedures with tele operated robots, Orthopedic surgery with cooperative robots, Prostate interventions with manual “robots”, Robotic catheters for heart electrophysiology.

Recommended Books:

1. Gomes P, “Medical Robotics: Minimally Invasive Surgery”, Elsevier, 2012.
2. M Stocksley, R Phillips, “Medical Imaging - Techniques, Reflections and Evaluation”, Elsevier, 2005.
3. Moore Jr, J.E. and Maitland, D.J. eds., 2013. *Biomedical technology and devices*. CRC press.
4. https://web.stanford.edu/class/me328/syllabus.pdf

Course Code	Course Name	L-T-P	Credits
EC225	Aerial and Mobile Robotics	(0-0-6)	3

Course Learning Outcomes (CLO):

CLO1: Understand basic wheel robot kinematics, common mobile robot sensors and actuators.

CLO2: Skill to apply various robot motion, sensor models in the system design.

CLO3: Apply techniques to solve problems in areas such as wireless robot control and navigation in employment.

CLO4: Students can apply techniques for solving problems in areas such like wireless robot control and navigation.

CLO5: They will learn to function effectively as members of multidisciplinary teams for developing and evaluating alternate solutions to real world problems.

Introduction to Aerial Robotics: Unmanned aerial vehicles, quadrotors, key components of autonomous flight, state estimation, applications. Energetics and System Design: Basic mechanics, dynamics and 1-D linear control, design consideration, agility and maneuverability, component Selection, effect of size, dynamical system, rates of convergence. Geometry and Mechanics: Quadrotor Kinematics: Transformation, rotation, Euler angles, axis/angle representation for rotation, angular velocity, rigid body displacement, properties of functions, symbolic calculations, the ATAN2 function, eigenvalues and eigenvectors of matrices, quaternions, matrix derivatives, skew symmetric matrices and hat operator. Quadrotor dynamics: Formulation, Newton-Euler equations, principal axes and principal moments of inertia, quadrotor equation of motion, state - space form. Planning and Control: 2-D quadrotor control, 3-D quadrotor control, time, motion and trajectory, motion planning for quadrotor, minimum velocity trajectories from the Euler-Langrange equations, solving for coefficient of minimum jerk trajectory, linearization of quadratic equation of motion. Advanced Topics: Sensing and estimation, nonlinear control, control of multiple robots, introduction to the motion capture system. Mobile Robotics: Differential drive robots, odometer, behavior-based robotics, mobile robot locomotion and kinematics, environment perception, probabilistic map based localization and mapping, motion planning and obstacle avoidance. Robotics Lab-2: Hands-on activities and development of related project(s) such as Design of a 4 channel RF module and interface motors with the RF module, Interfacing of RF modules with microcontrollers, Controlling the speed and direction of brushless motors using RF modules, Interfacing a Gyro (MPU-6050) with Arduino for self-balancing, Demonstrating the implementation of I2C communication bus with Arduino, Design of a project to control speed and direction of 4 motors using RF module and control balancing and position of the same.

Recommended Books

1. Burak Yuksel, "Design, Modeling and Control of Aerial Robots for Physical

Interaction and Manipulation", Logos Verlag Berlin Gmbh, 2017.

2. Omar D Lopez Mejia, Jaime Escobar, "Aerial Robts: Aerodynamics, Control and Applications", Published by Intech Croatia, 2017.
3. Bestaoui Sebbane, Yasmina, "Planning and Decision making for Aerial robots", Springer International Publishing, Switzerland, 2014.
4. Kagan, E., Shvalb, N. and Ben-Gal, I. eds., 2019. Autonomous Mobile Robots and Multi-Robot Systems: Motion-Planning, Communication, and Swarming. John Wiley & Sons.

Course Code	Course Name	L-T-P	Credits
EC229	Robotics Lab - 2	(0-0-2)	1

Course Learning Outcomes (CLO):

CLO1: After completion of this lab, the students are in a position to understand the theoretical concepts of Robotics design principles.

CLO2: Students will know and understand the importance of robot dynamics including force and torque sensing

CLO3: Knowledge of the working principles, components, functionality and limitations of robot actuators and sensors

CLO4: Students will be skilled to apply techniques for solving problems in areas such like wireless robot control and navigation.

CLO5: They will learn to function effectively as members of multidisciplinary teams for developing and evaluating alternate solutions to real world problems as an entrepreneur or employee.

To design a 4 channel RF module and interface motors with the RF module.(a) Interfacing of NRF with microcontrollers.(b) To control the speed and direction of brushless motors using NRF. Interfacing a Gyro (MPU-6050) with Arduino for self-balancing. Demonstrate the implementation of I2C communication bus with Arduino. Design a project to control speed and direction of 4 motors using NRF module and control balancing and position of the same.

Recommended Books

1. Mark W. Spong, Seth Hutchinson, and M. Vidyasagar, Robot Modeling and Control, First Edition, John Wiley & Sons.
2. Samarjit Ghosh, Control Systems: Theory and Applications, Pearson Education India.
3. Saha, S.K., 2014. Introduction to robotics. Tata McGraw-Hill Education.
4. Nenchev, D.N., Konno, A. and Tsujita, T., 2018. Humanoid robots: Modeling and control. Butterworth-Heinemann.

Course Code	Course Name	L-T-P	Credits
EC231	Machine Vision	(3-0-0)	3

Course Learning Outcomes (CLO):

CLO1: Students can apply basic methods of computer vision related to multi-scale representation, edge detection and detection of other primitives, stereo motion and object recognition

CLO2: Skill to identify the problem, design and optimize integrated solutions for designing a machine vision system for a multiple problem

CLO3: Use the techniques, skills, and modern machine vision engineering tools for engineering practice.

CLO4: Classification problem solving

CLO5: Applications in societal problem solving

Basic Components – Elements of visual perception, Lenses: Pinhole cameras, Gaussian Optics – Cameras – Camera-Computer interfaces. Fundamental Data Structures: Images, Regions, Sub-pixel Precise Contours – Image Enhancement: Gray value transformations, image smoothing, Fourier Transform – Geometric Transformation - Image segmentation – Segmentation of contours, lines, circles and ellipses – Camera calibration – Stereo Reconstruction. Object recognition, Approaches to Object Recognition, Recognition by combination of views – objects with sharp edges, using two views only, using a single view, use of dept values. Transforming sensor reading, Mapping Sonar Data, aligning laser scan measurements - Vision and Tracking: Following the road, Iconic image processing, Multiscale image processing, Video Tracking - Learning landmarks: Landmark spatio grams, K-means Clustering, EM Clustering. Basic introduction to Robotic Operating System (ROS) - Real and Simulated Robots - Introduction to Open CV, Open NI and PCL, installing and testing ROS camera Drivers, ROS to Open CV - The cv bridge Package.

Recommended Books:

1. Rafael C.Gonzalez and Richard E. Woods,“Digital Image Processing”, Richard E. Woods.
2. Rafael C. Gonzalez, Richard E. Woods, “Digital Image Processing using MATLAB”, Main purpose-Practical
3. Bershold Klaus, Paul Holm, “Robot vision”, The MIT press.
4. N. G. Palan, “Digital Signal Processing”, Tech-Max Publication
5. John G. Prokis, Dimitris G. Manolakis, “Digital Signal Processing (Principles, Algorithms and appls.)”, PHI.
6. Alan V. Oppenheim, Ronald W. Schafer, “Discrete-Time Signal Processing”, Pearson Edu...Publication
7. 4 A.K. Jain, “Fundamentals of Digital Image Processing”, Prentice Hall of India

Course Code	Course Name	L-T-P	Credits
EC232	Robotics Lab-3	(0-0-2)	1

Course Learning Outcomes (CLO):

CLO1: students will understand the basic concepts, terminology, theories, models and methods in the field of image capturing and processing

CLO2: Use Python for solving problems related to diverse fields.

CLO3: Students will attain skill to implement different models for analysing visual perception and understand the clustering techniques to implement various operations on images using Python

CLO4: Report analyses and results of practical problems faced during image and object recognition in their employment.

CLO5: Applications for societal problem solving

To explore the following adjacencies in a binary image: 4-Adjacency 8-Adjacency m-Adjacency, To explore the following image enhancement functions in spatial domain: Linear Transformations, Logarithmic Transformations, Power Law Transformations Piece-wise Linear Transformations, To explore the following image enhancement functions using histogram processing techniques: Histogram Equalization, Histogram Matching ,Local Histogram Processing Lab ,To perform correlation and convolution functions to enhance the images , To implement and compare the matrix and vector arrangements, computationally. To implement and compare the following statistical techniques for spatial filtering, computationally: Mean Filters using 3x3 sized mask, Median Filters using 3x3 sized mask

Recommended Books

1. Mark W. Spong, Seth Hutchinson, and M. Vidyasagar, Robot Modeling and Control, First Edition, John Wiley & Sons.
2. Samarjit Ghosh, Control Systems: Theory and Applications, Pearson Education India.
3. Saha, S.K., 2014. Introduction to robotics. Tata McGraw-Hill Education.
4. Nenchev, D.N., Konno, A. and Tsujita, T., 2018. Humanoid robots: Modeling and control. Butterworth-Heinemann.

Course Code	Course Name	L-T-P	Credits
EC269	Artificial Intelligence & expert system	(4-0-0)	4

Course Learning Outcomes (CLO):

CLO1: Students will be skilled to apply problem solving techniques associated with artificial intelligence

CLO2: Apply predicate logic and fuzzy logic to represent system in artificial intelligence.

CLO3: Skilled to solve techniques associated with artificial intelligence

CLO4: Skilled to represent fuzzy logic to represent system in artificial intelligence

CLO5: Skilled to solve intelligence expert system.

Introduction: Artificial Intelligence and its applications, Artificial Intelligence Techniques, Level of models, criteria of success, Intelligent Agents, Nature of Agents, Learning Agents. AI Techniques, Importance, functions, advantages, and limitations of AI, problem solving techniques: State space search, control strategies, heuristic search, problem characteristics, production system characteristics., Generate and test, Hill climbing, best first search, A* search, Constraint satisfaction problem, Mean-end analysis, Min-Max Search, Alpha-Beta Pruning, Additional refinements, Iterative Deepening, knowledge representation schemes: Mapping between facts and representations, Approaches to knowledge representation, LOGIC: Propositional logic, predicate logic, Resolution, Resolution in proportional logic and predicate logic, Clause form, unification algorithm, knowledge representation and reasoning: procedural vs declarative knowledge, Forward vs. Backward reasoning, Matching, conflict resolution, Non-monotonic reasoning, Default reasoning, statistical reasoning, fuzzy logic Weak and Strong filler structures, semantic nets, frame, conceptual dependency, scripts, planning: The Planning problem, planning with state space search, partial order planning, planning graphs, planning with propositional logic, Analysis of planning approaches, Hierarchical planning, conditional planning, Continuous and Multi Agent planning natural language processing and expert system: Basic Tasks of Natural Language processing, Expert systems, Expert system examples, Expert System Architectures, Rule base Expert systems, Non Monotonic Expert Systems, Decision tree base Expert Systems. AI problems: Pattern (biological sequence) recognition, Voice recognition, Feature extraction.

Recommended Books:

1. Stuart Russel, Artificial Intelligence: A modern approach by, Pearson Education, 2010
2. Rich and Knight, Artificial Intelligence by, TMH, 2003
3. Nils and Nilson , Artificial Intelligence: A new synthesis by, Elsevier, 1997
4. Luger,Artificial Intelligence by Pearson Education, 2008
5. Padhy, Artificial Intelligence by, Oxford Press, 2005.

Course Code	Course Name	L-T-P	Credits
EC201	Analog layout Design	(0-0-8)	4

Course Learning Outcomes (CLO):

CLO1: Enhance the skills of integrated circuit design for designing layouts of complex circuits

CLO2: Students will be able to design layouts using CMOS technology and learn industry related design tools such as Cadence Virtuoso to work as IC design engineer.

CLO3: Skill of applying different matching techniques in layouts of analog circuits and apply those techniques to design high quality and noise tolerant layout

CLO4: Able to evaluate combinational and sequential logic designs using various metrics:

CLO5: Skill to calculate switching speed, gate count , and energy dissipation and power

Introduction to CMOS physical design, Introduction to CMOS technology, Important Processes involved in IC fabrication, Fabrication steps of CMOS inverter, Demo of GDS 3D viewer, Introduction to the layout tool, Drawing-related features and functionality of the tool, Live demo of layout of basic commands, layout design rules, Live demo of virtuoso layout XL, DRC categories, DRC flow using the tool, LVS flow using the tool, Stick diagrams, Digital standard cell layouts, Introduction to standard cells, Parasitic associated with layout design, Layout optimization for minimum parasitic and area, Live demo of a NAND/NOR gate layout, Live demo of a decoder layout, multiplexer layout, Universal gates with LVS and DRC clean, Introduction to basic components, Introduction to various types of resistors & its parameters, BJTs and its parameters, Introduction to various types of capacitors & its parameters, MOSFETs parameters and matching, Analog layout concepts, Need & Techniques for Matching: Common centroid, interdigitization (Differential pairs and current mirror circuits),WPE and STI effect, Comparator layout using matching technique, OTA layout using matching technique, Overcoming layout related issues, Coupling & Shielding, Routing current/ voltage lines, Routing power/ signal lines, ESD & Latch-up, Electro-migration effects and metal width calculations.

Recommended Books:

1. Alan Hastings,The Art of Analog layout' by, 2001, ISBN 0-13-087061-7, Prentice Hall
2. R. Jacob Baker, CMOS circuit design, layout & simulation' by,3rd Edition, Wiley
3. Tony Chan Carusone, David A. Johns, Kenneth W. Martin, Analog Integrated Circuit Design' by,2nd Edition, ISBN 978-0-470-77010-8, Wiley.
4. Graeb, H.E. ed., 2010. Analog layout synthesis: a survey of topological approaches. Springer Science & Business Media.

Course Code	Course Name	L-T-P	Credits
EC211	High Speed VLSI Design Circuits	(0-0-6)	3

Course Learning Outcomes (CLO):

CLO1: Students will be able understand the need High Speed Circuits Design in the era of modern technology

CLO2: Skilled to apply the Method of Logical Effort in digital circuits to design high speed circuits as an employee

CLO3: Students will have an exposure of the types of Dynamic logic styles and their applications in high-speed Integrated circuit designing.

CLO4: Students will have an experience on Clocking strategies and Clocking styles in various types of digital circuits

CLO5 Clocking styles in various types of digital circuits

Introduction of High Speed VLSI Circuits Design, Ideal and non-ideal interconnect issues, Dielectric Thickness and Permittivity, Delay in a logic gate, Multi-stage logic networks, Choosing the best number of stages, Model of a logic, Delay in a logic gate, minimizing delay along a path, Choosing the length of a path, Using the wrong number of stages, Using the wrong gate size, Static CMOS, DCVS Logic, Non-Clocked Pass Gate Families. Clocked Logic Styles: Single-Rail Domino Logic Styles, Dual-Rail Domino Structures, Latched Domino Structures, Clocked Pass Gate Logic, Process Induced Variations, Design Induced Variations, Application Induced Variations, Noise, Basic Latch Design, latching single-ended logic, Latching Differential Logic, Race Free Latches for Pre-Charged Logic Asynchronous Latch Techniques, Signaling Standards, Chip-to-Chip Communication Networks, ESD Protection, Clock Jitter, Clock Skew, Clock Generation, Clock Distribution, Asynchronous Clocking Techniques.

Recommended Books:

1. Sung-Mo (Steve) Kang, Yusuf Leblebigi, “CMOS Digital integrated circuit analysis and design”, by Tata Mcgraw-Hill, (2007).
2. Chung-Kang Cheng, John Lillis,Shen Lin and Norman H.Chang, “Interconnect Analysis and Synthesis”,A wiley Interscience Publication(2000).
3. L.O.Chua, C.A.Desoer, and E.S.Kuh, “Linear and Non linear circuits”,McGraw-Hill,1987.
4. Wairya, S., Nagaria, R.K. and Tiwari, S., 2012. Performance analysis of high speed hybrid CMOS full adder circuits for low voltage VLSI design. VLSI Design, 2012.

Course Code	Course Name	L-T-P	Credits
EC212	High Speed VLSI Design Circuits Lab	(0-0-2)	1

Course Learning Outcomes (CLO):

CLO1: Students will be able to design high speed VLSI circuits practically with different logic styles

CLO2: Skilled to calculate delay associated with logic gates using industry oriented design tools in their employment

CLO3: Student will get practical skills to analyze delay and latching condition in Clock based circuits using EDA tools

CLO4: Evaluate combinational and sequential logic designs using various metrics:

CLO5: Skill to calculate switching speed, gate count , and energy dissipation and power

Calculate delays in CMOS based circuits using EDA tool, delay models in VLSI circuits, delays in multi-stage logic networks, designing circuits of minimum delay, delay dependence on number of stages, static CMOS and dynamic CMOS delay calculations, delay estimation in clocked logic styles, clocked pass gate logic circuit, designing of latches and calculate delay, Race condition in digital circuits, clock jitter, clock skew in digital logic, delay estimation using asynchronous clock.

Recommended Books:

1. Sung-Mo (Steve) Kang, Yusuf Leblebigi, “CMOS Digital integrated circuit analysis and design”, by Tata Mcgraw-Hill, (2007).
2. Chung-Kang Cheng, John Lillis,Shen Lin and Norman H.Chang, “Interconnect Analysis and Synthesis”,A wiley Interscience Publication(2000).
3. L.O.Chua, C.A.Desoer, and E.S.Kuh, “Linear and Non linear circuits”,McGraw-Hill,1987.
4. Wairya, S., Nagaria, R.K. and Tiwari, S., 2012. Performance analysis of high speed hybrid CMOS full adder circuits for low voltage VLSI design. VLSI Design, 2012.

Course Code	Course Name	L-T-P	Credits
EC220	Low power VLSI System Design	(3-0-0)	3

Course Learning Outcomes (CLO):

CLO1: Skill to identify the requirement of low power system design and physics of power dissipation in microelectronic devices

CLO2: solve the issues for power minimization in ICs and apply them in scaling of ICs

CLO3: Perform probabilistic power analysis techniques to calculate power required for microelectronic devices and carry power optimization at logic level and circuit level increases employability.

CLO4: Able to evaluate combinational and sequential logic designs using various metrics:

CLO5: Skill to calculate switching speed, gate count , and energy dissipation and power

Introduction: Need for low power VLSI chips, Sources of power dissipation on Digital Integrated circuits. Emerging Low power approaches. Physics of power dissipation in CMOS devices. Sources of Power Dissipation: Dynamic dissipation in CMOS, Transistor sizing & gate oxide thickness, Impact of technology Scaling, Technology & Device innovation. Power estimation, Simulation Power analysis: SPICE circuit simulators, gate level logic simulation, capacitive power estimation, static state power, gate level capacitance estimation, architecture level analysis, Monte Carlo simulation. Probabilistic power analysis: Random logic signals, probability & frequency, probabilistic power analysis techniques, signal entropy. Low Power Design: Circuit level: Power consumption in circuits. Flip Flops & Latches design, high capacitance nodes, low power digital cells library, logic level, Gate reorganization, signal gating, logic encoding, state machine encoding, pre-computation logic Leakage Power Minimization Approaches: Variable threshold voltage CMOS (VTCMOS) approach. Multi-threshold-voltage CMOS (MTCMOS), Dual-Vt assignment approach (DTCMOS), Transistor stacking. Low Power Static RAM Architecture: Architecture of SRAM array, Reduced Voltage Swings on Bit Lines, Reducing power in memory peripheral circuits.

Recommended Books

1. Kaushik Roy, Sharat Prasad, “Low-Power CMOS VLSI Circuit Design” Wiley,
2. Rabaey, Pedram, “Low power design methodologies” Kluwer Academic, 1997
3. Gary K. Yeap, “Practical Low Power Digital VLSI Design”, KAP, 2002.
4. Pal, A., 2014. Low-power VLSI circuits and systems. Springer.

Course Code	Course Name	L-T-P	Credits
EC221	Low power VLSI System Design Lab	(0-0-2)	1

Course Learning Outcomes (CLO):

CLO1: Can Calculate and analyse power in digital circuits using industry related design tools.

CLO2: Design memory using EDA tools by applying concepts of power dissipation.

CLO3: Perform probabilistic power analysis techniques to calculate power required for microelectronic devices and carry power optimization at logic level and circuit level increases employability.

CLO4: Able evaluate combinational and sequential logic designs using various metrics:

CLO5: Skill to calculate switching speed, gate count , and energy dissipation and power

Calculate power in CMOS circuits using EDA tool, calculation of static and dynamic power, measuring effect of scaling on power dissipation, power estimation using SPICE circuit simulators, gate level logic simulation, Monte-carlo simulation of VLSI circuits, Power dissipation in combinational circuits, Power dissipation in latchs, flip-flops and other sequential circuits using Monte-carlo simulation, power consumption in state machines, calculation of leakage power using simulation tools, power estimation in 1-bit SRAM cell.

Recommended Books

1. Kaushik Roy, Sharat Prasad, “Low-Power CMOS VLSI Circuit Design” Wiley,
2. Rabaey, Pedram, “Low power design methodologies” Kluwer Academic, 1997
3. Gary K. Yeap, “Practical Low Power Digital VLSI Design”, KAP, 2002.
4. Pal, A., 2014. Low-power VLSI circuits and systems. Springer.

Course Code	Course Name	L-T-P	Credits
EC234	VLSI Design and Verification	(0-0-8)	4

Course Learning Outcomes (CLO):

CLO1: Students will be skilled to design and verify an Integrated circuit in VLSI field.

CLO2: Students will learn to create testbench using the concept of procedural statements and routines

CLO3: Apply concepts of OOP and randomization in writing test bench with system Verilog during employment.

