ACADEMIC PROGRAMME GUIDE

BACHELOR OF ENGINEERING
(ELECTRONICS AND COMPUTER SCIENCE ENGINEERING)

Batch 2018

Department of Electronics and Communication Engineering
Chitkara University School of Engineering and Technology
Chitkara University, Himachal Pradesh, India

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1. General Information

Bachelor of Engineering programme in Electronics and Computer Science Engineering prepares the students for the ever-expanding field of Electronics and Computer Engineering. The curriculum is directed towards the major applications such as Programming, Data Science, embedded systems and Internet of things (IoT), and Very Large-Scale Integration (VLSI). We believe that, many creative opportunities exist at the boundaries of Electronics and Computer Engineering, 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 Computer Engineering few courses are in common with the other engineering programmes. Thereafter, for 3rd and 4th year, 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 (POs) of Electronics and Computer 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 Computer 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):

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.
PO13: Possess the capability and skills necessary for application and installation of Electronics and Computer systems.
PO14: Possess in-depth knowledge of modern design tools to solve real-life problems in the field of Electronics and Computer Engineering.

In B.E. Electronics and Computer Science 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, PO10, PO13 and PO14 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, and 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 IoT and Embedded Systems, Programming, Data Science, 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 Computer Engineering Graduates have tremendous employment opportunities in design, development, research, marketing, Customer support, Sales and testing areas in industries of:

Software development and testing, Database Management, Machine Learning, Computing, Bio medical instrumentation, Health engineering, Embedded System design, VLSI design, Human-Computer Interaction and 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 55 minutes.

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 Computer Engineering programme are categorized in terms of their academic affinity or their functional objectives as Basic Science course (BSC), Engineering Science course (ESC) Programme Core Courses (PCC), Programme Elective Course (PEC), Open elective course (OEC), Mandatory course (MC), Project work (PW), Generic course (GC), Specialization Courses, and Special Courses. PCC are compulsory set of courses. There is 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

Integrated Project: Every year, the students identify their team mates (at the most 4 students per team) and work on a unique integrated project allotted to them by faculty / group of faculty members. The projects are allotted to them either at the start of each semester or at a later stage (but not later than Sessional test I) in the semester. Integrated projects are designed by the faculty keeping in mind the courses which the students have studied so far and are currently studying. 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. The students work on the Integrated Project during their lab hours.

Industry Oriented skills are imparted to students in following courses:
IOHT (Industry Oriented Hands-on Training)
IOHC (Industry Oriented Hands – on Courses)
IOHE (Industry Oriented Hands on Experience)
IOHT: IOHT are very basic and low level industry skills which are essential for the students to build up their engineering mindset.

IOHC: IOHC are short term skill oriented courses and are more often than not, offered in association with an industry. They aim to train the students in a specific skill / platform/ tool/ technology which are state-of-art. It fills the gap between present curricula and the specific industry needs. It also circumvents the problem of revising the curricula time and again, to align it to current industry requirements. The short duration IOHCs (2-5 days) can be offered during the academic semester and long duration IOHCs (4-6weeks) are offered as summer courses. Summer IOHCs can be taken up at the campus or at the Industry. The IOHC may result in certification by Industry in a specific skill set. Dean of the Department has the authority to offer and assign IOHCs, as the case may be, for appropriate semesters or during summer, at various industries or at the campus. The students are may be given freedom to choose his/her own IOHC, but the decision of Dean is final while allotment.

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 Dean 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.

Programme Structure of BE Electronics and Computer Science 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	PH102	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	CS101	Introduction to C Programming	0-0-10	5
		Total	27	20
YEAR-01				
SEMESTER-2				
Course category	**Course Code**	**Title of course**	**L-T-P**	**Credits**
BSC	AM102	Engineering Mathematics – II	3-1-0	5
ESC	EE101	Basic of Electrical Engineering	3-1-0	4
ESC	EE102	Basics of Electrical Engineering Lab	0-0-2	1
ESC	CS102	Object Oriented Programming using C++	0-0-8	5
ESC	ME102	Engineering Graphics	3-1-0	4
ESC	ME152	Manufacturing Practices	0-0-2	2
ESC	ME153	Engineering Graphics 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
MC	HR101	Human Rights & Values	2-0-0	NC
PW	AS101	Engineering Exploration	0-0-2	3
		Total	35	29
YEAR-02				
SEMESTER 3				
Course category	**Course Code**	**Title of course**	**L-T-P**	**Credits**
PCC	EC107	Analog Electronics	3-1-0	3
PCC	EC108	Analog Electronics Lab	0-0-2	1
PCC	EC109	Microprocessor & Microcontroller	3-1-0	3
PCC	EC110	Microprocessor & Microcontroller Lab	0-0-2	1
PCC	EC111	Signals & Systems	3-1-0	3
PCC	EC113	Measurement and Virtual Instrumentation	0-0-2	1