CLO4: Able evaluate combinational and sequential logic designs using various metrics:

CLO5: Skill to calculate switching speed, gate count , and energy dissipation and power

System Verilog Data Types: Built-In Data Types, Fixed-Size Arrays, Dynamic Arrays, Queues, Associative Arrays, Linked Lists, Array Methods, choosing a Storage Type, Creating User-Defined Structures, Type conversion, Enumerated Types, Constants, Strings, Expression Width. Procedural Statements, Tasks, Functions, and Void Functions, Task and Function Overview, Routine Arguments, Returning from a Routine, Local Data Storage, Time Values. System Verilog Assertions (SVA) – Introduction to SVA, Building blocks, Properties, Boolean expressions, Sequence, Single & Multiple Clock definitions, Implication operators (Overlapping & Non-overlapping), Repetition operators, Built-in System functions, Constructs, assertion directives, nested implication, and formal arguments in property. BASIC OOP: Introduction, Your First Class, where to Define a Class, OOP Terminology, Creating New Objects, Object De allocation, Using Objects, Static Variables vs. Global Variables, Class Methods, Defining Methods Outside of the Class, Scoping Rules, Using One Class Inside Another, Understanding Dynamic Objects, Copying Objects. Randomization in System Verilog, Constraint Details, Controlling Multiple Constraint Blocks, Valid Constraints, Inline Constraints, the pre_randomize and post randomize Functions, Random Number Functions, Constraints Tips and Techniques, Common Randomization Problems, Random Control, Random Number Generators, Random Device Configuration. System Verilog Test Bench: Design Blocks, Testbench Blocks, Alternate Tests.

Recommended Books:

1. Stuart Sutherland, Simon Davidmann, Peter Flake. SystemVerilog for design: a guide to using SystemVerilog for hardware design and modeling By Edition: illustrated Published by Springer, 2004 ISBN 1402075308, 9781402075308
2. Chris Spear , System Verilog for Verification: A Guide to Learning the Test bench Language Features Edition: 2, Published by Springer, 2008 ISBN 0387765298, 9780387765297

3. Prakash Rashinkar, Peter Paterson, Leena Singh. System-on-a-Chip Verification: Methodology and Techniques by and Published by Kluwer Academic Publishers 2004, New York, ISBN-0-306-46995-2.
4. Srikanth Vijayaraghavan & Meyyappan Ramanathan. A Practical guide for System Verilog Assertions By Edition: illustrated Published by Springer, 2005 ISBN 0387260498, 9780387260495

Course Code	Course Name	L-T-P	Credits
EC235	VLSI Design and Verification Lab	(0-0-4)	2

Course Learning Outcomes (CLO):

CLO1: Students will get practical experience of writing test bench for digital circuits in system Verilog

CLO2: Students will get skills of writing test bench using procedural statements, routines and OOP to verify a VLSI chip.

CLO3: Skill to design test bench blocks by applying randomization method using EDA tools

Introduction of various types of commands in system verilog, programming of digital circuits using system verilog, declaration of arrays, functions, queues, implement FIFO using queue, implementing stacks using queue, function to print fibonaaci series, function to print factorial of a number, class definition, initialization, randomization using OOP, creating objects, designing test benches in system verilog, experiment on randomization.

Recommended Books:

1. Stuart Sutherland, Simon Davidmann, Peter Flake. SystemVerilog for design: a guide to using SystemVerilog for hardware design and modeling By Edition: illustrated Published by Springer, 2004 ISBN 1402075308, 9781402075308
2. Chris Spear , System Verilog for Verification: A Guide to Learning the Test bench Language Features Edition: 2, Published by Springer, 2008 ISBN 0387765298, 9780387765297
3. Prakash Rashinkar, Peter Paterson, Leena Singh. System-on-a-Chip Verification: Methodology and Techniques by and Published by Kluwer Academic Publishers 2004, New York, ISBN-0-306-46995-2.
4. Srikanth Vijayaraghavan & Meyyappan Ramanathan. A Practical guide for System Verilog Assertions By Edition: illustrated Published by Springer, 2005 ISBN 0387260498, 9780387260495

Course Code	Course Name	L-T-P,	Credits
EC244	IC fabrication and Technology	(4-0-0)	4

Course Learning Outcomes (CLO):

CLO1: Understand the fabrication technology of IC Technology.

CLO2: To understand and analyze operation of MOS Transistor.

CLO3: To learn the basic MOS technology to design physical process of VLSI Design flow.

CLO4: Able evaluate combinational and sequential logic designs using various metrics:

CLO5: Skill to calculate switching speed, gate count, and energy dissipation and power

Semiconductor Materials, Crystal Structure, Energy Bands, Carrier Concentrations, Carrier Transport Phenomena, Continuity Equation, Thermionic Emission Process, Tunneling Process, High Field Effects. Electron grade silicon. Crystal growth. Wafer preparation. Vapour phase and molecular beam epitaxy. SOI. Epitaxial evaluation. Oxidation techniques, systems and properties. Oxidation defects. Optical, electron, X-ray and ion lithography methods. Plasma properties, size, control, etch mechanism, etch techniques and equipment's. Deposition process and methods. Diffusion in solids. Diffusion equation and diffusion mechanisms. Ion implantation and metallization. Process simulation of ion implementation, diffusion, oxidation, epitaxy, lithography, etching and deposition. NMOS, CMOS, MOS memory and bipolar IC technologies. IC fabrication. Analytical and assembly techniques. Packaging of VLSI devices.

Recommended Books:

1. S.M.Sze, "VLSI Technology (2nd edition)" , McGraw Hill, 1988
2. S. M. Sze, Semiconductor Devices – Physics and Technology, 2nd Edition, Wiley, 2010
3. Donald A. Neamen 'Semiconductor Physics and Devices' McGraw-Hill.
4. Shimura, F. ed., 2012. Semiconductor silicon crystal technology. Elsevier.

Course Code	Course Name	L-T-P	Credits
EC224	Mixed Signal Circuit Design	(0-0-8)	4

Course Learning Outcomes (CLO):

CLO1: Apply knowledge of mathematics and engineering to design CMOS analog circuits to achieve desired performance specifications.

CLO2: Skilled to identify, formulates, and solve engineering problems in the area of mixed-signal design.

CLO3: Design and implement various types of mixed-signal integrated circuit for real world applications during their employment and entrepreneurship.

CLO4: Applications for real world applications.

CLO5: Applications for societal problem solving

Mixed Signal Introduction and IC Process. CMOS Amplifiers: Common Source (CS) stage with MOS as diode connected load and current source loads, CS stage with source degeneration, Source follower and common gate stage (Only voltage gain and output impedance of circuits). Cascade Stage: Cascade amplifier with cascade load, Folded cascade amplifier. Differential Amplifiers: Basic differential Amplifier, Differential amplifier with MOS (as diode connected) and current source loads. Frequency Response of Amplifiers: Miller Effect, Association of poles with Nodes, High frequency model of Common-Source, Source-follower, Common-Gate Stage, Cascade and Differential pair. CMOS Operational Amplifiers: Performance parameters, One-stage op amp, Two-stage op-amp. Comparators: Characterization of a comparator, Static and Dynamic Characteristics, Non-ideal effects, Two stage open loop comparator gain. Switched Capacitor Circuits: MOSFETs as Switches, Performance parameters (Speed, Precision, and Channel Charge Injection). Switched Capacitor Amplifiers: Unity- Gain Sampler/ Buffer, performance parameters (precision, speed, slewing), Switched capacitor non-inverting amplifier. Switched Capacitor Filter. Phase Locked Loop (PLL): Phase detector, Basics of VCO, Block diagram of PLL (Qualitative Analysis only).Data Converters: Introduction and characterization of Digital-Analog Converters (DACs), Static Characteristics of DACs (Resolution, SNR, Integral nonlinearity (INL), Differential nonlinearity (DNL), Dynamic Characteristics of DACs (conversion speed). Introduction to Analog to Digital Convert (ADC), Static and Dynamic characteristics of ADC, Pipelined Algorithmic ADC, Architecture of Flash ADC.

Recommended Books:

1. Behjad Razavi “Design of Analog CMOS Integrated Circuits”, Second Edition, Tata Mcgraw Hill.
2. Phillip E. Allen, Douglas R. Holberg. “CMOS Analog Circuit Design” Second Edition, Oxford University Press.
3. Baker, R.J., 2008. CMOS: mixed-signal circuit design. john Wiley & sons.
4. Burns, M. and Roberts, G.W., 2001. An introduction to mixed-signal IC test

and measurement (Vol. 2001). New York: Oxford university press.

Course Code	Course Name	L-T-P	Credits
EC237	Sensor & Communication Protocol	(0-0-8)	4

Course Learning Outcomes (CLO):

CLO1: Understand fundamental concepts of sensor technology.

CLO2: Understand networking techniques for data communication in IoT enabled devices and system.

CLO3: Comprehend different communication technologies for efficient connectivity in IoT devices during their employment.

CLO4: Evaluate various Protocols required.

Measurement Terminology: Input and output, range, accuracy, precision, resolution, sensitivity, linearity, repeatability, reproducibility, calibration and traceability, Testing, quality assurance and safety. Transducers and Sensors: Sensors and transducers: Temperature sensors, resistive sensors, capacitive sensors, electrostatic sensors, piezoelectric sensors, ultrasonic sensors, RFID, radiological sensors and MEMS. Optical sensing techniques: Common electromagnetic sensors, IR sensors, passive IR sensors, photo-resistive sensors, photovoltaic sensors, photodiodes, photoelectric detectors, solid state lasers, CCD and CMOS sensors. Smart Sensors: Primary Sensors, Excitation, Amplification, Filters, Converters, Compensation, Information Coding/Processing , Data Communication, Standards for Smart Sensor Interface, The Automation Sensors Applications: On-board Automobile Sensors (Automotive Sensors), Home Appliance Sensors, Aerospace Sensors, Sensors for Manufacturing, Sensors for environmental Monitoring. Network and Communication Protocols: Rules of communication, Network protocols and standards- Role of standard organizations OSI and TCP/IP model, data transfer in the network. Physical Layer: Physical layer protocols, network media- guided and unguided. Data Link Layer: Ethernet: Ethernet protocols, Ethernet MAC address, LAN switches- working, switch forwarding methods, Network layer: network layer protocols i.e. IPv4 and IPv6, IP addressing: IPv4 Network Addresses- structure and characteristics, IPv6 network addresses. Transport Layer: transport layer protocols-TCP and UDP. Application Layer: Introduction, application layer protocols, HTTP, HTTPS, email, SMTP, DNS, DHCP. Communication Technologies: Bluetooth Low Energy, ZigBee, Z-wave, Wi-Fi, Lora WAN, 6LoWPAN, Near Field Communication (NFC).

Recommended Books:

1. D. Patranabis ‘Sensors and Transducers’ by, PHI Learning Private Limited.
2. B. Forouzan ‘Introduction to Data Communications and Networking’ by, Tata McGraw Hill, Fourth Edition, 2004.
3. ‘Introduction to Networks Companion Guide’, by Cisco Networking Academy.
4. Raghavendra, C.S., Sivalingam, K.M. and Znati, T. eds., 2006. Wireless sensor networks. Springer.

Course Code	Course Name	L-T-P	Credits
EC249	IoT Application Development	(0-0-8)	4

Course Learning Outcomes (CLO):

CLO1: Implement various application development techniques used for designing IoT enabled devices.

CLO2: Skilled to utilize Cloud based services for IoT devices.

CLO3: Apply data analysis techniques for cloud computing applications during employment and as entrepreneur.

CLO4: Evaluate various cloud computing solutions.

CLO5: Applications in real-time problem solving

Introduction to IoT, IoT platforms and design methodology, basic building blocks of an IoT device, design methodology. IoT physical devices, exemplary devices like Node MCU, Raspberry pi, STM32 etc. Interfacing and programming IoT device. IoT physical server and cloud offerings. Introduction to cloud storage models and communication API's. WAMP server, designing a Restful web API, Amazon web services for IoT. Connecting IoT devices to AWS IoT platform. Optimizing IoT computing. Visualizing AWS IoT data. Case studies on IoT applications using AWS.

Recommended Books:

1. Arshdeep Bagha and Vijay Madisetti Internet of Things: A Hands-on-approach, by, Orient Blackswan publisher, 2015.
2. Agus Kurniawan , Learning AWS IoT, by, Packt publishing, 2018.
3. Kanagachidambaresan, G.R., Maheswar, R., Manikandan, V. and Ramakrishnan, K., 2020. Internet of Things in smart technologies for sustainable urban development. Springer International Publishing.
4. Seneviratne, P., 2018. Hands-On Internet of Things with Blynk: Build on the power of Blynk to configure smart devices and build exciting IOT projects. Packt Publishing Ltd.

Course Code	Course Name	L-T-P	Credits
EC250	Web Development for IoT	(0-0-8)	4

Course Learning Outcomes (CLO):

CLO1: The student would be design dynamic web forms for acquiring and processing the user and sensor data.

CLO2: The student would be skilled to interpret the IoT architecture and building blocks of various domains

CLO3: To design Interactive forms using Java script with a focus on Internet of Things which increases student's employability.

CLO4: Applications in real-time problem solving

HTML: Introduction to web programming, client-server architecture, static and dynamic content, HTML basic elements and attributes. HTML formatting. Introduction to link, images and tables. Introduction to HTML frames, layout of frames and elements. HTML forms, HTML form elements, input types and attributes.CSS: Introduction to CSS, Syntax, HTML CSS styles. CSS properties: background, text, font, list, tables and borders. Bootstrap: Introduction to Bootstrap, grid basic, typography, Bootstrap properties: tables, images, type of buttons. JavaScript: Introduction to JavaScript, syntax, variables, and operators. JavaScript data types, strings and arrays. JQuery: introduction to JQuery, syntax and events. JQuery effect, JQuery in HTML. JQuery in HTML: JQuery get, set, add, remove. PHP: Introduction to PHP, syntax, data types, variables and statements. MySQL: Introduction to database, create DB, table, insert and delete data, update data, select data. AJAX: Introduction, AJAX PHP, database and XML.JSON: Introduction, types and formats. IoT Node: Introduction to IoT enabled embedded device, pin configuration and use cases. Communication protocols and peripheral interfaces. Introduction to sensors: Types of sensors, interfacing of sensors with IoT node. Introduction to actuators: types and interfacing with IoT node. Creating web application: A capstone project to create web-based IoT application.

Recommended Books:

1. Niederst Robbins, 'Learning web designing: a beginner's guide to HTML, CSS, JavaScript, and web graphics', 4th Edition, Oreilly Publication.
2. Laura Lemay, Rafe Coburn, Jennifer Kyrnin, 'Mastering HTML, CSS &JAVAScript Web Publishing' by 7th edition, SAMS publication.
3. Ivan Bayross, Web Enabled Commercial Application Development using HTML, JavaScript, DHTML and PHP' by, 4th Edition, BPB Publications.
4. Peter Waher, Learning Internet of Things by, 1st Edition, Packt Publishing.

Course Code	Course Name	L-T-P	Credits
EC217	IoT and Industrial Applications	(4-0-0)	4

Course Learning Outcomes (CLO):

CLO1: The student would be able to interpret the concept of industrial IoT.

CLO2: Skilled to design IoT application using the communication protocols

CLO3: The student would be able to highlight the key attributes of industry 4.0 and its characteristics as an entrepreneur.

CLO4: Evaluate various cloud computing solutions.

CLO5: Applications in real-time problem solving

Industrial Internet, Key IIoT Technologies, Innovation and the IIoT, Key Opportunities and Benefits, IIoT Reference Architecture, The IIC Industrial Internet Reference Architecture, Industrial Internet Architecture Framework (IIAF), Industrial Internet Viewpoints, Control domain ,Operations domain, Information domain, Application domain, Business domain. Designing Industrial Internet Systems: Architectural Topology, Key System Characteristics, Key Functions of the Communication Layer. The Concept of the IIoT, The Proximity Network, WSN Edge Node, WSN Network Protocols, Low-Power Technologies, Designing Low-Power Device Networks, Legacy Industrial Protocols, Modern Communication Protocols, Wireless Communication Technologies, Proximity Network Communication Protocols. IIoT WAN Technologies and Protocols: IIoT Device Low-Power WAN Optimized Technologies for M2M, SigFox, LoRaWAN, Wave, Dash7, Ingénue RPMA, Low Power Wi-Fi, LTE Category-M, Weightless, Millimeter Radio. Securing the Industrial Internet: PLCs and DCS, Securing the OT, Network Level: Potential Security Issues, System Level: Potential Security Issues, Identity Access Management, Introducing Industry 4.0, Defining Industry 4.0, Four Main Characteristics of Industry 4.0, The Value Chain, Creating a Value Chain, Creating a Value Chain, Cost Differential, Benefits to Business, Industry 4.0 Design Principles, Building Blocks of Industry 4.0, Industry 4.0 Reference Architecture. Industrial Internet Use-Cases: Healthcare, Oil and Gas Industry, Smart Office, Logistics and the Industrial Internet, IOT Innovations in Retail.

Recommended Books:

1. Alasdair Gilchrist, Industry 4.0: The Industrial Internet of Things, by, Apress publication.
2. Dong-seong Kim Hoatrang-Dang. Industrial sensors and control in communication networks, by Springer publication.
3. Keramidas, G., Voros, N. and Hübner, M., 2016. Components and Services for IoT Platforms. Cham: Springer International Pu.
4. Ustundag, A. and Cevikcan, E., 2017. Industry 4.0: managing the digital transformation. Springer.

Course Code	Course Name	L-T-P	Credits
EC241	Cloud computing for IoT	(4-0-0)	4

Course Learning Outcomes (CLO):

CLO1: To analyze the features of different types of computing and benefits of Cloud Computing.

CLO2: To demonstrate the Open source Cloud- Open Stack and Google Cloud Platform.

CLO3: Skilled to interpret the security protocols used in Cloud based IoT application development as an employee and entrepreneur.

CLO4: Evaluate various cloud computing solutions.

CLO5: Applications in real-time problem solving

Introduction to Internet of Things (IoT) and Cloud Computing IoT Introduction, IoT Key Features, Advantages and Disadvantages of IoT, IoT Hardware, IoT-Technology and Protocol, IoT-Common Uses. Overview of Computing: Distributed Computing, Grid Computing, Cluster Computing, Utility Computing. Introduction to Cloud Computing, Characteristics of Cloud Computing, Properties, Characteristics, Advantages and Disadvantages of Cloud Computing, Cloud Computing Architecture, Cloud Computing Models: SaaS (software as a service), PaaS (platform as a service), IaaS (infrastructure as a service), FaaS (functions as a service). Service Level and Data Management in Cloud Computing. Deployment Models: Private Cloud, Public Cloud, Community Cloud, Hybrid Cloud, Cloud Computing Virtualization, Cloud Computing XML Basics, Cloud Computing Web Services, Service Oriented Architecture, Service Level Agreement, Cloud Economics, Managing Data. Resource Management in Cloud Computing and Cloud Computing Security Introduction to Map Reduce, Open Stack, Cloud Computing Demo-Microsoft Azure, CIA model, Cloud Computing Security in Collaborative SaaS Cloud. Extensions of Cloud Computing, Cloud Computing Broker for Cloud Marketplace Mobile Cloud Computing: Introduction, Requirement, Advantages, Examples, Privacy and Security Issues, Fog Computing, Geo-Spatial Cloud.

Recommended Books:

1. Rajkumar Buyya, James Broberg, Andrzej M. Goscinski, Cloud Computing: Principles and Paradigms,Wiley,2011
2. Gautam Shroff, Enterprise Cloud Computing - Technology, Architecture, Applications, Cambridge University Press, 2010
3. Barrie Sosinsky, Cloud Computing Bible, Wiley-India, 2010.
4. Ronald L. Krutz, Russell Dean Vines, Cloud Security: A Comprehensive Guide to Secure Cloud Computing, Wiley- India,2010.

Course Code	Course Name	L-T-P	Credits
EC236	Wearable Technology and Reality	(4-0-0)	4

Course Learning Outcomes (CLO):

CLO1: Skilled to identify products where smart textiles can be applied.

CLO2: Able to identify different mechanisms for energy harvesting and transmission which increases student's employee skill

CLO3: Skilled to outline the human body applications designed using wearable sensors.

CLO4: Applications of Wearable technology and reality in health monitoring.

CLO5: Applications in real-time problem solving

Wearables: World of wearables, Attributes of Wearables, Textiles and Clothing: Meta-Wearable, Challenges and Opportunities, The Future of Wearables, Wearable Haptics Introduction, The Need for Wearable Haptic Devices, Categories of Wearable Haptic and Tactile Display. Wearable Electronics Sensors: Introduction, Need, Sensors for Physiological Parameters Monitoring, types of activities, wireless technologies, Current Status and Future Opportunities, Wearable Bio and Chemical Sensors, Wearable Inertial Sensors and their Applications, Application of Optical Heart Rate Monitoring, Body Worn Heat Flow Sensors, Body Sensor Networks (BSN). Knitted Electronic Textiles: the Interlaced Network, Textile Sensors for Physiological State Monitoring, Biomechanical Sensing, Non-Invasive Sweat Monitoring by Textile Sensors, Smart Fabrics and Interactive Textile Platforms for Remote Monitoring, System for Remote Rehabilitation, Systems for Emotional State Assessment.

Energy harvesting from foot motion, wireless energy Transmission, RFID Technology. Wireless Body Area Network: Introduction, Evaluation Matrix, Technologies, Wearable Radios, Wearable Sensors for Physiological Signal Measurement, wearable sensor inside and outside of the human body for early detection if disease.

Recommended Books:

1. Edward Sazonov and Michael R. Neuman. "Wearable Sensors" Fundamentals, Implementation and Applications.
2. Subhas Chandra Mukhopadhyay. "Wearable Electronics Sensors for Safe and Healthy Living".
3. Holland, J. ed., 2016. Wearable Technology and Mobile Innovations for Next-Generation Education. IGI Global.
4. Barfield, W. ed., 2015. Fundamentals of wearable computers and augmented reality. CRC press.

Course Code	Course Name	L-T-P	Credits
EC204	Digital Image Processing	(3-0-0)	3

Course Learning Outcomes (CLO):

CLO1: After the completion of the course student will be able to understand the fundamental concepts of a digital image processing system like Image formation, Image sampling and quantization

CLO2: Students will develop the knowledge to analyze the different images in the frequency domain using various transforms

CLO3: Students will be skilled to realize the importance of filters for the images and also they will be able to differentiate between the different types of filters.

CLO4: Applications of image processing in recognition

CLO5: Applications in real-time problem solving

Introduction: What is Digital Image Processing? Fundamental steps in Digital Image Processing, Application fields and Components of an image processing system. Digital Image Fundamentals: Elements of Visual Perception, Monochrome and Color vision models. Simple image formation model, Image Sampling and Quantization, Basic relationship between pixels, Linear and Non-Linear operations. Image Enhancement in the spatial domain, Basic gray level transformations, Histogram processing-Histogram Equalization and Histogram specification. Enhancement using Image subtraction and averaging. Basics of spatial filtering, Smoothing and sharpening filters. Basic geometric transformations: Introduction to Fourier Transform and DFT. Properties of 2D Fourier Transform, FFT, Image Enhancement in the frequency domain: Smoothing frequency domain filters. Image Enhancement in the frequency domain: Sharpening frequency domain filters. Image Restoration: A Model of Image Degradation / restoration process. Noise models, Restoration in the presence of noise only: Spatial Filtering. Periodic noise reduction by Frequency domain filtering. Algebraic approach to restoration: Inverse filtering, Minimum Mean Square Error (Wiener) Filtering. Morphological Image Processing: Preliminaries: Some basic concepts from set theory, Logic Operations Involving Binary Images. Dilation and Erosion, Opening and Closing. The Hit-or-Miss Transformation. Some Basic Morphological Algorithms: Boundary Extraction, Region Filling, Extraction of Connected Components, Convex Hull, Thinning, Thickening, Skeletons, Pruning. Color Image Processing: Fundamentals, Color Models, Pseudocolor Image Processing. Basics of full color image processing. Color Transformations, Smoothening and Sharpening. Image Segmentation: Detection of Discontinuities, Point, Line and Edge detection. Edge linking and Boundary Detection. Thresholding, Region Based segmentation. Image Compression: Fundamentals, Lossless compression: Variable length coding, LZW coding, Bit plane coding, Lossless predictive coding.

Recommended Books:

1. Rafael C. Gonzalez & Richard E. Woods, Digital Image Processing, Pearson Education (2nd edition)
2. Anil K. Jain, Fundamentals of Digital Image Processing, Prentice Hall, Pearson Education (ISBN 81-297-0083-2)
3. Andrew Alasdar, Introducation to Digital image processing by McPublication: New Delhi: Cengage Learning. 2009 .Date: 2009
4. Jayaraman, S, Esakkirajan&Veerkumar, Digital image processing by TPublication: New Delhi: Tata McGraw Hill. 2010. Date: 2010
5. Annadurai, S. and Shanmugalakshmi,Fundamentals of digital image processing by R.Publication: New Delhi Pearson 2010 ..Date: 2010
6. Jayaraman, S, Esakkirajan&Veerkumar, Digital image processingby, TPublication: New Delhi: Tata McGraw Hill

Course Code	Course Name	L-T-P	Credits
EC205	Digital Image Processing Lab	(0-0-2)	1

Course Learning Outcomes (CLO):

CLO1: After completion of this lab, the students are in a portion to understand the concepts of structure of human eye and Image formation in the eye.

CLO2: Skill of applying the different techniques for the enhancement and filtering of images.

CLO3: Skill to understand the relevant aspects of digital image representation and their practical Implications.

CLO4: Applications of image processing in recognition

CLO5: Applications in real-time problem solving

To study the concept of Image processing including the image acquisition, image storage, image processing and display. To obtain contrast adjustment using histogram equalization of the image. To Implement smoothing or averaging filter in spatial domain using the general processes of convolution and correlation. Program for opening and closing of the image for studying the morphological image removal. To fill the region of interest for the image in order to identify and process a given purpose. Program for edge detection algorithm including the multistage algorithm to detect a wide range of edges in the given images. Program of sharpen image using gradient mask to bring about a directional change in the intensity or color in an image. Program for morphological operation: erosion and dilation 9. Program for DCT/IDCT computation.

Recommended Books:

1. Rafael C. Gonzalez & Richard E. Woods, Digital Image Processing, Pearson Education (2nd edition)
2. Anil K. Jain, Fundamentals of Digital Image Processing, Prentice Hall, Pearson Education (ISBN 81-297-0083-2)
3. Andrew Alasdar, Introducation to Digital image processing by McPublication: New Delhi: Cengage Learning. 2009 .Date: 2009
4. Jayaraman, S, Esakkirajan&Veerkumar, Digital image processing by TPublication: New Delhi: Tata McGraw Hill. 2010. Date: 2010.

Course Code	Course Name	L-T-P	Credits
EC262	Machine Learning	(4-0-0)	4

Course Learning Outcomes (CLO):

CLO1: Understand various basic concepts and techniques of Machine Learning.

CLO2: Skill to evaluate different classification algorithms and the results.

CLO3: Develop skills of using recent machine learning Algorithms for solving practical problems useful during employment

CLO4: Apply the algorithms to a real problem, optimize the models learned and report on the expected accuracy that can be achieved by applying the models.

CLO5: Applications of the machine learning based model in real-time problem solving.

Introduction to machine learning: Introduction and History of Machine Learning. Basic Concepts of Machine Learning, Examples of Machine learning application, how artificial Intelligence relates to Machine Learning, Machine Learning Concepts, Different phases of prediction modeling. Supervised Learning: Learning class from examples, learning multiple classes Non-parametric Methods: k-Nearest Neighbors (KNN), Introduction and building a Decision Tree. Representing disjunctive concepts as trees and rules, Random Forest Discriminative Learning models: Support Vector Machine (SVM) and its Kernels, Unsupervised Learning: Introduction to clustering, Unsupervised Learning: Introduction to clustering, k-Means clustering algorithm and Hierarchical Clustering, Supervised learning after clustering, Introduction to regression

Linear Regression and locally weighted or logistic, Regression. Reinforcement Learning: Introduction to Reinforcement Learning, Learning Task, Non-deterministic Rewards and actions with examples Evaluation Metrics: Introduction, Binary Classification, performance, Score based models and Point matrices.

Recommended Books:

1. Alpaydin, Ethem., "Introduction to machine learning", second edition.
2. Tom M. Mitchell., "Machine Learning", McGraw-Hill Science/Engineering/Math; ISBN: 0070428077.
3. Peter Flach, Machine Learning: The Art and Science of Algorithms that make sense of Data, Cambridge University Press.
4. Chris Bishop, Pattern Recognition and Machine Learning, Springer.

Course Code	Course Name	L-T-P	Credits
EC203	Biomedical Electronics	(4-0-0)	4

Course Learning Outcomes (CLO):

CLO1: Understand the fundamental principles of Biomedical circuit.

CLO2: Skilled to analyze bio electronic circuits using oscilloscopes and other electronic test equipment.

CLO3: Apply knowledge of biomedical electronic circuits to solve problems in the areas of biomedical signals.

CLO4: Applications of Bio-medical imaging

CLO5: Applications of biomedical electronics in real-time problem solving .

Brief introduction to human physiology. Biomedical transducers: displacement, velocity, force, acceleration, flow, temperature, potential, dissolved ions and gases. Bio-electrodes and biopotential amplifiers for ECG, EMG, EEG, etc. Measurement of blood temperature, pressure and flow. Impedance plethysmography. Ultrasonic, X-ray and nuclear imaging. Prostheses and aids: pacemakers, defibrillators, heart-lung machine, artificial kidney, aids for the handicapped. Safety aspects.

Recommended Books:

1. W.F. Ganong, Review of Medical Physiology, 8th Asian Ed, Medical Publishers, 1977.
2. J.G. Websster, ed., Medical Instrumentation, Houghton Mifflin, 1978.
3. A.M. Cook and J.G. Webster, eds., Therapeutic Medical Devices, Prentice-Hall, 1982.
4. Laskovski, A. ed., 2011. Biomedical Engineering, Trends in Electronics: Communications and Software. BoD–Books on Demand.

Course Code	Course Name	L-T-P	Credits
EC233	Speech and Audio Processing	(4-0-0)	4

Course Learning Outcomes (CLO):

CLO1: To acquire knowledge of audio and speech signals.

CLO2: Skill to develop understanding of speech generation and recognition models.

CLO3: Skill to relate human physiology and anatomy with signal processing paradigms.

CLO4: Design and implement algorithms for processing speech signals.

CLO5: Design and implement algorithms for processing audio signals.

Introduction- Speech production and modeling - Human Auditory System; General structure of speech coders; Classification of speech coding techniques – parametric, waveform and hybrid; Requirements of speech codecs –quality, coding delays, robustness. Speech Signal Processing- Pitch-period estimation, all-pole and all-zero filters, convolution; Power spectral density, periodogram, autoregressive model, autocorrelation estimation. Linear Prediction of Speech- Basic concepts of linear prediction; Linear Prediction Analysis of non-stationary signals –prediction gain, examples; Levinson-Durbin algorithm; Long term and short-term linear prediction models; Moving average prediction. Speech Quantization- Scalar quantization–uniform quantizer, optimum quantizer, logarithmic quantizer, adaptive quantizer, differential quantizers; Vector quantization – distortion measures, codebook design, codebook types. Scalar Quantization of LPC- Spectral distortion measures, Quantization based onreflection coefficient and log area ratio, bit allocation; Line spectral frequency – LPC to LSF conversions, quantization based on LSF. Linear Prediction Coding- LPC model of speech production; Structures of LPCencoders and decoders; Voicing detection; Limitations of the LPC model. Code Excited Linear Prediction-CELP speech production model; Analysis-by-synthesis; Generic CELP encoders and decoders; Excitation codebook search – state-save method, zero-input zerostate method; CELP based on adaptive codebook, Adaptive Codebook search; Low Delay CELP and algebraic CELP. Speech Coding Standards-An overview of ITU-T G.726, G.728 and G.729standards.

Recommended Books:

1. A.M.Kondoz, “Digital Speech” by Second Edition (Wiley Students Edition), 2004.
2. W.C. Chu, “Speech Coding Algorithms: Foundation and Evolution of Standardized Coders”, WileyInter science, 2003.
3. Gold, B., Morgan, N. and Ellis, D., 2011. Speech and audio signal processing: processing and perception of speech and music. John Wiley & Sons.
4. Ogunfunmi, T., Togneri, R. and Narasimha, M. eds., 2015. Speech and audio processing for coding, enhancement and recognition. New York: Springer.

Course Code	Course Name	L-T-P	Credits
EC208	Electronic System Design	(4-0-0)	4

Course Learning Outcomes (CLO):

CLO1: After the completion of this course students get familiarization with data storage elements along with their applications

CLO2: Students will able to get the idea about the different trends and limitation of CMOS technology scaling

CLO3: Students will acquire the knowledge regarding the various digital interfacing systems like UART, SPI and I2C

CLO4: Applications of UART, SPI and I2C

CLO5: Skilled to learn interfacing of real world input and output devices

Data Storage Elements: Concept of memory, ROM in verilog, RAM, applications on data storage elements, FPGA building blocks used in data storage elements. Sequential Circuits: Sequential circuit analysis, FSMs: definition of state and output equations, state table, state diagram, state representation in verilog, timings in sequential circuits-synchronous operation and asynchronous operation, shift register as a sequential circuit, counter as a sequential circuit, sequential circuit design and applications of sequential circuits, FPGA building blocks using sequential circuits. Digital Interfacing: Universal Asynchronous Receiver/ Transmitter (UART), UART Applications, Serial Peripheral Interface (SPI), Inter-integrated Circuit (I2C). Effects of Technology Scaling on CMOS Logic Styles: Trends and Limitations of CMOS Technology Scaling – MOSFET Scaling Trends, Challenges of MOSFET Scaling – Short- Channel Effects, Subthreshold Leakage Currents, Dielectric Breakdown, Hot Carrier effects, Soft Errors, Velocity Saturation and Mobility Degradation, DIBL, Scaling down Vdd/Vth ratio. Advanced Device Technology: SOI, SiGe, strained Si, Alternative oxide/gate materials, Alternative geometries (raised source/drain, dual gate, vertical, FinFET), Memory Devices (DRAM, Flash). Sub-micron and Deep sub-micron Device Modeling.

Recommended Books:

1. Kang, S. and Leblebici, Y., CMOS Digital Integrated Circuits – Analysis and Design, Tata McGraw Hill (2008) 3rd ed.
2. Unsalan,C and Tar, B., Digital system design with FPGA, McGraw Hill Education(India) Pvt. Ltd(2018).
3. Rigo, S., Azevedo, R. and Santos, L. eds., 2011. *Electronic system level design: an open-source approach*. Springer Science & Business Media.
4. Almaini, A.E., 1994. *Electronic logic systems*. Prentice-Hall, Inc..

Course Code	Course Name	L-T-P	Credits
EC206	Digital System Design	(3-0-0)	3

Course Learning Outcomes (CLO):

CLO1: The students completing this course are expected to understand the structure of various number systems and its application in digital design.

CLO2: Students will be able to design the appropriate truth table from a description of a combinational logic function

CLO3: Students will be skilled to analyze and design various combinational and sequential circuits like Comparators, Multiplexers, Encoders etc.

CLO4: Students will be skilled to design the synchronous circuits like Pulse train generator, Pseudo Random Binary Sequence generator

CLO5: Designing of Pseudo Random Binary Sequence generator

Logic Simplification and Combinational Logic Design: Review of Boolean Algebra and De Morgan's Theorem, SOP & POS forms, Canonical forms, Karnaugh maps up to 6 variables, Binary codes, Code Conversion. MSI devices like Comparators, Multiplexers, Encoder, Decoder, Driver & Multiplexed Display, half and Full Adders, Subtractors, Serial and Parallel Adders, BCD Adder, Barrel shifter and ALU Sequential Logic Design: Building blocks like S-R, JK and Master-Slave JK FF, Edge triggered FF, Ripple and Synchronous counters, Shift registers, Finite state machines, Design of synchronous FSM, Algorithmic State Machines charts. Designing synchronous circuits like Pulse train generator, Pseudo Random Binary Sequence generator, Clock generation Logic Families and Semiconductor Memories: TTL NAND gate, Specifications, Noise margin, Propagation delay, fan-in, fan-out, Tristate TTL, ECL, CMOS families and their interfacing, Memory elements, Concept of Programmable logic devices like FPGA. Logic implementation using Programmable Devices. VLSI Design flow: Design entry: Schematic, FSM & HDL, different modeling styles in VHDL, Data types and objects, Dataflow, Behavioral and Structural Modelling, Synthesis and Simulation VHDL constructs and codes for combinational and sequential circuits.

Recommended Books:

1. R.P. Jain, "Modern digital Electronics", Tata McGraw Hill, 4th edition, 2009.
2. Douglas Perry, "VHDL", Tata McGraw Hill, 4th edition, 2002.
3. W.H. Gothmann, "Digital Electronics- An introduction to theory and practice", PHI, 2nd edition ,2006.
4. D.V. Hall, "Digital Circuits and Systems", Tata McGraw Hill, 1989
5. Charles Roth, "Digital System Design using VHDL", Tata McGraw Hill 2nd edition, 2012.

Course Code	Course Name	L-T-P	Credits
EC207	Digital System Design Lab	(0-0-2)	1

Course Learning Outcomes (CLO):

CLO1: The students will be able to apply the knowledge to represent digital values in different logic families, including characterization of the noise margins.

CLO2: Students will be able to apply the knowledge to simulate and implement combinational and sequential circuits using VHDL systems.

CLO3: Students will be skilled to practically implement and evaluate combinational and sequential logic designs using various metrics: switching speed, gate count , and energy dissipation and power.

CLO4: Skill evaluates combinational and sequential logic designs using various metrics:

CLO5: Evaluate switching speed, gate count , and energy dissipation and power

To study the concept of Image processing including the image acquisition, image storage, image processing and display. To obtain contrast adjustment using histogram equalization of the image. To Implement smoothing or averaging filter in spatial domain using the general processes of convolution and correlation. Program for opening and closing of the image for studying the morphological image removal. To fill the region of interest for the image in order to identify and process a given purpose. Program for edge detection algorithm including the multistage algorithm to detect a wide range of edges in the given images. Program of sharpen image using gradient mask to bring about a directional change in the intensity or colour in an image. Program for morphological operation: erosion and dilation 9. Program for DCT/IDCT computation.

Recommended Books:

1. R.P. Jain, “Modern digital Electronics”, Tata McGraw Hill, 4th edition, 2009.
2. Douglas Perry, “VHDL”, Tata McGraw Hill, 4th edition, 2002.
3. W.H. Gothmann, “Digital Electronics- An introduction to theory and practice”, PHI, 2nd edition ,2006.
4. D.V. Hall, “Digital Circuits and Systems”, Tata McGraw Hill, 1989
5. Charles Roth, “Digital System Design using VHDL”, Tata McGraw Hill 2nd edition, 2012.

Course Code	Course Name	L-T-P	Credits
EC266	Cloud Computing & Virtualization	(3-1-0)	4

Course Learning Outcomes (CLO):

CLO1: Articulate the main concepts, key technologies, strengths, and limitations of Cloud computing and the possible applications for state-of-the-art Cloud computing

CLO2: Skill to identify the architecture and infrastructure of Cloud computing, including SaaS, PaaS, IaaS, public Cloud, private Cloud, hybrid Cloud, etc.

CLO3: Skill to identify problems, explain, analyze, and evaluate various cloud computing solutions.

CLO4: Evaluate various cloud computing solutions.

CLO5: Applications in real-time problem solving.

Introduction to Cloud, Defining the Cloud Computing, Characteristics of Cloud Computing,Evolution of Cloud Computing, Difference with Existent Technologies, Deployment Models Service Models, Benefits of Cloud Computing, Limitations of Cloud Computing, Enabling Technologies to Cloud Computing: Virtualization, Service Oriented Architecture, Web Services, Hardware Key Issues in Research\Industry Community , Future Roadmap, Resource Management, Load Balancing: Distributed Management of Virtual Infrastructures, Server consolidation, Dynamic provisioning and resource management, Resource Optimization, Resource dynamic reconfiguration, Scheduling Techniques for Advance Reservation Load Balancing, Load balancing techniques, Capacity Management to meet SLA Requirements, Migration and Fault Tolerance: Broad Aspects of Migration into Cloud, Migration of virtual Machines and techniques, Application-level Security, Data level Security, Virtual Machine level Security, Infrastructure Security, Multi-tenancy Issues, IDS: host-based and network-based B1 Course Plan Cloud Computing & Virtualization, Security-as-a-Service, Trust Management, Identity Management and Access Controls Techniques, Overview Traditional IT infrastructure, Shortcoming of physical Infrastructures, Benefits of virtualization, Implementing virtualization, Typical hardware/software server stack, Type of virtualization, Impact of virtualization, Type of server virtualization, Type of hypervisors, Type of desktop virtualization, Storage virtualization, Network virtualization, Application virtualization, Virtualization and cloud.

Recommended Books:

1. RajkumarBuyya, Christian Vecchiola and S. ThamaraiSelvi. Mastering Cloud Computing, Foundations and Applications Programming.
2. Anthony T. Velte Toby J. Velte, Cloud Computing: A Practical Approach by Robert Elsenpeter.
3. Tim Mather, Subra Kumaraswamy, Shahed Latif, Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance, O'Reilly.
4. Le, D.N., Kumar, R., Nguyen, G.N. and Chatterjee, J.M., 2018. Cloud

computing and virtualization. John Wiley & Sons.

Course Code	Course Name	L-T-P	Credits
EC214	Introduction to MEMS	(4-0-0)	4

Course Learning Outcomes (CLO):

CLO1: Develop the basic understanding of micro sensors and actuators with their types and applications in real world.

CLO2: Learn about the fabrication processes involved in designing of micro devices and employing them in real world applications

CLO3: Understand how micro manufacturing is done and what are the various design considerations in developing micro design systems

CLO4: Skilled to design considerations in developing micro design systems

CLO5: Applications of MEMs.

Overview of MEMS and Microsystems, Pressure Sensors, Micro-actuators, Micro actuation using electrostatic forces and piezoelectric, Scaling Laws in Micro actuation, Materials for MEMS and Microsystems, Epitaxy, Oxidation, Types of Oxidation, Oxidation Techniques, Introduction to Lithography, Lithographic techniques: Electron, Optical, X-Ray, Ion Beam, Etching, Diffusion Ion Implantation, Doping, PVD and CVD and Plasma assisted deposition, Microsystems fabrication processes, Micro manufacturing Overview, Bulk Micro manufacturing, Surface Micromachining, LIGA Process, Microsystems Design Considerations.

Recommended Books:

1. Tai-Ran Hsu MEMS and Microsystem Design and Manufacture, by, Tata McGraw Hill Publication
2. S.M. Sze, VLSI Technology by Tata McGraw Hill Publication.
3. Iannacci, J., 2017. RF-MEMS Technology for High-Performance Passives. IOP Publishing.
4. Santos, H. and De Los, J., 2002. RF MEMS circuit design for wireless communications. Artech House.