		lab		
PCC	EC135	Network Analysis & Control Systems	3-1-0	3
ESC	CS114	Data Structures	0-0-8	4
MC	DM101	Disaster Management	2-0-0	NC
		Total	32	19

YEAR-02

SEMESTER 4

Course category	Course Code	Title of course	L-T-P	Credits
PCC	EC114	Microelectronic Circuits	3-1-0	3
PCC	EC115	Microelectronic Circuits Lab	0-0-2	1
PCC	EC118	Digital Signal Processing	3-1-0	3
PCC	EC119	Digital Signal Processing Lab	0-0-2	1
PCC	EC129	Application development using Python	0-0-8	4
PCC	EC137	Embedded system& IoT	3-1-0	3
PCC	EC138	Embedded system & IoT Lab	0-0-2	1
PW	EC130	Integrated Project		2
PCC	CS115	Operating Systems	4-0-0	4
		Total	30	22

YEAR-03

Courses are being offered according to Specialization Tracks starting from Fifth Semester for Batch 2018

SEMESTER-5

Course category	Course Code	Title of course		L-T-P	Credits
PCC	EC123	Analog and Digital Communication		3-1-0	3
PCC	EC124	Analog and Digital Communication Lab		0-0-2	1
PCC	EC251	Database Management System		0-0-8	4
MC	ES101	Environmental Sciences		2-0-0	2
MC	GW	Global Week			NC
PEC		PE-1	(As per specialization track)	3-1-0	3
PEC		PE-1 lab		0-0-2	1
PEC		PE-2		3-1-0	3
PEC		PE-2 lab		0-0-2	1
PEC		PE-3		4-0-0	4
		Total		32	22

YEAR-03

SEMESTER-6

Course category	Course Code	Title of course	L-T-P	Credits
PCC	EC139	Introduction to CCNA routing and	4-0-0	4

		switching			
PW	EC131	Major Project		4-0-0	4
OEC		Open Elective-1		0-0-8	4
OEC		Open Elective-2		4-0-0	4
PEC		PE-4	(As per specialization track)	3-1-0	3
PEC		PE-4 lab		0-0-2	1
PEC		PE-5		4-0-0	4
		Total		30	24

Scheme-I

YEAR-04

For the students doing semester track

Year IV: In the final year of BE(E&CE) 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	AM104	Numerical Methods and Statistical Techniques		3-1-0	3
MC	CS501	Cyber Security		3-0-0	3
PW	EC132	Seminar			1
PEC		PE-6	(As per Specialization track)	3-1-0	3
PEC		PE-6 lab		0-0-2	1
PEC		PE-7		4-0-0	4
		Total		17	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

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

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
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 has a choice to opt for PE-7 (4 credits) and seminar (1 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 subject.

Disclaimer: The subjects (as in Table 4 and Table 5) being offered may change with respect to recommendation & approval of University Academic Authorities. The changes will be informed well in advance time to time.

Table 3: List of Electives

Track Names →		**IOT &Embedded**		**VLSI**		**Programming**		**Data Science**		**Core Full Stack**		**Credits**
PE	PE1	EC237	Sensor and Communication Protocol	EC125	Digital VLSI Design	EC258	Core JAVA	EC260	Business Statistics	EC116	Linear Integrated Circuits	4
										EC117	Linear Integrated Circuits lab	
										EC204	Digital Image Processing	4
										EC205	Digital Image Processing Lab	
										EC206	Digital System Design	4
										EC207	Digital System Design Lab	
				EC126	Digital VLSI Design LAB							
	PE2	EC249	IoT application development	EC220	Low Power VLSI System Design	EC261	Introduction to Web technologies	EC259	Data analytics	EC203	Bio-medical electronics	4
										EC239	Advance Wireless Communication	4
				EC221	Low Power VLSI System							