Course Code	Course Name	L-T-P	Credits
EC121	Embedded System Design	(3-0-0)	3

Course Learning Outcomes (CLO):

CLO1: Explain the use of various tools & technologies for developing an Embedded System

CLO2: Understand the fundamentals of RTOS and application development techniques

CLO3: Knowledge of techniques for writing fast-executing embedded code that utilizes the CPU, memory and peripheral resources efficiently

CLO4: Understand the various embedded protocols used for developing Networked Embedded Systems during their employment

CLO5: Skilled to understand the applications of Embedded system design

Embedded system, Processor embedded into a system, Embedded hardware units and devices in the system, Embedded software in the system, Examples of embedded systems, Embedded systems on chip (SoC) and use of VLSI circuit design technology, Design process in embedded system. Processor and memory organization, Introduction to advanced architectures, Instruction level parallelism, Basic processor Architecture (Intel x86), Performance metrics, Real world interfacing, Interrupts: Basics, Interrupt request, Role of Interrupt handler, Interrupt vector table, Context switching during Interrupts, Nesting of Interrupts, Shared-Data problem, Device Driver Programming Atomic and Critical Section of the code, Interrupt latency, Solving shared-data problem with and without disabling Interrupts Software Architectures: Round-robin architecture without and with Interrupts, Function-Queue-Scheduling architecture, Real-Time Operating System(RTOS): Basic concepts: Task and task states, Role of scheduler, Preemptive and Non-preemptive RTOS, Task control block, Concept of Reentrancy, Concept of Shared-Data problem and Semaphores, Semaphore types: binary, counting and mutex, Problem of priority inversion and priority inheritance protocol, Basic RTOS Services: Message queue, Mailbox and Pipes, Timer functions, Events, Signals, I/O types and examples, Serial communication devices, Parallel communication devices, Timer and counting devices, Watchdog timer, Real time clock, Serial bus communication protocols, Parallel bus device protocols, Network protocols for Internet Enabled systems Interrupts Software Architectures: Round-robin architecture without and with Interrupts, Function-Queue-Scheduling architecture, Real-Time Operating System(RTOS): Basic concepts: Task and task states, Role of scheduler, Preemptive and Non-preemptive RTOS, Task control block, Concept of Reentrancy, Concept of Shared-Data problem and Semaphores, Semaphore types: binary, counting and mutex, Problem of priority inversion and priority inheritance protocol, Basic RTOS Services: Message queue, Mailbox and Pipes, Timer functions, Events, Signals, I/O types and examples, Serial communication devices, Parallel communication devices, Timer and counting devices, Watchdog timer, Real time clock, Serial bus communication protocols, Parallel bus device protocols, Network protocols for Internet Enabled systems.

Recommended Books:

1. Raj kamal, Embedded System Design- architecture, programming and design by Second edition, Tata Mc-Graw hill.
2. David E Simon, An Embedded Software Primer first edition, Pearson.
3. Gajski, D.D., Abdi, S., Gerstlauer, A. and Schirner, G., 2009. Embedded system design: modeling, synthesis and verification. Springer Science & Business Media.
4. Dubey, R., 2008. Introduction to embedded system design using field programmable gate arrays. Springer Science & Business Media.

Course Code	Course Name	L-T-P	Credits
EC122	Embedded System Design Lab	(0-0-2)	1

Course Learning Outcomes (CLO):

CLO1: Understand fundamental concepts and technologies related to embedded system and IoT based devices

CLO2: Understand the fundamentals of RTOS and application development techniques.

CLO3: Skill to write fast-executing embedded code that utilizes the CPU, memory and peripheral resources efficiently

CLO4: Understand the various communication and networking protocols used for developing IoT enabled devices during their employment.

CLO5: Applications of Embedded system design

Understanding PIN out description, compiler usage and API basics., on-board LED in the first blinky program a delay of 0.1-1.1 seconds. Using the four on-board mbed LEDs, write a program that will use a potentiometer input on pin 20 to continuously control how many LEDs are on. Understanding Analog and Digital functions of mbed API. Reading and Logging data from analog input mbed pin 20 and transfer serially to hyper terminal software or Tera Term software. Logging the analog data (approx. 100 samples) to Local file system using file system object in .CSV format. Generate a sawtooth voltage and analyse it using CRO. Create a PWM signal which we can see on an oscilloscope. The code will generate a 100 Hz pulse with 50% duty cycle. Change the duty cycle to some different values, say 0.2 (20%) and 0.8 (80%) and check the correct display is seen on the 'scope, use a pulse width modulation signal to increase and decrease the brightness of the on-board LED. The program requires the use of a host terminal application to communicate the brightness value to the mbed, using the 'u' and 'd' keys. Interfacing 7 segment display to mbed prototype board, Program mbed using digital output to display number 5. Write a testing code to display count from 0 to 9. Use a busout object to display count from 0 to 9. Write a seg_convert() function with function prototype char seg_convert(char seg_value) that performs the same functionality that we have achieved in b and c of Lab exercise 4. return type of seg_convert function is hex value corresponding to display pattern and seg_value is the count value from 0 to 9.

Recommended Books:

1. Raj kamal, Embedded System Design- architecture, programming and design by Second edition, Tata Mc-Graw hill.
2. David E Simon, An Embedded Software Primer first edition, Pearson.
3. Gajski, D.D., Abdi, S., Gerstlauer, A. and Schirner, G., 2009. Embedded system design: modeling, synthesis and verification. Springer Science & Business Media.
4. Dubey, R., 2008. Introduction to embedded system design using field programmable gate arrays. Springer Science & Business Media.

Course Code	Course Name	L-T-P	Credits
EC213	Information Theory and Coding	(4-0-0)	4

Course Learning Outcomes (CLO):

CLO1: Design the channel performance using Information theory:

CLO2: Comprehend various error control code properties

CLO3: Apply linear block codes for error detection and correction

CLO4: Skill to apply convolution codes for performance analysis & cyclic codes for error detection and correction.

CLO5: Skill to apply different codes for performance analysis for error and correction.

Information Theory-Introduction; Discrete and Continuous Messages – Message Sources, Amount of Information; Average Information and Entropy; Characteristics of a Discrete Memoryless Channel; Mutual Information; Shannon's Channel-Coding Theorem; Channel Capacity. Source Coding-Introduction; Basics of Source Encoding - Classification of Source Codes, Kraft-McMillan Inequality, Source-Coding Theorem; Source Coding Techniques – Shannon-Fano Source Code, Huffman Source Code, Lempel-Ziv Code. Error-Control Channel Coding-Types of Errors and Error-Control Codes; Hamming Codes; Cyclic Codes; BCH Codes; Hadamard Codes; LDPC Codes; Convolution Coding and Decoding; Burst-Error Correction Techniques – Interleaving, RS Codes, Turbo Codes. Spread-Spectrum Communications-Introduction, Principles of Spread-Spectrum Modulation; Spread-Spectrum Techniques – Frequency Hopping Spread-Spectrum (FHSS), FHSS with BFSK or M-ary FSK, Performance of FHSS System, Direct Sequence Spread-Spectrum (DSSS), Comparison of FHSS and DSSS, Salient Features of Spread-Spectrum Systems.

Recommended Books:

1. T L Singal, Digital Communication, ISBN: 978-93-392-1952-9, McGraw Hill Education, First Edition, Copyright © 2015.
2. Moser and Chen, A Student's Guide to Coding and Information Theory, ISBN: 978-1-107-68457-7, Cambridge University Press, First Edition, Copyright © 2012.
3. Gravano, An Introduction to Error Control Codes, ISBN: 978-0-199-23678-7, Oxford University Press, 1st edition, 2007.
4. Richard B. Wells, Applied Coding and Information Theory for Engineers, Pearson Education, 1st edition, 2009.

Course Code	Course Name	L-T-P	Credits
EC215	Introduction to Mobile Technology	(4-0-0)	4

Course Learning Outcomes (CLO):

CLO1: Students will gain complete knowledge about mobile network elements, Service Flow and the operation of mobile networks

CLO2: Understand the function of service provider operational support system and anatomy of a cell site.

CLO3: Students will learn about various technologies of mobile networks including FWA, GSM architecture, UMTS and LTE.

CLO4: Students will be skilled with the knowledge about API and RESTfull web services which increases their employability.

Introduction into mobility, Mobility as a service, Packet switching and Circuit switching, Technologies of mobile networks including FWA, GSM architecture, UMTS and LTE, Mobile devices and their specializations, API and technologies: Web sockets, HTTP requests, Restful API, Mobile OS and their possibilities and limitations.

Recommended Books:

1. Wilkinson, N. Next generation networks services: Technologies and strategies. Chichester: John Wiley & Sons, 2002. 196 p. ISBN 0-471-48667-1
2. Stallings, W. Wireless communications and networks. Upper Saddle River: Prentice Hall, 2002. 584 p. ISBN 0-13-040864-6.
3. Trentin, G. and Repetto, M. eds., 2013. Using network and mobile technology to bridge formal and informal learning. Elsevier.
4. Goggin, G., 2006. Cell phone culture: Mobile technology in everyday life. Routledge.

Course Code	Course Name	L-T-P	Credits
EC222	Microwave and Satellite Communication	(3-0-0)	3

Course Learning Outcomes (CLO):

CLO1: Students will gain complete knowledge about the significance, types and characteristics of various microwave solid state devices

CLO2: Analyze mathematically the operation and working of various tubes or sources for the transmission of the microwave frequencies

CLO3: Students will gain the basic understanding about the principles and working of RADAR.

CLO4: Students will acquire basic understanding of satellite communication and various design links in satellite communication

CLO5: Skilled to understand the important applications of the satellite communications system

Introduction to microwave , Klystrons, Reflex Klystrons, Magnetrons and TWT, Classification of solid state microwave devices, Microwave transistors, Diode (Tunnel, Varactor, PIN), Transferred electron devices (Gunn Diode), Avalanche transit time effect, Analysis of MW components using s-parameters, junctions, directional coupler , bends and corner, MW posts, S. S. Tuner, attenuators, phase shifter, ferrite devices (isolator , circulator , gyrator), cavity resonator, matched termination, Introduction to radar communication, Basic principle: block diagram and operation of radar, Radar range equation, PRFs and range ambiguities, application of radar, Doppler radar (Doppler determine of velocity, CW radar and its limitation, FMCW radar, basic principle and operation of MTI radar, delay line cancellers, blind speed, Origin of Satellite Communication, Technical characteristics of a satellite communications, Advantages of Satellite Communication, Active & Passive satellite, Introduction to Communication Satellite Link Design, General link design equation, system noise temperature, C/N & G/T ratio, atmospheric & ionospheric effects on link design, complete link design, interference effects on complete link design, earth station parameters.

Recommended Books:

1. John Dunlop and Smith, Telecommunication Engineering 3rd Edition, by CRC Press.
2. Zedan and Balmani,Electromagnetic waves and radiating systems.
3. R. E. Collin, Foundations for Microwave Engineering, McGraw Hill.
4. Timothy Pratt, Charles W. Bostian Satellite Communications.

Course Code	Course Name	L-T-P	Credits
EC223	Microwave and Satellite Communication Lab	(0-0-2)	1

Course Learning Outcomes (CLO):

CLO1: Students will be able to design and use a microwave test bench to analyze various types of microwave measurements.

CLO2: Students will be able to measure the parameters and characteristics of the various waveguide components.

CLO3: Acquire an understanding of various characteristics of Microwave Tee's through practical demonstrations.

CLO4: Students will be able determine the radiation characteristics and gain of an antenna during their employment.

CLO5: Understanding of important devices/ components of the Satellite communications system

Study of microwave components and instruments, Measurement of klystron characteristics, To study the frequency and wavelength of propagating wave in a rectangular wave guide, Measurement of VSWR and standing wave ratio, Measurement of Directivity and coupling coefficient of a directional coupler, Calibration of the attenuation constant of an attenuator To Study the characteristics of various microwave Tee's. Determination of the radiation characteristics and gain of an antenna. Measurement of crystal characteristics and proof of the square law characteristics of the diode.

Recommended Books:

1. John Dunlop and Smith, Telecommunication Engineering 3rd Edition, by CRC Press.
2. Zedan and Balmani,Electromagnetic waves and radiating systems.
3. R. E. Collin, Foundations for Microwave Engineering, McGraw Hill.
4. Timothy Pratt, Charles W. Bostian Satellite Communications.

Course Code	Course Name	L-T-P	Credits
EC226	Optical Communication systems	(4-0-0)	4

Course Learning Outcomes (CLO):

CLO1: Understand the fundamentals, advantages and advances in optical communication system

CLO2: Acquire a detailed understanding of types, basic properties and transmission characteristics of optical fibers

CLO3: Understand configuration and architecture of advanced optical communication, advanced system techniques and nonlinear optical effects and their applications

CLO4: Gain the knowledge of working and analysis of optical amplifiers and important devices/components of the optical communications system

CLO5: Skilled to understand the important devices/ components of the optical communications system.

Introduction: Historical development, optical power basics, need of optical power communications, General system of optical communication system, Advantages and limitations of optical fiber communication. Basics of transmission of optical fibers: Review of optical ray theory, Light propagation in optical fiber: Total internal reflection, acceptance angle, Numerical aperture, skew rays, optical fibers structures: step index fiber, graded index fiber, propagation mode. Fiber characteristics: Introduction, attenuation, Material absorption, linear scattering losses, nonlinear scattering losses, fiber bend loss, Dispersion, intermodal and intra modal dispersion. Optical sources: Light emitting diode, LED structures, LED characteristics, Basic concepts of laser, absorption and emission of radiation, population inversion, types of lasers Optical Amplifiers: Semiconductor optical amplifier & traveling wave amplifier (TWA), Gain of SOA and TWA. ERBIUM-Doped Fiber Amplifier (EDFA's), Gain and Noise in EDFA. Optical receivers: Requirements of photo detector, semiconductor photo detectors, Absorption, quantum efficiency, responsivity, receiver noise and receiver sensitivity. Wavelength division multiplexing: Principle of wavelength division multiplexing, Add and Drop multiplexer, requirements of Transmitter and Receiver in WDM.

Recommended Books:

1. John M Senior , Optical Fiber Communications by; Pearson Education, Third Edition.
2. K. Mynbaev & Lowell L. Scheiner, Fiber-Optics Communications Technology by Djafar Prentice Hall, 2006.
3. R.P. Khare, Fiber Optics and Optoelctronics by, Oxford publication, First edition.
4. Cvijetic, M. and Djordjevic, I., 2013. Advanced optical communication systems and networks. Artech House.

Course Code	Course Name	L-T-P	Credits
EC239	Advance Wireless Communication	(4-0-0)	4

Course Learning Outcomes (CLO):

CLO1: The students would be able to demonstrate knowledge and understanding on existing digital cellular systems and standards across the world.

CLO2: The students would have an ability to recognize the need of 3G/4G cellular networks and evolve its architecture.

CLO3: The students would possess the capability for evolving technological path for higher user performance in cell phone technology during their employment.

CLO4: Analyze the Mobile radio propagation, fading, diversity concepts and the channel modeling.

CLO5: Analyze the design parameters, link design, smart antenna, beam forming and MIMO systems

Architecture of 2G, Function of MSC, Functions of HLR and VLR, formats for IMSI and MSISDN, Authentication Centre functions, how to make calls 2.5 G Architecture and functions, SGSN, 3G Architecture and functions, 2.5 G TDMA, GPRS Technology, WCS and WPS Connectivity diagram, Call flows, EDGE Technology.

Recommended Books:

1. T. L. Singal 'Analog and Digital Communications', ISBN: 978-0-07-107269-4, McGraw Hill Education Publications, First Edition Copyright @ 2012, Fifth Reprint 2015.
2. T. L. Singal 'Electronic Communications'ISBN: 978-93-82782-16-2, Chitkara University Publications, First edition Copyright @ 2014.
3. B. P. Lathi and Zhi Ding,`Modern Digital and Analog Communication Systems' by Oxford University Press, International 4th Edition Copyright @ 2010.
4. T. L. Singal `Digital Communication' ISBN: 978-93-392-1952-9, McGraw Hill Education Publications, First Edition Copyright @ 2015.

Course Code	Course Name	L-T-P	Credits
EC243	Wireless Sensor Networks	(4-0-0)	4

Course Learning Outcomes (CLO):

CLO1: The students would be skilled to formulate network architecture and operating environment

CLO2: They would possess an ability to design solutions for wireless transmission technology and protocols

CLO3: The students would possess in-depth knowledge about optimization techniques for efficient operation in modern applications including healthcare helps in their employability.

CLO4: Evaluate the performance of schedule based and random Medium Access Control protocols for power consumption, fairness, channel utilization and control packet overhead.

CLO5: Able to specify the requirements for the hardware and software solutions for energy-efficient sensor network for new applications.

Introduction & Applications of Wireless Sensor Networks: Introduction, basic Overview of the Technology, Applications of Wireless Sensor Networks. Architecture: Single node architecture, Hardware components, Sensor Node Technology, Sensor Taxonomy, WN operating environment, WN Trends, Network architecture, sensor network scenarios, optimization goals and figures of merit, Gateway concepts. Networking Sensors: Physical layer, Wireless channel and communication fundamentals, frequency allocation, modulation and demodulation, wave propagation effects and noise, Wireless Transmission Technology and Systems, Radio technology primer, available wireless technologies, Medium Access Control Protocols for Wireless Sensor Networks, Fundamentals of MAC protocols, MAC protocols for WSNs, Sensor MAC case study, IEEE 802.15.4 LR-WPANs Standard Case Study, Naming & Addressing, Fundamentals, Address and name management in wireless sensor networks, assignment of MAC addresses, Routing protocols for Wireless Sensor Networks, routing challenges and design issues in wireless sensor networks, Routing strategies in wireless sensor networks, Flooding and its variants, Sensor protocols for information via negotiation, low energy adaptive clustering hierarchy, Power efficient gathering in sensor information systems, directed diffusion, Geographical routing. Infrastructure Establishment: Introduction to time synchronization problem, Properties of localization and positioning, possible approaches, Topology control, controlling topology in flat networks-power control, Hierarchical networks by dominating sets, Hierarchical networks by clustering. Operating System for WSN: Operating system design issues, examples of operating systems, Node level software platform, node level simulators, State centric programming.

Recommended Books:

1. KazemSohraby, Daniel Minoli, TaiebZnati, Wireless Sensor networks: Technology, Protocols & Applications' by Wiley India Pvt Ltd.
2. by Holger Karl & Andreas Willig, 'Protocols & Architectures for Wireless Sensor Networks' John Wiley, 2005.
3. Raghavendra, C.S., Sivalingam, K.M. and Znati, T. eds., 2006. Wireless sensor networks. Springer.
4. Li, Y. and Thai, M.T. eds., 2008. Wireless sensor networks and applications. Springer Science & Business Media.

Open Elective Courses

S. No.	Course Code	Name of the Course	Credits
1	EC139	Introduction to CCNA routing and switching	4
2	EC252	Scientific computing	4
3	EC273	Computer system Architecture	4
4	EC270	Computer Networks	4
5	CS115	Operating Systems	4
6	EC251	Database Management System	4
7	EC271	Object Oriented Software Engineering	4
8	EC272	Advanced Programming Concepts	4
9	CS114	Data Structures	4
10	AM104	Numerical Methods and Statistical Techniques	4
11	GI101	Numerical Ability & logical reasoning	4
12	EC275	Essentials of Information Technology	4
13	EC227	Probability Theory and Random Processes	4
14	EC228	Project Management	4
15	EC259	Data Analytics	4

Course Code	Course Name	L-T-P	Credits
EC139	Introduction to CCNA Routing and Switching	(0-0-8)	4

Course Learning Outcomes (CLO):

CLO1: Understand different topologies and small networks by following the down-top approach from physical layer to application layer.

CLO2: Formulate functioning of different protocols (e.g. IP, TCP, UDP, WWW, http, email, DNS) of layered networking model.

CLO3: Analyze basics concepts of routing, switching, and advanced technologies.

CLO4: Students will be able to design simple networks using the application-driven paradigm helps in their employment

CLO5: Skilled to simulate and design network.

Introduction: uses of Computer networks, Network hardware, Network Software Configuring network operating system: IOS boot camp, basic device configuration, address schemes, Seven- Layer OSI architecture of ISO, Concepts of Layer Protocols and Layer interfaces TCP/IP reference model, comparison of OSI and TCP/IP reference models, Physical Layer: Transmission Media, Wireless Transmission, Data Link Layer: data link layer protocols- Media access control ,Ethernet protocols, Ethernet MAC address, LAN switches- working, switch forwarding methods, Address resolution protocol (ARP). Network layer: network layer protocols i.e. IPv4 and IPv6, routing(routing tables) , routers, configuration of a router IP addressing: IPv4 Network Addresses- structure and characteristics, IPv6 network addresses, connectivity verification, Subnetting IP networks: Subnetting an IPv4 Network, Addressing Schemes, Design Considerations for IPv6Transport Layer: transport layer protocols-TCP and UDP, communication process of TCP and UDP, comparison of TCP and UDP Application Layer: Introduction, application layer protocols, well known application layer protocols and services- web and mail protocols(HTTP, HTTPS, email, SMTP, POP, IMAP), IP addressing services (DNS, DHCP), File sharing services(FTP, SMB) Building small Networks: Network Design: Protocols and devices used, Network Security, Basic Network Performance, Network Troubleshooting Routing Concepts: Routing Concepts, Initial Configuration of a Router, Routing Decisions, Router Operation Static and dynamic routing RIP, single area OSPF, Multiarea OSPF, EIGRP- Implementation and troubleshooting Access Control Lists: IP ACL Operation, Standard IPv4 ACLs, Extended IPv4 ACLSs, Contextual Unit: Debug with ACLs, Troubleshoot ACLs Contextual Unit: IPv6 ACLs NAT: Introduction, NAT working, Types of NAT- static, dynamic and PAT.

Recommended Books:

1. Todd Lammle, 'CCNA Cisco Certified Network Associate Study Guide', by Wiley, 6th edition
2. Andrew S. Tanenbaum ‘Computer Networks’ by, Pearson Education, Fourth

Edition.

3. CCNA Routing and Switching 200-125 official cert guide
4. James Kurose and K.W. Ross, 'Computer Networking: A Top-Down Approach', by Pearson Education, 3rd Edition.

Course Code	Course Name	L-T-P	Credits
EC252	Scientific Computing	(0-0-8)	4

Course Learning Outcomes (CLO):

CLO1: The students shall be able to exhibit the knowledge of the basic fundamentals of Scientific Computing and Quantum computing

CLO2: Apply the different methods used in computing like Wentzel-Kramer-Brillouin Method, Runge-Kutta method, Trapezoidal method to solve the computational problems.

CLO3: Apply different equations and interpolations to solve the underlying problems in scientific computing

CLO4: Interpolations to solve the underlying problems in scientific computing

CLO5: Skilled to solve societal problems.

Foundation of Scientific Computing, Quantum computing, Wentzel-Kramer-Brillouin Method, Runge-Kutta method, Trapezoidal method, Quasilinear, Laplace equation, wave packets, Pressure fluctuation, linearized shallow water wave equation, 1D convection equation, Upwinding, Numerical amplification factor, Parabolic partial differential equation, Elliptic partial differential equations, Lagrange and hermite interpolations.

Recommended Books:

1. Bertil Gustafsson, Fundamentals of Scientific Computing. Springer-Verlag Berlin Heidelberg, 2011
2. Tveito Hans, Petter Langtangen,Bjorn Frederik, Nielsen Xing Cai. Elements of Scientific Computing by Aslak Springer, Berlin, Heidelberg, 2010.
3. Liu, J.S. and Liu, J.S., 2001. Monte Carlo strategies in scientific computing (Vol. 10, pp. 978-0). New York: springer.
4. Vetterling, W.T., Press, W.H., Teukolsky, S.A. and Flannery, B.P., 1992. Numerical recipes: example book C (The Art of Scientific Computing). Press Syndicate of the University of Cambridge.

Course Code	Course Name	L-T-P	Credits
EC273	Computer system Architecture	(0-0-8)	4

Course Learning Outcomes (CLO):

CLO1: Demonstrate the knowledge of the basic structure of computers, functional units, software and identify the performance issues in software.

CLO2: To be able to identify the organization of components and modules of the Processor, Information representation, number formats.

CLO3: To depict and implement the Microprogrammed Control and Microprogrammed computers with memory organization.

CLO4: Skilled to to identify the System organization, and interface the Input - Output systems, Interrupt, DMA, Standard I/O interfaces, Concept of parallel processing and interconnect network

CLO5: Concept of parallel processing and interconnect network

Basic Structure of Computers, Functional units, software, performance issues software, machine instructions and programs, Types of instructions, Instruction sets: Instruction formats, Assembly language, Stacks, Ques, Subroutines. Processor organization, Information representation, number formats. Multiplication & division, ALU design, Floating Point arithmetic, IEEE 754 floating point formats Control Design, Instruction sequencing, Interpretation, hard wired control - Design methods, and CPU control unit. Microprogrammed Control - Basic concepts, minimizing micro instruction size, multiplier control unit. Microprogrammed computers - CPU control unit Memory organization, device characteristics, RAM, ROM, Memory management, Concept of Cache & associative memories, Virtual memory. System organization, Input - Output systems, Interrupt, DMA, Standard I/O interfaces Concept of parallel processing, Pipelining, Forms of parallel processing, interconnect network.

Recommended Books:

1. V.Carl Hammacher, “Computer Organisation”, Fifth Edition.
2. A.S.Tanenbum, “Structured Computer Organisation” , PHI, Third edition
3. Y.Chu, "Computer Organization and Microprogramming”, II, Englewood Chiffs, N.J., Prentice Hall Edition
4. M.M. Mano, “Computer System Architecture”, Edition
5. C.W. Gear, “Computer Organization and Programming”, McGraw Hill, N.V. Edition
6. Hayes J.P, “Computer Architecture and Organization”, PHI, Second edition

Course Code	Course Name	L-T-P	Credits
EC270	Computer Networks	(0-0-8)	4

Course Learning Outcomes (CLO):

CLO1: Understand the small networks by following the top-down approach from application to physical layer.

CLO2: Acquire theoretical knowledge about the different network technologies

CLO3: Skilled to understand the functioning of different layers in OSI model and TCP/IP .

CLO4: Skilled to identify various system security and protection issues.

CLO5: Administer the system for managing its resources.

Introduction:Data Communications, Network criteria, Physical topology, Categories of networks, Protocols and standards, Network Models – Layered Tasks, The OSI model, Layers in the OSI model, TCP/IP protocol suite, Addressing: Physical addresses, logical addresses, port addresses, specific addresses. Transmission impairments, Data Rate limits, Performance, Transmission Media: Guided Media, Unguided Media: wireless Switching: Circuit switched networks, Datagram networks, virtual circuit Networks. Data Link Layer - framing, Character stuffing, bit stuffing, Error Detection and Correction (CRC, Hamming Code, Parity Bit, checksum) Data link protocols -simplest, stop-and-wait protocol, Sliding window protocols- 1-bit sliding window protocol, go back-n, selective repeat protocol, piggybacking, : Channel allocation, Multiple access protocols: random access (Aloha, Pure aloha, slotted aloha), controlled access (reservation, polling, token passing), Wired LANS- standard Ethernet, Wireless LANs, Bluetooth, IPv4 addresses (IP protocol, IP addresses, Subnets, NAT) , IPv6 addresses, Routing protocols: delivery, forwarding, Unicast routing protocols (optimization, intra and inter domain routing, distance vector routing, link state routing, path vector routing), Process to process delivery, Process to process delivery UDP (user datagram, checksum, UDP operation) , Process to process delivery TCP (TCP services, TCP features, TCP connection), Congestion and Congestion control. DNS, Electronic Mail and File Transfer, HTTP, WWW, TELNET.

Recommended Books:

1. B. Forouzan ‘Introduction to Data Communications and Networking’ by, Tata McGraw Hill, Fourth Edition, 2004
2. Andrew S. Tanenbaum, ‘Computer Networks’ by Pearson Education, Fourth Edition.
3. Peterson, L.L. and Davie, B.S., 2007. Computer networks: a systems approach. Elsevier.
4. Black, U., 1993. Computer networks protocols, standards, and interfaces. Prentice-Hall, Inc..

Course Code	Course Name	L-T-P	Credits
CS115	Operating systems	(0-0-8)	4

Course Learning Outcomes (CLO):

CLO1: Identify different types of Operating System and their components.

CLO2: Design and implementation of new system calls for any open source operating system.

CLO3: Implementation of existing resource management algorithms in Linux operating system.

CLO4: Identify various system security and protection issues.

CLO5: Skilled to administer the system using various Operating systems (Windows and Ubuntu) for managing its resources.

Introduction: Concept of Operating Systems, Generations of Operating systems, Types of Operating Systems, OS Services, System Calls, Structure of an OS - Layered, Monolithic, Microkernel Operating Systems, Concept of Virtual Machine. Case study on UNIX and WINDOWS Operating System. Processes: Definition, Process Relationship, Different states of a Process, Process State transitions, Process Control Block (PCB), Context switching Thread: Definition, Various states, Benefits of threads, Types of threads, Concept of multithreads, Process Scheduling: Foundation and Scheduling objectives, Types of Schedulers, Scheduling criteria: CPU utilization, Throughput, Turnaround Time, Waiting Time, Response Time; Scheduling algorithms: Pre-emptive and Non pre-emptive, FCFS, SJF, RR; Multiprocessor scheduling: Real Time scheduling: RM and EDF. Inter-process Communication: Critical Section, Race Conditions, Mutual Exclusion, Hardware Solution, Strict Alternation, Peterson's Solution, The Producer Consumer Problem, Semaphores, Event Counters, Monitors, Message Passing, Classical IPC Problems: Reader's & Writer Problem, Dinning Philosopher Problem etc. Deadlocks: Definition, Necessary and sufficient conditions for Deadlock, Deadlock Prevention, Deadlock Avoidance: Banker's algorithm, Deadlock detection and Recovery. Memory Management: Basic concept, Logical and Physical address map, Memory allocation: Contiguous Memory allocation – Fixed and variable partition– Internal and External fragmentation and Compaction; Paging: Principle of operation – Page allocation – Hardware support for paging, Protection and sharing, Disadvantages of paging. Virtual Memory: Basics of Virtual Memory – Hardware and control structures – Locality of reference, Page fault, Working Set, Dirty page/Dirty bit – Demand paging, Page Replacement algorithms: Optimal, first in First Out (FIFO), Second Chance (SC), Not recently used (NRU) and Least Recently used (LRU). I/O Hardware: I/O devices, Device controllers, Direct memory access Principles of I/O Software: Goals of Interrupt handlers, Device drivers, Device independent I/O software, Secondary-Storage Structure: Disk structure, Disk scheduling algorithms File Management: Concept of File, Access methods, File types, File operation,

Directory structure, File System structure, Allocation methods (contiguous, linked, indexed), Free-space management (bit vector, linked list, grouping), directory implementation (linear list, hash table), efficiency and performance. Disk Management: Disk structure, Disk scheduling - FCFS, SSTF, SCAN, C-SCAN, Disk reliability, Disk formatting, Boot-block, Bad blocks.

Recommended Books:

1. AviSilberschatz, Peter Galvin,Greg Gagne,Operating System Concepts Essentials, 9th Edition by Wiley Asia Student Edition.
2. William Stallings, Operating Systems: Internals and Design Principles, 5th Edition, Prentice Hall of India.
3. Milenkovic, M., 1992. *Operating systems: concepts and design*. McGraw-Hill, Inc.
4. Madnick, S.E. and Donovan, J.J., 1974. *Operating systems* (Vol. 197, No. 4). New York: McGraw-Hill.

Course Code	Course Name	L-T-P	Credits
EC251	Database Management System	(0-0-8)	4

Course Learning Outcomes (CLO):

CLO1: Master the basic concepts and appreciate the applications of database systems

CLO2: Students will be familiar with the basic issues of transaction processing and concurrency control.

CLO3: Students will be able to analyze a problem, and define the computing requirements appropriate to its solution during their employment.

CLO4: Students will develop an ability to use and apply current technical concepts and practices in the core information technologies during their employment.

CLO5: Applications in the core information technologies.

Introduction to database and characteristics of data base approach. Advantages and Disadvantages of DBMS approach. Introduction to Data Models: ER Model, Relational Model. Schemas, Instances, Schema architecture and Data Independence Client Server Architecture for DBMS. ER Model: Data base design process, Entity Types, Entity sets, Attributes, keys and their types Weak entity types.ER diagrams, naming convention and design issues. E.F Codd Rules, Relational Model: Basic concept, Characteristics of relations Relational Algebra: Unary operation Relation, Relational Algebra Operations from Set Theory. Binary Relational Operations (Join, Division), Aggregate Functions and Grouping. Introduction to Normalization, their practical uses. Functional Dependencies (Fully, Transitive, Multi-valued, Join Dependencies) 1st Normal Form 2nd Normal Form 3rd Normal Form Boyce Codd Normal Form (BCNF), 4th Normal Form, Introduction to 5th Normal. Introduction to Transaction and its desirable properties. System Log. Characterizing Schedules Based on Recoverability and Serializability. Introduction to Concurrency Control Techniques. Two Phase Locking Techniques for Concurrency Control. Concurrency Control based on Timestamp Ordering Dealing with Deadlocks. Introduction to Database Recovery Techniques Recovery techniques based on Deferred update and recovery techniques based on Immediate Update, Introduction to Checkpoints and Shadow Paging Introduction to Database Security, Discretionary access control based on granting and revoking privileges. Distributed Databases: Introduction to distributed databases, Advantages and Functions of distributed databases, Types of distributed databases System (Homogeneous and Heterogeneous),Parallel DBMS VS Distributed DBMS Data Fragmentation-Horizontal, Vertical & Hybrid, Data distribution transparencies, Replication and allocation techniques for Distributed database design.

Recommended Books:

1. Raghu Ramakrishnan, Johannes Gehrke, Data base Management Systems, , McGraw Hill Education (India) Private Limited, 3rd Edition. (Part of UNIT-I, UNIT-II, UNIT-III, UNIT-V)
2. A. Silberschatz, Henry. F. Korth, S. Sudarshan, Data base System Concepts, , McGraw Hill Education(India) Private Limited l, 6th edition. (Part of UNIT-I, UNIT-IV)
3. R Elmasri, Shamkant B.Navathe, Database Systems, 6th edition, Pearson Education.
4. Peter Rob & Carlos Coronel, Database System Concepts, Cengage Learning.
5. M. L. Gillenson and others. Introduction to Database Management, Wiley Student Edition.
6. Lee Chao, Database Development and Management, Auerbach publications, Taylor & Francis Group. Introduction to Database Systems, C. J. Date, Pearson Education.

Course Code	Course Name	L-T-P	Credits
EC271	Object Oriented Software	(0-0-8)	4

Course Learning Outcomes (CLO):

CLO1: Conceptualize the Business System and carry out the System Analysis & Design. .

CLO2: Students shall be able to specify the system requirements and implement different models for System design. .

CLO3: To apply Coding skills and perform Documentation and testing of the system during their employment.

CLO4: Master the skills required for Software Project Management helps in their employability.

CLO5: Incorporation of programming in real time applications

Overview of System Analysis & Design, Business System Concept, System Development Life Cycle, Waterfall Model, Spiral Model, Feasibility Analysis, Technical Feasibility, Cost- Benefit Analysis, COCOMO model. System Requirement Specification – DFD, Data Dictionary, ER diagram, Process Organization & Interactions. System Design – Problem Partitioning, Top-Down and Bottop-Up design; Decision tree, decision table and structured English; Functional vs. Object- Oriented approach. Coding & Documentation - Structured Programming, OO Programming, Information Hiding, Reuse, System Documentation. Testing – Levels of Testing, Integration Testing, Test case Specification, Reliability Assessment, Validation & Verification Metrics, Monitoring & Control. Software Project Management – Project Scheduling, Staffing, Software Configuration Management, Quality Assurance, Project Monitoring. CASE TOOLS: Concepts, use and application.

Recommended Books:

1. R. G. Pressman – Software Engineering, TMH
2. Behforooz, Software Engineering Fundamentals, OUP
3. Ghezzi, Software Engineering, PHI.
4. Pree, W., 1995. Design patterns for object-oriented software development. ACM Press/Addison-Wesley Publishing Co.

Course Code	Course Name	L-T-P	Credits
EC272	Advanced Programming Concepts	(0-0-8)	4

Course Learning Outcomes (CLO):

CLO1: Students will gain an in-depth knowledge about overall syntax and semantics of C/C++ programs

CLO2: Students will be skilled to use an IDE to compile, load, save, and debug a C/C++ program

CLO3: Students will develop technical thinking and problem solving ability to find an appropriate solution for a problem.

CLO4: Students will be able to demonstrate the ability to create test cases to determine that a solution produces expected outputs for given inputs

CLO5: Incorporation of programming in real time applications

Module 1: Structure of a c program, Writing C program, Compilation, Linking & Execution, Using comments, Identifiers: Nomenclature of an Identifier, Variables, Constants, Reserved Keywords Data Types: Introduction, Initialization and Declaration of Data Type, Expressions, Statements, Symbolic Constants, Type Conversion / Type Casting, Input Output in C: Introduction, scanf(), printf( ), Operators : Operations: Arithmetic, Relational, Logical, Assignment, Conditional, sizeof , Precedence. Decision Control Construct: Conditional Statements: if, if – else, Nested if –Else, switch, conditional operator, looping: Types of Loops: while, do – while, for, Nested loops, Continue, break. Functions: User defined functions, Recursion , Storage classes, Arrays: Introduction, Need & Importance, Types of Arrays: One Dimensional Arrays, Two Dimensional Arrays, Initialization of arrays, inputing values ,assigning Values, Multi-Dimensional Arrays , Declaration of an Array , Initialization of an Array, Passing 1d to Function, passing two dimensional array to function, Sparse Matrix, Strings : Reading and writing strings String functions (Predefined), isalpah(), isdigit(), isspace(), strcat(), strncat(), strcpy(), strncpy(), strlen(), strncpy, Implementing user defined functions for Strcpy, strlen, strcmp, strlwr, strupr, strcat, Pointers, Introduction to pointer :Pointer expression and pointer arithmetic Assignment, Value finding (dereferencing),Taking a pointer address, Adding an integer to a pointer, Incrementing a pointer, File Handling : File pointer, open file, close file Read data from file, fgetc(), fgets(), fscanf(), fprintf() , writing data from a file, fputc(), fputs(), fprintf(), fwrite(), Difference between Text Mode, Binary Mode, Detecting End-of-file , Accepting command line arguments, Functions for selecting record randomly fseek(), ftell(), rewind(), Difference between Text Mode, Binary Mode, Detecting End-of-file Accepting command line arguments ,Functions for selecting record randomly fseek(), ftell(), rewind(). PreProcessor Directive and Revision, Structure: Declaring Structure Accessing members of Structure, Copying Structure Accessing Structure elements, Nested Structure Array of structure, passing structure elements to a function individually Passing entire structure to a function. Union: Union Accessing member of Union Unions Inside

structure, Pointer to structure ,Passing pointer of structure to function, Pointers and strings Passing pointer to a function, Representing arrays as pointer, Arrays of pointers, Null pointers, Generic pointer, Dynamic Allocation of Arrays, Allocating block of memory ,Releasing the used block, To Alter the size of allocated memory ,Allocating memory to single dimensional array, Allocating memory to two dimensional array, PreProcessor Directive And Revision. Introduction to object-oriented programming: Properties of Object –Oriented Programming, Advanced C++ fundamentals: bool data type, namespaces, Relation among structures, unions and Classes, Concept of Public, protected and Private, Concept of Constructors, types of constructors: Default, Parameterized and Copy Constructors, Destructors. Classes and Functions: Friend Functions, Friend Classes, Inline Functions, Const Objects and const Member Functions, Static Class Members, Scope Resolution operator, nested classes, local classes, passing object to function, returning object, Object assignment. Arrays, Pointers and References: Arrays of Objects of Class, Pointers as Data Members and class variables, The Size of a Class Object, passing array of objects to functions, this pointer, References, passing reference to objects and returning references. Dynamic Memory Management in C++: Dynamic memory management - new and delete Operators, Allocating objects and arrays at runtime, Possible problems with the use of pointers - Dangling/wild pointers, Null pointer assignment, Memory leak and allocation failures. Function Overloading: Function Overloading, Overloading Constructor, Copy Constructors, Default Function Arguments. Operator Overloading: Creating a member operator function, Overloading the Assignment Operators, unary and binary Operators, Operator overloading using friend function, Type Conversions , Overloading Operators new and delete, and some special operators ([ ],( ),->,comma), Inheritance: Defining derived classes, Types of inheritance, Changing the Access Specification of Inherited Members, Multiple Inheritance, Multilevel inheritance, Inherited Member Ambiguity, Virtual Base Classes, Constructors in derived classes, Nesting of classes. Virtual Functions and Polymorphism: Understanding Polymorphism, Base Class Pointer, Virtual Function, Pure Virtual Functions, Abstract Classes, Virtual Destructors, Early vs Late binding. Templates: Introduction to Generic Functions and Classes, overloading a generic function and function template, applications of function and class template Exception Handling: Understanding type of Exceptions, throwing mechanism, catching mechanism, Rethrowing an exception, Applying exception handling. C++ Console I/O and File I/O: Stream Classes, Input/ Output using Overloaded operators >> and << and Member functions of I/O stream classes, Formatting Output, Formatting using ios class functions and flags, Formatting using manipulators. File Streams, different methods of file data reading and writing, Accessing records randomly. Standard Template Library: Introduction to the STL Architecture, STL Components, Containers, Algorithms, Iterators, Applications of Container Classes, Using the vector Container, Accessing Elements in a vector Container and Operations on a vector Container.

Recommended Books:

1. E Balagurusamy, Object Oriented Programming with C++, 4th Edition, Tata McGraw Hill.
2. Robert Lafore, Object Oriented Programming in C++, Third Edition, Galgotia 2008.
3. Herbert Schildt, The Complete Reference C++, Second edition, Tata McGraw

Hill.

4. Stroustrup, Bjarne, The C++ Programming Language, Pearson Education.
5. Lippman, S.B. and Lajoie, J., C++Primer, Pearson Education.

Course Code	Course Name	L-T-P	Credits
CS114	Data Structures	(0-0-8)	4

Course Learning Outcomes (CLO):

CLO1: After understanding the basic types for data structure, students will be able to implement different real world applications.

CLO2: Students will be able to determine time and memory complexity of basic algorithm constructs.

CLO3: Implement algorithms for the creation, insertion, deletion, and traversal of each data structure.

CLO4: Skilled to solve problems based on searching and sorting algorithms.

CLO5: Formulate new solutions for programming problems or improve existing code using learned algorithms during their employment.

Introduction: Basic Terminology, Elementary Data Organization, Data Structures and Operations, Algorithm: Complexity, Time-Space Tradeoff, Asymptotic Notations for Complexity(Ω ,θ, O). Array: Introduction, Representation of Linear Arrays in Memory, Traversing Linear Arrays, Arrays: Inserting and Deleting (at Beginning, middle and at the end), Searching: Linear and Binary Search with their Complexity, Sorting: Bubble Sort & its Complexity. Linked List: Introduction & its memory representation, Traversing a Linked List, Insertion into Linked List (sorted and unsorted Linked List), Deleting from Linked List, Operations on Doubly Linked List,, Circular linked List & its applications. Stacks: Array and Linked representation of Stacks, Implementations of recursive and non-recursive procedures by Stacks. Applications: Arithmetic Expressions, Polish Notation, Transforming Infix Expressions into Postfix Expressions Queues : Representation as Array and Linked List, Dequeue,, Circular Queues, Priority Queues, Sorting Techniques-Quick sort , Merge Sort , Radix Sort, Selection Sort, Insertion Sort & their complexity, Trees: Binary trees, complete binary trees, Data structures for representing binary trees, Tree Traversal: preorder, In order, Post order and their algorithms, Binary Search Trees, Insertion, deletion and searching in these trees. Balanced binary Trees, AVL trees, insertion and Deletion in AVL tree, Red Black Tree, Heaps, Difference between heap and Array, insertion and deletion in heap. Heap sort and its applications. Graphs: Basic terminology, directed and undirected graphs, notion of path, Representation of graphs: edge list structures, adjacency list structures, adjacency matrix, Linked List representation of Graph, Operations on Graph, Graph traversals: DFS, BFS. Hashing: Techniques, Collision and its resolving.

Recommended Books:

1. Seymour Lipschutz, Data Structures, Schaums' Outlines Indian Adapted Edition 2006, Tata McGraw-Hill.
2. Tanenbaum, Augenstein, & Langsam, Data Structures using C and C++,

Prentice Hall of India, Second edition.
3. Richard Gilberg, Behrouz Forouzan, Data Structures, Second edition.
4. Wirth, N., 1985. Algorithms & data structures. Prentice-Hall, Inc..

Course Code	Course Name	L-T-P	Credits
AM104	Numerical Methods and Statistical Techniques	(0-0-8)	4

Course Learning Outcomes (CLO):

CLO1: Understand various methods of modelling and solve mathematical equations by various methods.

CLO2: Understand statistical methods for data analysis and sampling techniques.

CLO3: Students will be skilled to apply numerical integration and find best curve fitting for given data.