					Design lab							
	PE3	EC250	Web Development for Iot	EC224	Mixed Signal Circuit Design	EC266	Cloud computing & Virtualization	EC230	Python for Data Science	EC242	Nano Electronics	4
	PE4	EC217	IOT and Industrial Application	EC211	High Speed VLSI Design Circuits	EC267	Advanced Web technologies (server side)	EC262	Machine learning	EC208	Electronic System design	4
										EC213	Information Theory and Coding	4
				EC212	High Speed VLSI Design Circuits lab							
	PE5	EC241	Cloud Computing for IoT	EC201	Analog Layout Design	EC268	Android Application development	EC248	Data extraction & Visualization	EC214	Introduction to MEMs	4
										EC215	Introduction to mobile technology	4
	PE6	EC236	Wearable technology and reality	EC234	VLSI Design and Verification	EC262	Machine learning	EC263	Advanced Machine learning	EC233	Speech and audio Processing	4
										EC243	Wireless Sensor Networks	4
				EC235	VLSI Design and							

					Verification lab							
	PE7			EC244	IC fabrication and Technology			EC264	Big Data Analytics with Ecosystem			4
		EC222 EC223	Microwave and Satellite communication Microwave and Satellite communication lab									4
		EC226	Optical communication systems									4
		EC269	Artificial Intelligence & expert system									4
OE	OE-1	EC270	Computer Networks									4
		EC271	Object Oriented Software Engineering									4
		EC272	Advanced Programming Concepts									4
		EC273	Computer system Architecture									4
		EC227	Probability Theory and Random Processes									4
		GI101	Numerical Ability & logical reasoning									4
	OE-2	CL601	Life skills									4
		EC252	Scientific computing									4
		EC274	Business Intelligence and data warehousing									4
		EC228	Project Management									4
		EC275	Essentials of Information Technology									4
MC		GW2001	G-Visions									NC

6. Assessment and Evaluation

The evaluation will be continuous and the weightage of various components are as given in Table 4 (For Theory courses) and in Table 5 (for Practical Courses), Table 6 (for Integrated Projects) and Table 7 (for Programming courses).

Table 4: Evaluation components for Theory Courses

For Theory Courses	
Quizzes /Assignments/ Presentation/Class Test/ Open Book Test/ Case Study	10
Sessional Tests (STs)	30
End Term Examination	60
Total	**100**

There are three Sessional Tests (STs) for all theory papers, the average of best two are 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).

Table 5: Evaluation Components for Practical Courses

For Lab Courses	
Lab Performance / File work	40
Internal Viva – Voce	20
End Term	40
Total	**100**

Table 6: Evaluation Components for Integrated Project

For Integrated Projects	
Performance / Presentation / Project report	40
Internal Viva – Voce	20
End Term – Project Display	40
Total	**100**

Table 7: Evaluation Components for Programming Courses

For Programming Courses	
Internal Assessment	50
End term	50
Total	**100**

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 10.

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 8: 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. GPA will indicate the performance of student for any particular semester. Formulas for calculation of GPA and CGPA have been provided as below:

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

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 GPA

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 11 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 9: 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	A+	10	3 x 10	30
Course Z	2	A+	10	2 x 10	20
Total	11			Total	92

Thus, the total GPA of the student would be =

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

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

$$CGPA = \frac{7\times12+8\times11}{12+11} = \frac{84+88}{23} = 7.48$$

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 (single or dual 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 10.

Table 10: Minimum Credits to be Earned for Award of Degree in BE

Course / Year	BE in Electronics and Computer Engineering
Year I	49
Year II	41
Year III	46
Year IV	30
Total	**166**

It is mandatory for the student to earn minimum 166 credits by clearing mandatory core and elective courses. The student can choose electives of his interest from the list of electives attached in the scheme. The maximum credits that can be earned by student are 172 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.