CLO4: Demonstrate understanding of common numerical methods and how they are used to obtain approximate solutions to otherwise intractable mathematical problems.

CLO5: Apply numerical methods to obtain approximate solutions to mathematical problems.

Errors in Numerical Calculations: Errors and their analysis, general error formula, errors in a series approximation, Solution of algebraic and Transcendental equations: Bisection method, Method of false position,, Newton -Raphson method, order of convergence, Interpolation method: finite difference , forward, backward and central difference, Difference of a polynomial, Newton's formulae for interpolation, central difference interpolation formulae, Interpolation with unevenly spaced points, Newton's divided difference method, Numerical Differentiation and Integration: Numerical differentiation, maximum and minimum values of a tabulated function; Numerical Integration- trapezoidal rule, Simpson1/3 rule, Simpson's 3/8 rule, Newton-cots integration formulae; Euler-Meclaurin formula, Gaussian integration(One dimensional only), Linear systems of equations: Gaussian Elimination method, gauss seidel iteration method, rayleigh's power method for Eigen values and eigen vectors, Numerical solution of ordinary differential equations: Solution by Taylor's series, Prediction -correction method, Boundary value problems, Prediction corrector method, Euler's and modified Euler's method, Runge-Kutta method, finite difference methods, Numerical solution of Partial differential equations: Finite difference approximation to derivatives, Solution to Laplace's equation- Jacobi's method, Gauss -Seidel method, Probability and Statistical methods : Introduction to probability, Baye's theorem ,curve fitting, random variable(discrete and continuous),binomial, poisson, normal, exponential distribution, sampling distribution of means and variance, t-distribution and F-distribution, correlation, lines of regression(two variables only).

Recommended Books:

1. E.balagurusamy 'Numerical Methods' by, TMH
2. 'Advance Numerical Analysis with programming in C++' by Chitkara

University Publication.
3. Monahan, J.F., 2011. Numerical methods of statistics. Cambridge University Press.
4. Antia, H.M., 2012. Numerical methods for scientists and engineers (Vol. 2). Springer.

Course Code	Course Name	L-T-P	Credits
GI101	Numerical Ability and Logical Reasoning	(0-0-8)	4

Course Learning Outcomes (CLO):

CLO1: Enhance the mental and Intellectual ability and critical thinking of the students.

CLO2: Enhance the student's ability to use numerical data as a tool to make reasonable decisions and solve problems.

CLO3: Skilled to Interpret, analyze and draw logical conclusions based on numerical data presented in graphs and tables.

CLO4: Draw logical conclusions

CLO5: Problem solving strategies.

VEDIC MODULE: Square and Square + Introduction with aptitude , Cube and cube root, Division, Addition and Subtraction + Basic Trick, Algebric formula base, questions +Series(No.),Rec. Numbers + Approximation, Number System Module: Number System – 1, Number System – 2,H.C.F & L.C.M – 1,H.C.F & L.C.M – 2,Average (Basic), Average(Tricks), Ratio Module: Ratio (Basic), Ratio (How to Balance a Ratio and Tricks), Ratio (Type of Question), Problem on Ages (Basic + Questions), Partnership (Basic + Questions), Allegations Part -1 (Basic Formula), Allegation (Type of Questions), Percentage Module: Introduction to Percentage, Percentage (inc. and dec.) + Population problem +Voting problem, Percentage (%Table +Questions) + Book Questions, Simple Interest (Introduction +T.E.R), Simple Interest (Type of Questions), Simple Interest (Problems), Compound Interest (Introduction to Basic), Compound Interest (Type of Questions) + Problem discussion +Installment, Profit and Loss (Basic), Profit and Loss (Type of Questions), Discount, Work and Time Module: Work and Time (Basic) Work and Time (Part – 2), Work and Time (Part – 3), Work and Wages, Pipes and Cistern (Part -1), Pipes and Cistern (Part – 2),Time Speed and Distance Module: TSD Part – 1 – Basic, TSD Part – 2 – Type of Questions, TSD Part – 3 –Problems, The Train – Part – 1 – Basic, The Train – Part – 2 – Type of Questions + Problems, Boat and stream – Part – 1, Boat and stream – Part – 2, Permutation and Combination Module: P and C Introduction ([or] and [and]) P and C Part – 2 Type of Questions, P and C Part – 3 Problems, Problems, D.I and D.S Module: D.I Simple Questions (Tables) D.I (Pie Chart) D.I (Mix Graph) Geometry Module: Introduction (Lines, Angles, Pt., Angle System), Type of Similarity and Congru, Properties of Quadrilateral and its properties, Circle and its properties Centres and their properties, Mix Questions, Coordinate Geometry, 2 D Figures, 3 D Figures, 2 D and 3 D figures(mix diagrams), Algebric Module Introduction to formula, Types of Questions, Substitute Method, Problems + Line System, Remainder th^{th} Module, Basic Question, Wilsens and formetsthth, Cyclocitythth + Problems, Reasoning, Distance and Direction, Blood Relation (Introduction), Analogy and Venn diagram, Syllogism and Classification and Mathematical operation, Coding – Decoding, and Alphabet Test, Problem on Ages and dictionary, Series Cube and Dice and Missing

number, Ranking, Clock, and Calendar, Inequalities and I/P and O/P, Puzzle, Sitting Arrangement, Statement –Argument, Statement- course of Action, Non-verbal (misc)full.

Recommended Books:

1. Copyrighted issue of book by Rishi Gurukul is distributed among students.
2. R.S.Aggarwal, Donald Quantitative Aptitude & Verbal – Nonverbal Reasoning by, Quantum Cat by Arihant Publications.
3. Carter, P., 2009. The complete book of intelligence tests: 500 exercises to improve, upgrade and enhance your mind strength. John Wiley & Sons.
4. Sinha, N.K., 2012. The Pearson Guide to Verbal Ability and Logical Reasoning for the CAT. Pearson Education India.

Course Code	Course Name	L-T-P	Credits
EC275	Essentials of Information Technology	(0-0-8)	4

Course Learning Outcomes (CLO):

CLO1: Understand the concepts of Information Technology and its current and future developments

CLO2: Understand the fundamental principles for the effective use of computer-based information systems

CLO3: Get knowledge about the various applications of Information Technology.

CLO4: Acquire knowledge about software development tools and relational databases

CLO5: Students will be skilled to work on Web, database, and graphical user interface (GUI) which increases employability.

Information technology concepts and trends underlying current and future developments in information technology, and fundamental principles for the effective use of computer-based information systems. Networks and distributed computing, including the World Wide Web, hardware and operating systems, software development tools and processes, relational databases, security and cryptography, enterprise applications, and electronic commerce. Hands-on exposure to Web, database, and graphical user interface (GUI) tools.

Recommended Books:

1. R. Kelly Rainer, Casey G. Cegielski, Brad Prince, Introduction to Information Systems, Fifth Edition, Wiley Publication, 2014.
2. 2. James F. Kurose, Computer Networking: A Top-Down Approach, Sixth Edition, Pearson, 2012.
3. Eason, K.D., 1989. Information technology and organisational change. CRC Press.
4. Turban, E., Rainer, R.K. and Potter, R.E., 2003. Information technology. Islamic Studies, 2(0).

Course Code	Course Name	L-T-P	Credits
EC227	Probability Theory and Random Processes	(0-0-8)	4

Course Learning Outcomes (CLO):

CLO1: Apply the fundamentals of probability theory and random processes to practical engineering problems, and identify and interpret the key parameters that underlie the random nature of the problems.

CLO2: Gain advanced and integrated understanding of the fundamentals of and interrelationship between discrete and continuous random variables and between deterministic and stochastic processes.

CLO3: Analyse the performance in terms of probabilities and distributions achieved by the determined solutions.

CLO4: Skilled to acquire competence in applying statistical methods to solve basic problems in information and communication technology

CLO5: Understanding the problem and its methodology

Probability Theory**:** Definitions of Probability, Axioms of Probability, Probability Spaces, Properties of Probabilities, Joint and Conditional Probabilities, Independent Events. Random Variables**:** Probability Distribution Functions, Probability Density Functions, Joint Distribution of Two Variables, Conditional Probability Distribution and Density, Independent Random Variables. Statistical Averages**:** Functions of Random Variables and Random, Statistical Averages, Characteristic Function of Random Variables, Inequalities of Chebyshev and Schwartz, Convergence Concepts, Central Limit Theorem. Random Processes**:** Stationarity, Ergoridicity, Covariance Function and their Properties, Spectral Representation, Weiner- Kinchine Theorem, Linear operations, Gaussian Function, Poisson Processes, Low pass and Band-pass Noise Representation.

Recommended Books:

1. S. P. Eugene Xavier, Probability Theory and Random Processes, , S. Chand and Co. New Delhi, 1998 (2nd Edition).
2. Probability Theory and Random Signal Principles, Peebles, Tata McGrew Hill Publishers.
3. Signal Analysis, Papoulis, McGraw Hill N. Y., 1977.
4. W. B. Jrs. and W. I. Root, Introduction to Random Signals and Noise, Davenport McGraw Hill N.Y., 1954.

Course Code	Course Name	L-T-P	Credits
EC228	Project Management	(4-0-0)	4

Course Learning Outcomes (CLO):

CLO1: Develop, implement and evaluate various stages including planning, scheduling and Execution of projects.

CLO2: Understand risk management, administration, costing and budgeting challenges during projects improve skill as employee and entrepreneur.

CLO3: Identify project goals, constraints and performance criteria in project implementation in entrepreneurship.

CLO4: Skilled to understand design process.

CLO5: Application in solving the societal issues

Examining Professional Project Management-Identify Project Management Processes, Identify Professional and Social Responsibilities, Identify the Interpersonal Skills Required for a Project Manager. Initiating a Project, Examine the Project Management Context, Examine Project Selection, prepare a Project Statement of Work, create a Project Charter, Identify Project Stakeholders. Planning Project Work-Identify Elements of the Project Management Plan, Document Stakeholder Requirements, Create a Scope Statement, Develop a Work Breakdown Structure, Developing Project Schedules-Create an Activity List, Create a Project Schedule Network Diagram, Estimate Activity Resources, Estimate Duration for Project Activities, Develop a Project Schedule, Identify the Critical Path, Optimize the Project Schedule, Establish a Schedule Baseline, Developing Cost Estimates and Budgets-Estimate Project Costs, Estimate the Preliminary, Cost Baseline, Reconcile Funding and Costs ,Planning Project Quality, Staffing, and Communications- Create a Quality Management Plan, Document the Project Roles, Responsibilities, and Reporting Relationships, Create a Communications Management Plan, Analyzing Risks and Planning Risk Responses-Examine a Risk Management Plan, Identify Project Risks and Triggers, Perform Qualitative Risk Analysis, Perform Quantitative Risk Analysis, Develop a Risk Response Plan, Planning Project Procurement- Plan Project Procurements, Prepare a Procurement Statement of Work, Prepare a Procurement Document, Executing Project urance Plan, Acquire the Project Team, Develop the Project Team, Manage the Project TeaWork-Identifying the Direct and Manage Project Execution Process, Execute a Quality Assm, Distribute Project Information, Manage Stakeholder Relationships and Expectations. Managing Project Procurement, Identify the Conduct Project Procurements Process, Obtain Responses from Sellers, Determine Project Sellers. Monitoring and Controlling Project Work, Identify the Monitor and Control Project Work Process ,Develop an Integrated Change Control System, Utilize the Integrated Change Control System, Review Deliverables and Work Results ,Control the Project Scope ,Monitoring and Controlling Project Schedule and Costs, Control the Project Schedule, Control Project Costs, Monitoring and Controlling Project Performance and Quality, Perform Quality Control, Report on Project Performance ,Monitoring and Controlling Project

Risk and Procurements, Monitor and Control Project Risk, Administer Project Procurements, Closing the Project, Close Project Procurements ,Close the Project or Phase Administratively.

Recommended Books:

1. A Systems Approach to Planning, Scheduling, and Controlling, 10th ed. , Harold Kerzner, PhD, ISBN-13: 978-0-470-27870-3.
2. Burke, R., 2013. Project management: planning and control techniques. John Wiley & Sons.
3. Newell, M. and Grashina, M., 2003. The project management question and answer book. Amacom.
4. Heagney, J., 2016. Fundamentals of project management. Amacom.

Course Code	Course Name	L-T-P	Credits
EC259	Data Analytics	(0-0-8)	4

Course Learning Outcomes (CLO):

CLO1: Apply knowledge of dispersion on grouped and ungrouped data cases.

CLO2: Evaluate discrete and continuous probability distributions to various business problems in entrepreneurship.

CLO3: Perform Test of Hypothesis as well as calculate confidence interval for a population parameter.

CLO4: Skilled to calculate confidence interval for a population parameter.

CLO5: Application and its utilization.

Data Science fundamentals, R and R Studio, Version Control and GitHub, R Markdown, scientific thinking and Big data, Programming with R, Loop Functions and Debugging, Simulation & Profiling, finding data and reading different file types, data storage systems and the appropriate tools to extract data from web or from databases like MySQL, organizing, merging and managing the data you have collected, text and date manipulation in R, the basics of analytic graphics and the base plotting system in R, graphing systems available in R: the Lattice system and the ggplot2 system. While the base graphics system provides many important tools for visualizing data, it was part of the original R system and lacks many features that may be desirable in a plotting system, particularly when visualizing high dimensional data, statistical methods for exploratory analysis, clustering and dimension reduction techniques that allow you to make graphical displays of very high dimensional data (many variables), EDA tools.

Recommended Books:

1. Microsoft Business Intelligence Tools for Excel Analysts (WILEY).
2. Runkler, T.A., 2020. Data analytics. Springer Fachmedien Wiesbaden.
3. Moreira, J., Carvalho, A. and Horvath, T., 2018. A general introduction to data analytics. John Wiley & Sons.
4. Aggarwal, C.C., 2011. An introduction to social network data analytics. In Social network data analytics (pp. 1-15). Springer, Boston, MA.

Appendix-A

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
AM101	Engineering Mathematics – I	CLO1: Use the matrices to present mathematical solutions in a concise and informative manner to the problems related to linear equations.		M			H							
		CLO2: Solve problems related to local extreme values of functions of several variables, related application problems using Lagrange multipliers and examine the conditions for the existence of absolute extreme values.				H								
		CLO3: Skill for applying the principles of Integral Calculus to solve a variety of practical problems in Engineering and applied Sciences	M						H					
		CLO4: Skill to employ appropriate regression models in determining statistical relationships through interpretation with the help of probability & distributions and hypothesis testing for means, variances and proportions of large as well as small data.					M							

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
PH101	**Engineering Physics**	CLO1: Apply the knowledge of physics through fundamental concepts together with analytical tools in everyday life.	H											
		CLO2:Analyze a physical problem, and suggest appropriate possible solution based on the physics concepts.					H							
		CLO3: Explore physical systems by setting up experiments, collecting and analysing data, identifying sources of uncertainty, and interpreting their results in terms of the fundamental principles and concepts of physics		H										
		CLO4: Evaluate and analyze scientific measurement and error analysis.		H					M					
		Skill to apply the fundamental concepts of physics to related engineering problems												M
PH103	**Engineering Physics Lab**	CLO1: Students would be able to correlate practical knowledge of physics with the theoretical concepts.			M									
		CLO2: Students would achieve perfectness in									H			

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
		experimental skills related to physics fundamentals.												
		CLO3:The study of practical applications will bring more confidence.										M		
		CLO4: Ability among the students to design, perform, document and analyze advanced experiments in physics to enhance their skills											M	
EC101	**Basics of Electronics Engineering**	CLO1:Students would know the basics of electronics elements, their functionality and applications. They would be able to perceive the concept of logic gates and integrated circuits in electronics.	H	M										
		CLO2:Skilled to interpret the characteristics of various types of diodes and transistors to describe the operation of related circuits for evolving engineering solutions.		H										
		CLO3:Students would be able to apply fundamental principles of electronics together with analytic tools to evaluate and describe physical situations appropriate to address a scientific problem.				M			H					

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
		CLO4:Students would possess a skill to explore physical systems by setting up experiments, collecting and analysing data, identifying sources of uncertainty, and interpreting their results in terms of the fundamental principles and concepts of electronics.						M		H				
		CLO5: Skilled to apply fundamental principles of electronics together with analytic tools			M				H					
EC102	**Basics of Electronics Engineering Lab**	CLO1: After completing the course, students would know the basics of electronics elements, their functionality and applications and would be able to design basic electronics projects.	H	M	H									
		CLO2: They would be able to analyze and characterize the electronic circuits and have basic understanding for their implementation.		H		M								
		CLO3: They would possess a skill to perceive the concept of logic gates like XOR and X-NOR and integrated circuits in electronics.	H	M										
		CLO4: Skill of explaining					M			M				

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
		the basics of electronics fundamentals												
		CLO5: Development of hands on training skill.												
CS101	**Introduction to C Programming**	CLO1: Choose the appropriate C programming constructs to solve the problems.		H										
		CLO2: Demonstrate the advantages and disadvantages of specific techniques to be used.					H							
		CLO3: Skilled to differentiate between efficient and inefficient way of programming.			M									
		CLO4: Determine and demonstrate bugs in a program and recognize needed basic operations.	M				H							
		CLO5: Formulate new solutions for programming problems or improve existing code to program effectively						H						
AM102	**Engineering Mathematics – II**	CLO1: Develop skill to analyze and correlate many real life problems mathematically and thus find the appropriate solution for them using Fourier series and Transforms (Fourier and Laplace transform).				M				H				
		CLO2: Use ordinary	H											

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
		differential equations student will be able to solve various practical problems in Science and Engineering.												
		CLO3: Skill to recognize and find families of solutions for most real physical processes such as heat transfer, elasticity, quantum mechanics, water flow and others, which are governed by partial differential equations subject to boundary conditions.					M			H				
		CLO4: Recognize functions of complex variables, techniques of complex integrals and compute integrals over complex surfaces to provide solution for relevant physical processes.			H							M		
EE101	**Basic of Electrical Engineering**	CLO1: Students would know the basics of DC circuits, Series and parallel connections, Kirchhoff's current and voltage laws, mesh and nodal analysis. They would be able to compute various electrical engineering concepts based on real time applications.	H	H										

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
		CLO2:Students would possess an ability to analyze and characterize the RL, RC & RLC circuits and have basic understanding of their implementation and also able to compute parameters related to these circuits like impedance and power. They would also learn phenomenon like resonance	H	H		M								
		CLO3: Students would be skilled to apply and clarify fundamental principles of magnetic effects, magnetism and their functionality for electrical equipment's.						M	H					
		CLO4: Students would possess the skill to conduct experiments, understand the principle, construction and working of Transformers, DC motors and Induction motors.				M						H		
EE102	**Basics of Electrical Engineering Lab**	CLO1:After completing the course, students would know the basic components of electrical elements, equipment's and their functionality with applications. With the knowledge of the basic components, students	H		M									

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
		would be able to make basic electrical projects												
		CLO2: They would possess an ability to analyze and characterize the electrical equipment's and instrument's basics for their implementation.				M								
		CLO3: They would be skilled to measure power and power factor of ac circuits and understand three-phase star and delta connections with and without applying loads to calculate 3-phase power.	M	M				M						
		CLO4: Possess skill to perceive the concept of Fuse/MCB characteristics for different fault currents. Students will be familiarized with appearance and functioning of the MCB and fuse used in their homes.						M						
		CLO5: Skilled to conduct experiments, understand the principle, construction and working of electrical devices			M						H			
EC105	**Digital Electronics & Logic Design**	CLO1: Understand the basics of difference between analog and digital circuits and their	H											

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
		applications.												
		CLO2: Skill to implement simple logical operations required for the designing of digital circuits and understand common forms of number representation.		M										
		CLO3: Reduction of Boolean expressions for the designing of minimized logical circuits.												H
		CLO4: Skill to design and implementation of combinational circuits.				H								
		CLO5: Skill to design and implementation of sequential circuits and their application.				M								L
EC106	**Digital Electronics & Logic Design Lab**	CLO1: To understand the digital logic and create various systems by using these logics.	H											
		CLO2: Develop a skill to understand the design and simulation of digital logic circuits.		M										
		CLO3: To get a basic understanding of layout of electronic circuits.			M									H
		CLO4: Skill to use the Multisim tool for design and simulation.				H								
		CLO5: Skill to design and implementation of sequential circuits and				L								

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
		their application.												
ME102	Engineering Graphics	CLO1: Improve the technical writing, basic sketching and drawing.	H											
		CLO2:Use engineering scale effectively								M				
		CLO3: Use dimensioning effectively.								M				
		CLO4: Use development of surfaces.									M			
		CLO5: Skilled to communicate through Engineering Graphics.												L
ME153	Engineering Graphics lab	CLO1: Students would know the basics commands of the AutoCAD and their practical application.	H											
		CLO2: Skilled to use various draw and modify commands to achieve practical industrial drawings.								M				
		CLO3: They would be able to understand the usage of various drawing aids to achieve required drawings.									M			
ME152	Manufacturing Practices	CLO1: 4. The students will be skilled in understanding the working of engines and simple machines			H									
		CLO2: The students will gain knowledge about different processes							M					

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
		involved in manufacturing process												
AS101	**Engineering Exploration**	CLO1: Skilled to identify community problems and engineering solutions helps in entrepreneurship.			H			H						
		CLO2: Analyse a given problem using process of engineering problem analysis.										H		
		CLO3: Build simple systems using engineering design process helps to increase their employability and in entrepreneurship.									H		H	H
		CLO4: Ability to communicate efficiently and effectively						H	H					
		CLO5: Ability to understands the problem.	H											
EC107	**Analog Electronics**	CLO1:Develop the Ability to understand the design and working of BJT amplifiers	M		M									
		CLO2: Skill to design BJT based circuits and observe the amplitude and frequency responses of common amplifiers.		H										
		CLO3: Skill to design and develop the audio and power amplifiers using re and hybrid equivalent models.			H									

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
		CLO4: Develop skill to build, and troubleshoot analog circuits.	H											
		CLO5: Skill to build, and troubleshoot analog circuits in their job					M							
EC108	**Analog Electronics Lab**	CLO1: To be able to read and interpret electronic datasheets and diagrams.				M							M	
		CLO2: To be able to measure the electronics & electrical parameters of an amplifier like voltage gain, input & output impedance.	H											
		CLO3: Skill to design, construct and troubleshoot transistor based amplifier complex electronic circuits		H										
EC109	**Microprocessor & Microcontroller**	CLO1: After completing the course students will be skilled to differentiate between the real time applications of microprocessor and a microcontroller											H	
		CLO2: The student will be able to design a memory and I/O interface aspects for an 8085-based computer systems	L				H							
		CLO3: Students will develop the knowledge regarding architecture and peripheral configuration of STM32L476	M											

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
		CLO4: Students will be able to write embedded C code to develop applications using I/O ports, timers and other peripherals of a microcontroller.											M	
		CLO5: Skilled to develop applications using I/O ports, timers and other peripherals of a microcontroller in their employment	L											
EC110	**Microprocessor & Microcontroller lab**	CLO1: After the completion of this lab course students will be skilled to handle the technical issues during the programming and also able to evaluate possible causes of discrepancy in practical experimental observations.			M									
		CLO2: The students will be able to write a program in assembly language to perform the specific task like arithmetic and logical operations, ON/OFF procedure for an LED pattern etc.					H							
		CLO3: Student will be able to understand how to Interface the external devices to the controller		M										
		CLO4: Skilled according			M									

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
		to the user requirements to create novel products and solutions for the real time problems as entrepreneur												
		CLO5: Skilled to create innovation through microprocessor circuit designing			M									
EC111	**Signal & Systems**	CLO1: Categorize various types of signals and systems as continuous/ discrete.	L	L										
		CLO2: Apply various transforms in analysis of systems with different input signals.		M										
		CLO3: Skill to interpret the behaviour of Linear time invariant systems (Continuous & Discrete) in terms of system stability and response.			L									
		CLO4: Skilled for evaluation of several transforms in analysis of systems with different input signals		M										
		CLO5: Skilled to design Linear time invariant systems in terms of system stability and response.		M										
EC112	**Network Analysis & Synthesis**	CLO1: Students will develop sufficient knowledge on circuit analysis techniques.		H										

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
		CLO2: Students will be skilled to perform time domain as well as frequency domain analysis of any electrical circuit.				M								
		CLO3: Students will be skilled to synthesize various electrical networks like two port networks and filters circuits.												L
		CLO4: Skilled to execute all domain analysis of any electrical circuit.			L									
		CLO5: Skilled to synthesize various electrical networks in practical applications			M									
EC113	**Measurement & Virtual Instrumentation Lab**	CLO1: The students will be skilled to design any instrumentation-based project in employment			H									
		CLO2: The students will be able to simulate any type of signals and check performance of any circuit based on these simulated signals.					M							
		CLO3: Skill of using Elvis instrument and perform experiment on it												
		CLO4: Skilled to work on interfacing hardware with software.				M								
		CLO5: Skilled for the creation of new projects.			M									

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
EC129	**Application development using Python**	CLO1: Choose the appropriate Python programming constructs to solve the problems.		H										
		CLO2: Demonstrate the advantages and disadvantages of specific techniques to be used.				M								
		CLO3: Skill to differentiate between efficient and inefficient way of programming.												L
		CLO4: Increase employability in demonstrate bugs in a program and recognize needed basic operations.												L
		CLO5: Formulate new solutions for programming problems or improve existing code to program effectively.												L
EC114	**Microelectronic Circuits**	CLO1:After completion of the course, students will be able to construct and apply physical model to determine the electrical characteristic and operation principle of microelectronic devices.	M											
		CLO2: Skill of designing digital as well as analog circuits using CMOS technology				M								
		CLO3: Students will					M							

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
		apply the concept of IC fabrication to create layouts of digital circuits at entrepreneur level.												
		CLO4: Able to design both circuits using CMOS technology used in industry.			L									
		CLO5: Execute the concept of IC fabrication to create layouts of digital circuits during their employment					L							
EC115	**Microelectronic Circuits Lab**	CLO1: Students will acquire hands on experience of industry oriented circuit designing tools	H											
		CLO3: Students will be skilled to design different digital and analog circuits and verify the same through simulation on cadence design tool.	H	M			M							
		CLO4: Capable of designing layouts of the designed circuit in accordance with layout design rules during employment					H		M		M			
		CLO4: Skill of using simulator	H			H	H							
		CLO5: Skill of interfacing hardware with software.					H				M	M		
EC116	**Linear**	Skilled to design Op-amp	H											

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
	Integrated Circuits	based circuit to give specified gain.												
		CLO2: To compute component values to design different Op-amp based applications such as arithmetic building blocks, filters, waveform generators.		H										
		CLO3: Develop practical skills for building and testing circuits using analog ICs during employment.			H									
		CLO4: Able to compute component values to design different Op-amp based applications in their employment		M										
		CLO5: Skilled in practical skills for building and testing circuits using analog ICs in their employment.	L											
EC117	**Linear Integrated Circuits Lab**	CLO1: Skilled able to select an appropriate IC for a industrial and domestic applications by interpreting electronic datasheet.	L	M			M							
		CLO2: Skilled to design an op amp based circuit such as filters, oscillators, generators, converters and can solve problems related			H				M					

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
		to it during employment.												
		CLO3: Skilled to troubleshoot and replace the defective parts of op amp based electronic circuits during employment.				M								
		CLO4: Develop appropriate communication skills, particularly technical reports through the laboratory for student as entrepreneur.		M										
		CLO5: Skill of hands-on training of designing linear integrated circuits		L										
EC118	**Digital Signal Processing**	CLO1: Identify different types of discrete signals, implement these signals on different systems using z transform, Discrete Fourier Transform and Fast Fourier Transform.	H	H										
		CLO2: Student can apply knowledge to design and filters and implement them for signal processing applications.	H	H										
		CLO3: Apply the knowledge to design and analyse a practical discrete-time signal system, such as a radar, image, speech, audio, bio-					H							

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
		medical or wireless system during employment.												
		CLO4: Implementation of signal processing applications in employment		L										
		CLO5: Skilled to design and analyse a practical discrete-time signal system, in their employment.			M									
EC119	**Digital Signal Processing Lab**	CLO1: To understand and analyze the different types of signals in time domain and frequency domain.				M								
		CLO2: Skill to design and implement the characteristics of the digital filters (FIR and IIR).					H							
		CLO3: Can apply skill of programming using MATLAB to develop the computation of Transforms and convolution during employment.												L
		CLO4: Skill of hand-on training on MATLAB programming and simulation.				M								
		CLO5: Skill of modeling FIR and IIR filters on MATLAB.				M								
EC120	**Control System**	CLO1: The students would be able to understand	M											

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
		operation of basic control systems employed in industries.												
		CLO2: The students would be able to propose automation solutions to real world problems					H							L
		CLO3: The students would attain skill to carry out time domain and frequency domain analysis of a designed control system.												L
		CLO4: Skilled to solve automation solutions to real world problems	M											
		CLO5: Skilled to carry out analysis of a designed control system.					L							
EC123	**Analog and Digital Communication**	CLO1: The students would understand various modulation concepts and distinguish between various modulation schemes on the basis of advantages, disadvantages and applications as used in analog and digital wireless communication systems.	H	M		M	M			L		M		
		CLO2: The students would be skilled to analyze design aspects of generation and detection techniques of AM and FM signals as used in			H	M		L	M					

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
		broadcast radio and TV transmissions.												
		CLO3: The students would be able to select appropriate method to convert an analog signal to digital signal with suitable line coding technique for baseband transmission systems.		M	M	H	L		L					
		CLO4: They would possess an ability to apply knowledge of various digital modulation schemes to improve performance of advanced digital cellular communication systems during employment.	H			M	L							
		CLO5: Skill of various schemes to improve performance of communication systems.	M											
EC124	**Analog and Digital Communication Lab**	CLO1: The students would have a good understanding of both time and frequency domain representations of information and modulated signals used in analog, pulse and digital communication systems	M	H	M	M	H					M		
		CLO2: They would be able to evolve functional blocks of Tx and Rx for AM/FM broadcast radio, baseband			H	M		M	L			L		

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
		PCM transmission and digital wireless communication applications.												
		CLO3: The students would be skilled to evaluate binary and M-ary shift keying digital modulation and demodulation techniques for digital cellular applications		M	H	M	L							
		CLO4: They would possess an ability to apply knowledge of various digital modulation schemes to improve performance of advanced digital cellular communication systems.	M				M							
		CLO5: Skill of various schemes to improve performance of communication systems.					H							
EC125	**Digital VLSI Design**	CLO1: Students will get a clear understanding of VLSI design flow and different types of design styles which are used for integrated circuit design		M										
		CLO2: Students will be able to design building blocks of digital IC using different types of modelling styles used in Verilog and perform					M							

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
		timing analysis of the blocks												
		CLO3: Students will acquire skills to identify the faults associated in VLSI circuits and various techniques to test the ICs during employment.												M
		CLO4: Skilled to design building blocks of digital IC using Verilog		M										
		CLO5: Skilled to identify the faults associated in VLSI circuits and test the ICs.				M	M							L
EC126	**Digital VLSI Design lab**	CLO1: Students will be able to use digital design tools such as Xilinx/Vivado for implementing digital circuits			M		H							
		CLO2: Conduct experiments to evaluate the performance of digital circuits with respect to time.			M									
		CLO3: Design and simulate the sequential circuits such as registers, counters and state machines using ISE design tool will increase employability.			H									
		CLO4: Skilled to design building blocks of digital			H									

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
		IC using Verilog												
		CLO5: Skilled to identify the faults associated in VLSI circuits and test the ICs.				M								
EC127	**Electromagnetic waves and Antenna**	CLO1: Develop sufficient knowledge on fundamental of Electromagnetic field theory and its applications such as Vector Calculus and Co-ordinates Systems.	H											
		CLO2: Understand Maxwell's equations and apply them to solve practical electromagnetic fields problems.	H	M										
		CLO3: Analyses the behavior of EM Wave through different medium such as Transmission Lines and Waveguides.					H							
		CLO4: Skill to solve transmission line impedance mismatching problems in communication and power transmission using stub matching and Smith chart.					H							
		CLO5:Understand the basic parameters & properties of Antennas, Antenna Types, and Antenna Arrays for Antenna Gain and Directivity Enhancement.				M	M							

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
CL601	Life Skills	CLO1: Recognize diverse communication styles (body language, tone of voice) and effectively increase comprehension and build rapport with others.										M		
		CLO2: Draw comparison and demonstrate communication in a clear and direct manner. To be able to understand words and language used in formal and casual communication in entrepreneurship.										L	M	
		CLO3: Use creative thinking skills to analyze and evaluate issues and arguments, to solve problems, or to make decisions during their employment and entrepreneurship.						M						
		CLO4: Understanding a leader's responsibilities to assess the requirements of a task, identifying the strengths within the team, utilizing the diverse skills of the group to achieve the set objective as an entrepreneur and employee.									H		M	

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
EC128	Wireless and Mobile Communication	CLO1: The students would be able to apply the knowledge of mobile communication engineering to solve coverage and call failure problems in cell phones.	H	M			H		M			M		
		CLO2: They would be skilled to implement the cellular concept and antenna system design consideration aspects in optimizing the cellular architecture as per user needs during their employment.		M	M	L	M				L	H		
		CLO3: The students would possess in-depth knowledge to select and use optimum multiple access technique for interference-free communication.	H	M	L				L				M	L
		CLO4: The students would possess an ability and technical skills necessary to understand digital cellular standards and architecture designs.						L				M	L	M
		CL05: The students would have acquired adequate knowledge about major aspects of 3G/4G digital cellular networks.			L			M	L		L	H		M

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
CS501	**Cyber Security**	CLO1: Acquire Information and risk models including confidentiality, integrity and availability									H			
		CLO2: Acquire knowledge on Threats and attacks and exploit vulnerabilities						M						
		CLO3: Gain sufficient knowledge on Cyber security architecture and operations and acquire ability to handle the threats during employment.				L								
ER101	CEED Acceleration Program(CAP) Cohort-II-Module I	CLO1: Use confidence acquired in oral and visual presentation skills to sell their ideas							H					
		CLO2: Implement personal skills for sales and marketing and work under pressure.									M			
		CLO3: Develop, implement and evaluate strategies for setting up a business idea.										H		
		CLO4: Implement personal skills in their employment.										H		
		CLO5: Design strategies to be a entrepreneur.									H	H		
ER102	CEED Acceleration Program(CAP) Cohort-II-	CLO1:Realize entrepreneurship as a career choice and identify resources to do business							H					

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
	Module II	CLO2: Implement personal skills for sales and marketing and work under pressure in entrepreneurship.									M			
		CLO3: Develop, implement and evaluate strategies for setting up a business idea in entrepreneurship.										H		
		CLO4: Implement personal skills in their employment.												
		CLO5: Design strategies to be a entrepreneur.									M	H		
EC202	Robotics Lab-1	CLO1: Skill to identify the problem, propose robotic solution for specific application and Interface various Servo and hardware components.	L				M							
		CLO2: Skill to identify and evaluate parameters required to control a Robot			M		M	L						
		CLO3: Develop small automatic/autotropic applications for real world problems and test the robotics circuit at entrepreneurship and employee level.			L									
		CLO4: Students can apply techniques for solving problems in areas such like wireless robot control			L									

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
		and navigation.												
		CLO5: They will learn to function effectively as members of multidisciplinary teams for developing and evaluating alternate solutions to real world problems.					M							
EC210	Robotics system modelling and control	CLO1: Skill to identify the problem, design and optimize integrated solutions, adopting new directions.	M				L							
		CLO2: Involve, interact and solve related Instrumentation & control in robotics.		M			L							
		CLO3: Use the techniques to implement movement of robotic joints with microcontrollers.	L				M							
		CLO3: Use the techniques to implement movement of robotic joints with microcontrollers.		M										
		CLO4: Students can apply techniques for solving problems in areas such like wireless robot control and navigation.	L											
		CLO5: They will learn to function effectively as members of multidisciplinary teams for					L							

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
		developing and evaluating alternate solutions to real world problems.												
EC209	Introduction to Robotic sensor	CLO1: Skill to design and implement the sensor technology and instrumentation in robotics	L				L							
		CLO2: Sill to design and evaluate the performance of a system based on robotic sensors with respect to desired specifications, as well as analyze and interpret data.		M	L		M							
		CLO3: Define and solve engineering problems to meet certain requirements.				L								
EC225	Aerial and Mobile Robotics	CLO1: Understand basic wheel robot kinematics, common mobile robot sensors and actuators.	M		M									
		CLO2: Skill to apply various robot motion, sensor models in the system design.	L				M							
		CLO3: Apply techniques to solve problems in areas such as wireless robot control and navigation in employment.		M										M
		CLO4: Students can apply techniques for solving problems in areas such like wireless robot control and navigation.			M									

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
		CLO5: They will learn to function effectively as members of multidisciplinary teams for developing and evaluating alternate solutions to real world problems.					L							
EC229	Robotics lab -2	CLO1. After completion of this lab, the students are in a position to understand the theoretical concepts of Robotics design principles.			M		H							
		CLO2: Students will know and understand the importance of robot dynamics including force and torque sensing	M		M		H							
		CLO3: Knowledge of the working principles, components, functionality and limitations of robot actuators and sensors	M	L			M							
		CLO4: Students will be skilled to apply techniques for solving problems in areas such like wireless robot control and navigation.				H								
		CLO5: They will learn to function effectively as members of multidisciplinary teams for developing and evaluating alternate solutions to real									M	H		

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
		world problems as an entrepreneur or employee.												
EC216	Biomedical Robotics	CLO1: Skill to identifying the problem, design and optimize integrated solutions for adopting new directions.						H	H					
		CLO2: Skill to identifying identify different types of medical robots and implement the knowledge in kinematics, dynamics, and control	M				H		H					
		CLO3: Develop the analytical and experimental skills necessary to design and implement robotic assistance for both minimally invasive surgery and image-guided interventions for student as an employee and entrepreneur.											H	
		CLO4: design and implement robotic assistance for both minimally invasive surgery and image-guided interventions					M							
		CLO5: Applications in societal problem solving	L											
EC231	Machine Vision	CLO1: students can apply basic methods of computer	H	H	M									

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
		vision related to multi-scale representation, edge detection and detection of other primitives, stereo motion and object recognition.												
		CLO2: Skill to identify the problem, design and optimize integrated solutions for designing a machine vision system for a multiple problem	M		L	H								
		CLO3: Use the techniques, skills, and modern machine vision engineering tools for engineering practice.								H		H		
		CLO4: Classification problem solving		M										
		CLO5: Applications in societal problem solving	L											
EC232	Robotics Lab-3	CLO1: students will understand the basic concepts, terminology, theories, models and methods in the field of image capturing and processing	H	M										
		CLO2: Use Python for solving problems related to diverse fields.						H		M				
		CLO3: Students will attain skill to implement different models for analysing visual	M				H							

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
		perception and understand the clustering techniques to implement various operations on images using Python												
		CLO4: Report analyses and results of practical problems faced during image and object recognition in their employment.	M											
		CLO5: Applications for societal problem solving					L							
EC269	Artificial Intelligence & expert system	CLO1: Students will be skilled to apply problem solving techniques associated with artificial intelligence	M											
		CLO2: Apply predicate logic and fuzzy logic to represent system in artificial intelligence.	H											
		CLO3: Skilled to solve techniques associated with artificial intelligence		M										
		CLO4: Skilled to represent fuzzy logic to represent system in artificial intelligence					L							
		CLO5: Skilled to solve intelligence expert system.		M										
EC220	Low Power VLSI System Design	CLO1: Skill to identify the requirement of low power system design and physics of power dissipation in							L					M

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
		microelectronic devices												
		CLO2:solve the issues for power minimization in ICs and apply them in scaling of ICs				M								
		CLO3: Perform probabilistic power analysis techniques to calculate power required for microelectronic devices and carry power optimization at logic level and circuit level increases employability.				M								
		CLO4: Able to evaluate combinational and sequential logic designs using various metrics:		L										
		CLO5: Skill to calculate switching speed, gate count , and energy dissipation and power			L									
EC221	Low Power System Design lab	CLO1: Can Calculate and analyse power in digital circuits using industry related design tools.					H							
		CLO2: Design memory using EDA tools by applying concepts of power dissipation.							H					
		CLO3: Perform probabilistic power analysis techniques to calculate power required					M							

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
		for microelectronic devices and carry power optimization at logic level and circuit level increases employability.												
		CLO4: Able evaluate combinational and sequential logic designs using various metrics:							L					
		CLO5: Skill to calculate switching speed, gate count , and energy dissipation and power						M						
EC224	Mixed Signal Circuit Design	CLO1: Apply knowledge of mathematics and engineering to design CMOS analog circuits to achieve desired performance specifications.	H											
		CLO2: Skilled to identify, formulates, and solve engineering problems in the area of mixed-signal design.		M										
		CLO3: Design and implement various types of mixed-signal integrated circuit for real world applications during their employment and entrepreneurship.			M									
		CLO4: Applications for real world applications.	M											

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
		CLO5: Applications for societal problem solving		L										
EC211	High Speed VLSI Design Circuits	CLO1:Students will be able understand the need High Speed Circuits Design in the era of modern technology				M								M
		CLO2: Skilled to apply the Method of Logical Effort in digital circuits to design high speed circuits as an employee												M
		CLO3: Students will have an exposure of the types of Dynamic logic styles and their applications in high speed Integrated circuit designing.												M
		CLO4: Students will have an experience on Clocking strategies and Clocking styles in various types of digital circuits												M
		CLO5: Clocking styles in various types of digital circuits												
EC201	Analog Layout Design	CLO1:Enhance the skills of integrated circuit design for designing layouts of complex circuits		H		M								M
		CLO2:Students will be able to design layouts using CMOS technology and learn industry related design tools such as			M	H								

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
		Cadence Virtuoso to work as IC design engineer.												
		CLO3: Skill of applying different matching techniques in layouts of analog circuits and apply those techniques to design high quality and noise tolerant layout			M									
		CLO4: Able evaluate combinational and sequential logic designs using various metrics:		L										
		CLO5: Skill to calculate switching speed, gate count , and energy dissipation and power			M									
EC234	VLSI design and Verification	CLO1: Students will be skilled to design and verify an Integrated circuit in VLSI field.		H										M
		CLO2: Students will learn to create testbench using the concept of procedural statements and routines	H				M							
		CLO3: Apply concepts of OOP and randomization in writing test bench with system Verilog during employment.		M			M							
		CLO4: Able to evaluate combinational and sequential logic designs using various metrics:	M	M										
		CLO5: Skill to calculate	M											

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
		switching speed, gate count , and energy dissipation and power												
EC235	VLSI Design and Verification lab	CLO1:Students will get practical experience of writing test bench for digital circuits in system verilog												M
		CLO2: Students will get skills of writing test bench using procedural statements, routines and OOP to verify a VLSI chip.					M							
		CLO3: Skill to design test bench blocks by applying randomization method using EDA tools					M							
EC244	IC Fabrication & Technology	CLO1:Understand the fabrication technology of IC Technology.	H											
		CLO2:To understand and analyze operation of MOS Transistor.		H										
		CLO3:To learn the basic MOS technology to design physical process of VLSI Design flow.			M									
		CLO4: Able evaluate combinational and sequential logic designs using various metrics:		L										
		CLO5: Skill to calculate switching speed, gate count, and energy			M									

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
		dissipation and power												
EC212	High Speed VLSI Design Circuits lab	CLO1:Students will be able to design high speed VLSI circuits practically with different logic styles				M								M
		CLO2: Skilled to calculate delay associated with logic gates using industry oriented design tools in their employment	M	M										
		CLO3: Student will get practical skills to analyze delay and latching condition in Clock based circuits using EDA tools		M										
		CLO4: Evaluate combinational and sequential logic designs using various metrics:				L								
		CLO5: Skill to calculate switching speed, gate count , and energy dissipation and power			M									
EC237	Sensor and Communication Protocol	CLO1: Understand fundamental concepts of sensor technology.					M							
		CLO2: Understand networking techniques for data communication in IoT enabled devices and system.				L								
		CLO3: Comprehend different communication technologies for efficient connectivity in IoT					L							