12. Programme Overview

Table 11: 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	17	4	-	-	-	-	-	-	-	31	31
PCC	Programme Core Course	-	4	15	20	8	4	3	-	-	-	54	51
PEC	Programme elective Course	-	-	-	-	12	8	8	-	-	-	28	20
OEC	Open Elective Course	-	-	-	-	-	8	-	-	-	-	8	8
MC	Mandatory course	-	-	-	-	2	-	3	-	-	-	5	2
PW	Project work	-	3	-	2	-	4	1	15	15	15	25	39
GC	Generic Course*	-	-	-	-	-	-	-	-	-	-	-	-
Total												166	166

* Generic Courses (as in Table 11) are not mandatory to opt.

** Scheme I is 6 months Training track and Scheme II is Co-op Track

12.1 Basic Science Courses:

S. No.	Course Code	Name of the Course	Credits
1	AM101	Engineering Mathematics- I	5
2	AM102	Engineering Mathematics – II	5
3	PH102	Engineering Physics	4
4	PH103	Engineering Physics Lab	1

Course Code	Course Name	L-T-P	Credits	Pre-requisite
AM101	**Engineering Mathematics- I**	**4-1-0**	**5**	**NIL**
Course Outcomes (CO)*:				
CO1:	Use the matrices to present mathematical solutions in a concise and informative manner to the problems related to linear equations.			
CO2:	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.			
CO3:	Apply the principles of Integral Calculus to solve a variety of practical problems in Engineering and applied Sciences.			
CO4:	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.			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				

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.

Suggested Books:

- "Advanced Engineering Mathematics", Erwin Kreyszig, Wiley India Pvt. Ltd.
- "Engineering Mathematics", Srimanta Pal & Subodh C. Bhunia, Edition 2015, Oxford University Press.
- "The Engineering Mathematics", 2nd Ed., Chitkara University Publication, Vol. I.

- "Higher Engineering Mathematics", B.V. Ramana, Tata McGraw-Hill Education.
- "Advanced Engineering Mathematics", R.K. Jain and S.R.K. Iyengar, Alpha Science International Ltd.
- "Higher Engineering Mathematics", B.S. Grewal, Khanna Publications.
- "A text book of Engineering Mathematics", N. P. Bali and Manish Goyal, Laxmi Publications.
- "Vector Analysis with applications", by MD. Ali Ashraf, MD. Abdul Khaleq Hazra, Published by New Age International (New Delhi).
- "Calculus", by Howard Anton, Irl Bivens Stephens Davis.
- "Advanced Engineering Mathematics",H.C. Taneja,I.K. International, Vol I.

Course Code	Course Name	L-T-P	Credits	Pre-requisite
AM102	**Engineering Mathematics- II**	**4-1-0**	**5**	**Engineering Maths-I**
Course Outcomes (CO)*:				
CO1:	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).			
CO2:	Use ordinary differential equations student will be able to solve various practical problems in Science and Engineering.			
CO3:	Possess an ability 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.			
CO4:	Recognize functions of complex variables, techniques of complex integrals and compute integrals over complex surfaces to provide solution for relevant physical processes.			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				

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 integerals, 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.

Suggested Books:

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

Course Code	Course Name	L-T-P	Credits	Pre-Requisite
PH102	**Engineering Physics**	**3-1-0**	**4**	**NIL**
Course Outcomes (CO)*:				
CO1:	Apply the knowledge of physics through fundamental concepts together with analytical tools in everyday life.			
CO2:	Analyze a physical problem, and suggest appropriate possible solution based on the physics concepts.			
CO3:	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			
CO4:	Evaluate and analyze scientific measurement and error analysis and apply the fundamental concepts of physics to related engineering problems.			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				

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.

Suggested Books

- Engineering Physics by H. K. Malik and A. K. Singh, Mc Graw Hill Education.
- Engineering Physics by Chitkara Publication 2nd Edition.
- Semiconductor Physics and devices, Donald A Neamen and Dhrubes Biswas, Mc Graw Hill Education

Course Code	Course Name	L-T-P	Credits	Pre-requisite
PH103	**Engineering Physics Lab**	**0-0-2**	**1**	**NIL**
Course Outcomes (CO)*:				
CO1:	Students would be able to correlate practical knowledge of physics with the theoretical concepts.			
CO2:	Students would achieve perfectness in experimental skills related to physics fundamentals.			
CO3:	The study of practical applications will bring more confidence and ability among the students to design, perform, document and analyze advanced experiments in physics.			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				
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.