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
		devices during their employment.												
		CLO4: Evaluate various protocols required.				M								
EC249	IoT application development	CLO1: Implement various application development techniques used for designing IoT enabled devices.					H							
		CLO3: Skilled to utilize Cloud based services for IoT devices.				M								
		CLO4: Apply data analysis techniques for cloud computing applications during employment and as entrepreneur.				M								
		CLO4: Evaluate various cloud computing solutions.			L									
		CLO5: Applications in real-time problem solving	M	M										
EC250	Web Development for Iot	CLO1: The student would be design dynamic web forms for acquiring and processing the user and sensor data.	L		M									
		CLO2: The student would be skilled to interpret the IoT architecture and building blocks of various domains			M	H								
		CLO3: To design Interactive forms using					H							

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
		Java script with a focus on Internet of Things which increases student's employability.												
		CLO5: Applications in real-time problem solving		M										
EC217	IoT and Industrial Application	CLO1:The student would be able to interpret the concept of industrial IoT.							L					
		CLO2 Skilled to design IoT application using the communication protocols	L											
		CLO3: The student would be able to highlight the key attributes of industry 4.0 and its characteristics as an entrepreneur.			M									
		CLO4: Evaluate various cloud computing solutions.		L										
		CLO5: Applications in real-time problem solving			M									
EC241	Cloud Computing for IoT	CLO1: To analyze the features of different types of computing and benefits of Cloud Computing.		L	H								M	
		CLO2: To demonstrate the Open source Cloud- Open Stack and Google Cloud Platform.			L	M								
		CLO3: Skilled to interpret the security protocols used in Cloud based IoT application development as an employee and		L					M					

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
		entrepreneur.												
		CLO4: Evaluate various cloud computing solutions.			M									
		CLO5: Applications in real-time problem solving								L				
EC236	Wearable technology and reality	CLO1: Skilled to identify products where smart textiles can be applied.		L										
		CLO2:Able to identify different mechanisms for energy harvesting and transmission which increases student's employee skill		M	L									
		CLO3: Skilled to outline the human body applications designed using wearable sensors.							M	L				
		CLO4: Applications of Wearable technology and reality in health monitoring.		M										
		CLO5: Applications in real-time problem solving				L								
EC204	Digital Image Processing	CLO1: After the completion of the course student will be able to understand the fundamental concepts of a digital image processing system like Image formation, Image sampling and quantization	H											

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
		CLO2:Students will develop the knowledge to analyze the different images in the frequency domain using various transforms		M										
		CLO3 Students will be skilled to realize the importance of filters for the images and also they will be able to differentiate between the different types of filters.		L										
		CLO4: Applications of image processing in recognition			M									
		CLO5: Applications in real-time problem solving						L						
EC205	Digital Image Processing Lab	CLO1:After completion of this lab, the students are in a portion to understand the concepts of structure of human eye and Image formation in the eye.	H											
		CLO2: Skill of applying the different techniques for the enhancement and filtering of images.		M										
		CLO3: Skill to understand the relevant aspects of digital image representation and their practical Implications.			H								M	

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
		CLO4: Applications of image processing in recognition			L									
		CLO5: Applications in real-time problem solving	M											
EC262	Machine learning	CLO1: Understand various basic concepts and techniques of Machine Learning.	H											
		CLO2: Skill to evaluate different classification algorithms and the results.			H		L							
		CLO3: Develop skills of using recent machine learning Algorithms for solving practical problems useful during employment.		M			H							
		CLO4: Apply the algorithms to a real problem, optimize the models learned and report on the expected accuracy that can be achieved by applying the models.		L										
		CLO5: Applications of machine learning based model in real-time problem solving			L									
EC203	Bio-medical electronics	CLO1: Understand the fundamental principles of Biomedical circuit .	H											
		CLO2: Skilled to analyze bio electronic circuits using oscilloscopes and			H		L							

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
		other electronics test equipment.												
		CLO3: Apply knowledge of biomedical electronic circuits to solve problems in the areas of biomedical signals.		M			H							
		CLO4: Applications of Bio-medical imaging		L										
		CLO5: Applications of biomedical electronics in real-time problem solving .				M								
EC233	Speech and Audio processing	CLO1:To acquire knowledge of audio and speech signals.	H											
		CLO2: Skill to develop understanding of speech generation and recognition models.		H										
		CLO3: Skill to relate human physiology and anatomy with signal processing paradigms.			M									
		CLO4: Design and implement algorithms for processing speech signals			L									
		CLO5: Design and implement algorithms for processing audio signals	L											
EC208	Electronic System design	CLO1:After the completion of this course students get familiarization with data storage elements along	L											

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
		with their applications												
		CLO2:Students will able to get the idea about the different trends and limitation of CMOS technology scaling					M							
		CLO3: Students will acquire the knowledge regarding the various digital interfacing systems like UART, SPI and I2C											H	
		CLO4: Applications of UART, SPI and I2C		M										
		CLO5: Skilled to learn interfacing of real world input and output devices					L							
EC206	Digital system Design	CLO1: The students completing this course are expected to understand the structure of various number systems and its application in digital design.		M										
		CLO2: Students will be able to design the appropriate truth table from a description of a combinational logic function			M									
		CLO3:Students will be skilled to analyze and design various combinational and sequential circuits like	H											

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
		Comparators, Multiplexers, Encoders etc.												
		CLO4: Students will be skilled to design the synchronous circuits like Pulse train generator, Pseudo Random Binary Sequence generator											H	
		CLO5: Designing of Pseudo Random Binary Sequence generator		L										
EC207	Digital System Design Lab	CLO1: The students will be able to apply the knowledge to represent digital values in different logic families, including characterization of the noise margins.		M										
		CLO2: Students will be able to apply the knowledge to simulate and implement combinational and sequential circuits using VHDL systems.		M										
		CLO3: Students will be skilled to practically implement and evaluate combinational and sequential logic designs using various metrics: switching speed, gate count , and energy dissipation and power "			H									

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
		CLO4: Skill evaluates combinational and sequential logic designs using various metrics:			M									
		CLO5: Evaluate switching speed, gate count , and energy dissipation and power	L											
EC266	Cloud Computing & Virtualization	CLO1:Articulate the main concepts, key technologies, strengths, and limitations of Cloud computing and the possible applications for state-of-the-art Cloud computing			M				M					
		CLO2: Skill to identify the architecture and infrastructure of Cloud computing, including SaaS, PaaS, IaaS, public Cloud, private Cloud, hybrid Cloud, etc.			H									
		CLO3: Skill to identify problems, explain, analyze, and evaluate various cloud computing solutions.	M											
		CLO4: Evaluate various cloud computing solutions.		M										
		CLO5: Applications in real-time problem solving				L								

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
EC214	Introduction to MEMs	CLO1: Develop the basic understanding of micro sensors and actuators with their types and applications in real world.	H											
		CLO2: Learn about the fabrication processes involved in designing of micro devices and employing them in real world applications			H									
		CLO3: Understand how micro manufacturing is done and what are the various design considerations in developing microdesign systems			M									
		CLO4: Skilled to design considerations in developing micro design systems		M										
		CLO5: Applications of MEMs						L						
EC121	Embedded system design	CLO1: Explain the use of various tools & technologies for developing an Embedded System	M				M							L
		CLO2: Understand the fundamentals of RTOS and application development techniques			M									
		CLO3: Knowledge of techniques for writing	M				M							M

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
		fast-executing embedded code that utilizes the CPU, memory and peripheral resources efficiently												
		CLO4: Understand the various embedded protocols used for developing Networked Embedded Systems during their employment		M									L	
		CLO5: Skilled to understand the applications of Embedded system design		M										
EC122	Embedded system design Lab	CLO1: Understand fundamental concepts and technologies related to embedded system and IoT based devices	M				L							
		CLO2: Understand the fundamentals of RTOS and application development techniques.	L											H
		CLO3: Skill to write fast-executing embedded code that utilizes the CPU, memory and peripheral resources efficiently	L				M							
		CLO4: Understand the various communication and networking protocols used for developing IoT enabled devices during their employment.	L											

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
		CLO5: Applications of Embedded system design			M									
EC213	Information Theory and Coding	CLO1:Design the channel performance using Information theory:	H											
		CLO2: Comprehend various error control code properties	H											
		CLO3: Apply linear block codes for error detection and correction		H										
		CLO4: Skill to apply convolution codes for performance analysis & cyclic codes for error detection and correction.												L
		CLO5: Skill to apply different codes for performance analysis for error and correction.		M										
EC215	Introduction to mobile technology	CLO1: Students will gain complete knowledge about mobile network elements, Service Flow and the operation of mobile networks	M											
		CLO2: Understand the function of service provider operational support system and anatomy of a cell site.	M											
		CLO3: Students will learn about various technologies of mobile networks including FWA, GSM	H											

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
		architecture, UMTS and LTE.												
		CLO4 Students will be skilled with the knowledge about API and RESTfull web services which increases their employability.			M									
EC222	Microwave and Satellite communication	CLO1: Students will gain complete knowledge about the significance, types and characteristics of various microwave solid state devices	H											
		CLO2: Analyze mathematically the operation and working of various tubes or sources for the transmission of the microwave frequencies		H										
		CLO3: Students will gain the basic understanding about the principles and Woking of RADAR.	H											
		CLO4: Students will acquire basic understanding of satellite communication and various design links in satellite communication				M								
		CLO5: Skilled to understand the important applications of the satellite communications system						L						

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
EC223	Microwave and Satellite communication lab	CLO1: Students will be able to design and use a microwave test bench to analyze various types of microwave measurements.				M								
		CLO2: Students will be able to measure the parameters and characteristics of the various waveguide components.				M								
		CLO3: Acuire an understanding of various characteristics of Microwave Tee's through practical demonstrations.					M							
		CLO4: Students will be able determine the radiation characteristics and gain of an antenna during their employment.					M							
		CLO5: Skilled to Understand the important devices/ components of the Satellite communications system			L									
EC226	Optical communication system	CLO1:Understand the fundamentals, advantages and advances in optical communication system			H									
		CLO2:Acquire a detailed understanding of types, basic properties and transmission characteristics of optical	M			H								

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
		fibers												
		CLO3:Understand configuration and architecture of advanced optical communication, advanced system techniques and nonlinear optical effects and their applications							M					
		CLO4:Gain the knowledge of working and analysis of optical amplifiers and important devices/components of the optical communications system.	M											
		CLO5: Skilled to understand the important devices/ components of the optical communications system.		L										
EC239	Advance Wireless Communication	CLO1: The students would be able to demonstrate knowledge and understanding on existing digital cellular systems and standards across the world.						L						
		CLO2: The students would have an ability to recognize the need of 3G/4G cellular networks and evolve its architecture.							M			H		

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
		CLO3: The students would possess the capability for evolving technological path for higher user performance in cell phone technology during their employment.							M					L
		CLO4: Analyze the Mobile radio propagation, fading, diversity concepts and the channel modeling.		M										
		CLO5: Analyze the design parameters, link design, smart antenna, beam forming and MIMO systems				L								
EC243	Wireless Sensor Network	CLO1: The students would be skilled to formulate network architecture and operating environment		H			L		M		M	M		L
		CLO2: They would possess an ability to design solutions for wireless transmission technology and protocols			H									
		CLO3: The students would possess in-depth knowledge about optimization techniques for efficient operation in modern applications including healthcare helps in their employability.				M		L					L	

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
		CLO4: Evaluate the performance of schedule based and random Medium Access Control protocols for power consumption, fairness, channel utilization and control packet overhead.		L										
		CLO5: Able to specify the requirements for the hardware and software solutions for energy-efficient sensor network for new applications.				M								
EC139	Introduction to CCNA routing and switching	CLO1:Understand different topologies and small networks by following the down-top approach from physical layer to application layer.	H			L								
		CLO2: Formulate functioning of different protocols (e.g. IP, TCP, UDP, WWW, http, email, DNS) of layered networking model.					L		H					
		CLO3: Analyze basics concepts of routing, switching, and advanced technologies.			H			L						
		CLO4: Students will be able to design simple networks using the application-driven			H									

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
		paradigm helps in their employment												
		CLO5: Skilled to simulate and design network.		M										
EC252	Scientific computing	CLO1: The students shall be able to exhibit the knowledge of the basic fundamentals of Scientific Computing and Quantum computing	M											
		CLO2: Apply the different methods used in computing like Wentzel-Kramer-Brillouin Method, Runge-Kutta method, Trapezoidal method to solve the computational problems.				H								
		CLO3: Apply different equations and interpolations to solve the underlying problems in scientific computing					H							
		CLO4: Interpolations to solve the underlying problems in scientific computing		L										
		CLO5: Skilled to solve societal problems.				M								
EC273	Computer system Architecture	CLO1: Demonstrate the knowledge of the basic structure of computers, functional units, software and identify the performance issues in	H				M							

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
		software.												
		CLO2: To be able to identify the organization of components and modules of the Processor , Information representation, number formats.	H	M			M							
		CLO3: Skilled to depict and implement the Microprogrammed Control and Microprogrammed computers with memory organization.				M	H							
		CLO4: Skilled to identify the System organization, and interface the Input - Output systems, Interrupt, DMA, Standard I/O interfaces, Concept of parallel processing and interconnect network											H	
		CLO5: Concept of parallel processing and interconnect network					L							
EC270	Computer Networks	CLO1: Understand the small networks by following the top-down approach from application to physical layer.	H			M								
		CLO2: Acquire theoretical knowledge about the different network	M		H									

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
		technologies												
		CLO3: Understand the functioning of different layers in OSI model and TCP/IP .		H				M						
		CLO4: Skilled to identify various system security and protection issues.		M										
		CLO5: Skilled to administer the system for managing its resources.											L	
CS115	Operating Systems	CLO1: Identify different types of Operating System and their components.		H										
		CLO2: Design and implementation of new system calls for any open source operating system.				M								
		CLO3: Implementation of existing resource management algorithms in Linux operating system.					M							
		CLO4: Skilled to identify various system security and protection issues.						L						
		CLO5: Skilled to administer the system using various Operating systems (Windows and Ubuntu) for managing its resources.				M								
EC251	Database Management System	CLO1: Master the basic concepts and appreciate the applications of database systems	H		M		L							

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
		CLO2: Students will be familiar with the basic issues of transaction processing and concurrency control.		M				M						
		CLO3: Students will be able to analyze a problem, and define the computing requirements appropriate to its solution during their employment.												L
		CLO4: Students will develop an ability to use and apply current technical concepts and practices in the core information technologies during their employment.				M								
		CLO5: Applications in the core information technologies.					M							
EC271	Object Oriented Software Engineering	CLO1: Conceptualize the Business System and carry out the System Analysis & Design. .	M											
		CLO2: Students shall be able to specify the system requirements and implement different models for System design. .				M								
		CLO3: To apply Coding skills and perform Documentation and testing of the system during their											M	

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
		employment.												
		CLO4: Master the skills required for Software Project Management helps in their employability.											H	
		CLO5: Incorporation of programming in real time applications	L											
EC272	Advanced Programming Concepts	CLO1:Students will gain an in-depth knowledge about overall syntax and semantics of C/C++ programs					H							
		CLO2 Students will be skilled to use an IDE to compile, load, save, and debug a C/C++ program				H								
		CLO3: Students will develop technical thinking and problem solving ability to find an appropriate solution for a problem.					M							
		CLO4: Students will be able to demonstrate the ability to create test cases to determine that a solution produces expected outputs for given inputs				H								
		CLO5: Incorporation of programming in real time applications			M									
CS114	Data Structures	CLO1: After understanding the basic	H		H									

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
		types for data structure, students will be able to implement different real world applications.												
		CLO2: Students will be able to determine time and memory complexity of basic algorithm constructs.				M								
		CLO3: Implement algorithms for the creation, insertion, deletion, and traversal of each data structure.							M					
		CLO4: Skilled to solve problems based on searching and sorting algorithms.												
		CLO5: Formulate new solutions for programming problems or improve existing code using learned algorithms during their employment.										M		
AM104	Numerical Methods and Statistical Techniques	CLO1:Understand various methods of modelling and solve mathematical equations by various methods.	M		H		M							
		CLO2: Understand statistical methods for data analysis and sampling techniques.	H											
		CLO3:Students will be skilled to apply numerical integration and find best		M	H		H							

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
		curve fitting for given data.												
		CLO4: Demonstrate understanding of common numerical methods and how they are used to obtain approximate solutions to otherwise intractable mathematical problems.		L										
		CLO5: Apply numerical methods to obtain approximate solutions to mathematical problems.			M									
GI101	Numerical Ability & logical reasoning	CLO1: enhance the mental and Intellectual ability and critical thinking of the students.	H				L			H				
		CLO2: enhance the student's ability to use numerical data as a tool to make reasonable decisions and solve problems.					H							
		CLO3: Skilled to interpret, analyze and draw logical conclusions based on numerical data presented in graphs and tables.			H									
		CLO4: draw logical conclusions				M								
		CLO5: Problem solving strategies.				L								

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
EC275	Essentials of Information Technology	CLO1: Understand the concepts of Information Technology and its current and future developments	M											
		CLO2: Understand the fundamental principles for the effective use of computer-based information systems				M								
		CLO3: Get knowledge about the various applications of Information Technology.				M								
		CLO4:Acquire knowledge about software development tools and relational databases					M							
		CLO5: Students will be skilled to work on Web, database, and graphical user interface (GUI) tools					H							
EC227	Probability Theory and Random Processes	CLO1: Apply the fundamentals of probability theory and random processes to practical engineering problems, and identify and interpret the key parameters that underlie the random nature of the problems.	H											
		CLO2: Gain advanced and integrated understanding of the fundamentals of and		H										

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
		interrelationship between discrete and continuous random variables and between deterministic and stochastic processes.												
		CLO3: Analyse the performance in terms of probabilities and distributions achieved by the determined solutions.			M									
		CLO4: Skilled to acquire competence in applying statistical methods to solve basic problems in information and communication technology					H							
		CLO5: Understanding the problem and its methodology		M										
EC228	Project Management	CLO1: Develop, implement and evaluate various stages including planning, scheduling and Execution of projects.											H	
		CLO2: Understand risk management, administration, costing and budgeting challenges during projects improve skill as employee and entrepreneur.												M
		CLO3: Identify project goals, constraints and performance criteria in												L

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
		project implementation in entrepreneurship.												
		CLO4: Skilled to understand design process.		M										
		CLO5: Application in solving the societal issues										L		
EC259	Data Analytics	CLO1: Apply knowledge of dispersion on grouped and ungrouped data cases.	H			M								
		CLO2: Evaluate discrete and continuous probability distributions to various business problems in entrepreneurship.		H			M							
		CLO3: Perform Test of Hypothesis as well as calculate confidence interval for a population parameter.		H				L						
		CLO4: Skilled to calculate confidence interval for a population parameter.		M										
		CLO5: Application and its utilization.					L							
GW2001	G-Visions	CLO1: Skilled to understand complex dimension of diversity, equity, and inclusion around the world, including language, culture and identity.				H	M							
		CLO2:Synthesizes knowledge and meaning from multiple sources to enhance decision - making								H				

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
		in diverse contexts.												
		CLO3:Use technology, human and natural capital, information resources, and diverse ways to solve problems												L
EC133	Industry Oriented Hands on Experience (Six Month Industrial Training)	CLO1: Understanding of the importance of sustainability and cost-effectiveness in design and developments of engineering solution as an entrepreneur.	H					L						
		CLO2:Ability to identify, formulate and model problems and find engineering solution based on a systems approach.		L			M							
		CLO3: Capability and enthusiasm for self-improvement through continuous professional development and life-long learning as an employee or entrepreneur.						H			H			H
		CLO4: Ability to communicate efficiently and effectively as an entrepreneur								M		L		
EC134	Co-op Project at Industry:	CLO1:Understanding of the importance of	H					L						

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
	Module I	sustainability and cost-effectiveness in design and developments of engineering solution.												
		CLO2:Ability to identify, formulate and model problems and find engineering solution based on a systems approach.		L			M							
		CLO3: Capability and enthusiasm for self-improvement through continuous professional development and life-long learning as an entrepreneur.						H			H			H
		CLO4: Ability to communicate efficiently and effectively as an employee or entrepreneur.								M		L		
		CLO5: Ability to understands the problem.			L									
EC136	Co-op Project at Industry: Module II	CLO1:Understanding of the importance of sustainability and cost-effectiveness in design and developments of engineering solution.	H					L						
		CLO2:Ability to identify, formulate and model problems and find engineering solution based on a systems approach.		L			M							
		CLO3:Capability and enthusiasm for self-						H			H			H

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
		improvement through continuous professional development and life-long learning as an entrepreneur.												
		CLO4:Ability to communicate efficiently and effectivel as an employee and as an entrepreneur.								M		L		
		CLO5: Ability to understands the problem.		M										
EC132	Seminar	CLO1: The student would be able to demonstrate the usage of technology in different areas of application.	L				M							
		CLO2: The student will be able to demonstrate the ability to collect, analyze and interpret technical documents as an entrepreneur.		H										
		CLO3: The student will be able to represent his/her thoughts and ideas efficiently with an appreciation for complex social and cultural sensibilities.										H		
		CLO4: Improvement in skills		M										

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
		CLO5: Potential to identify the problem and its solution					L							
EC131	Major Project	CLO1: To apply multidisciplinary approach in solving engineering problems.								H		H		
		CLO2: Undertake problem identification, formulation and solution as an entrepreneur.							H				H	
		CLO3: Design prototype models for the problems solved through engineering design process as an employee		M										
		CLO4: Understanding of design process.		L									L	
		CLO5: Application in solving the societal issues					M							
ES101	Environmental Sciences	CLO1: Understanding the concepts about natural resources, ecosystems, biodiversity, energy resources, environmental pollution and waste management which are required to understand the interrelationships of the natural world.		M					H					
		CLO2: Identification and analysis of environmental problems both natural (disasters such as floods		M					H					

Course Code	Title of the Course	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12
		and earthquakes) and man-made (industrial pollution and global warming).												
		CLO3: Skilled to understand the societal and environmental impacts of energy and examine alternative solutions for meeting the growing energy needs		M					H					