Suggested Books:

- Lab Manuals prepared by faculty of Physics.
- Practical physics by Squirres, Cambridge University press.

12.2 Engineering Science Courses

S. No.	Course Code	Name of the Course	Credits
1	EC101	Basics of Electronics Engineering	4
2	EC102	Basics of Electronics Engineering Lab	1
3	CS101	Introduction to C Programming	5
4	EE101	Basic of Electrical Engineering	4
5	EE102	Basics of Electrical Engineering Lab	1
6	CS102	Object Oriented Programming using C++	5
7	ME102	Engineering Graphics	4
8	ME152	Manufacturing Practices	2
9	ME153	Engineering Graphics lab	1
10	CS114	Data Structures	4

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC101	**Basics of Electronics Engineering**	**3-1-0**	**4**	**NIL**
Course Outcomes (CO)*:				
CO1:	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.			
CO2:	Interpret the characteristics of various types of diodes and transistors to describe the operation of related circuits for evolving engineering solutions.			
CO3:	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.			
CO4:	Students would possess an ability 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.			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				
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.

Suggested Book(s)

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

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC102	**Basics of Electronics Engineering Lab**	**0-0-2**	**1**	**NIL**
Course Outcomes (CO)*:				
CO1:	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.			
CO2:	They would be able to analyze and characterize the electronic circuits			

	and have basic understanding for their implementation.
CO3:	They would possess an ability to perceive the concept of logic gates like XOR and X-NOR and integrated circuits in electronics.
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A	
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 (V_r) versus capacitance (C). **Suggested Book(s)** • 'Basic Electrical and Electronics', R Muthusubramanian, S Salivahanan,K, Tata McGraw Hill, ISBN: 9780070146129, Eighth Reprint 2012. • 'Basic Electronics', D P Kothari,I J Nagrath ,McGraw Hill, ISBN(13) : 978-93-329-0158-2, 2014. • Lab manuals	

Course Code	**Course Name**	**L-T-P**	**Credits**	**Pre-requisite**
CS101	**Introduction to C Programming**	**0-0-10**	**5**	**NIL**
Course Outcomes (CO)*:				
CO1:	Choose the appropriate C programming constructs to solve the problems.			
CO2:	Demonstrate the advantages and disadvantages of specific techniques to be used.			
CO3:	Differentiate between efficient and inefficient way of programming.			
CO4:	Determine and demonstrate bugs in a program and recognize needed basic operations.			
CO5:	Formulate new solutions for programming problems or improve existing code to program effectively			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				
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(), strcpy(), 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

Suggested Books:

- Reema Thareja, Programming in C, 2nd Edition, Oxford University Press.
- Vikas Gupta, Computer concepts and C programming, 1st edition, DreamTech Press.
- Dennis Ritchie and Brian. W. Kernighan, The C Programming Language, 2nd edition, Prentice Hall.

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EE101	**Basics of Electrical Engineering**	**3-1-0**	**4**	**NIL**
Course Outcomes (CO)*:				
CO1:	Students would know the basics of DC circuits, Series and parallel connections, Kirchoff's current and voltage laws, mesh and nodal analysis. They would be able to compute various electrical engineering concepts based on real time applications.			
CO2:	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
CO3:	Students would be able to apply and clarify fundamental principles of magnetic effects, magnetism and their functionality for electrical equipment.
CO4:	Students would possess an ability to conduct experiments, understand the principle, construction and working of Transformers, DC motors and Induction motors.
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A	

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, mutual 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 phaseAC 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 MachinesTransformer: 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.

Suggested Book(s)

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

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EE102	**Basics of Electrical Engineering Lab**	**0-0-2**	**1**	**NIL**
Course Outcomes (CO)*:				
CO1:	After completing the course, students would know the basic components of electrical elements, equipments and their functionality			

	with applications. With the knowledge of the basic components, students would be able to make basic electrical projects
CO2:	They would possess an ability to analyze and characterize the electrical equipment's and instrument's basics for their implementation
CO3:	They would be able 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.
CO4:	Possess an ability 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.
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A	

To study the use of multi-meter and testing of various components. , Verification of Kirchoff'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.

Suggested Books:

- 'Basic Electrical Engineering' by D C Kulshreshtha', Tata McGraw Hill, 2009.
- Lab manuals.

Course Code	Course Name	L-T-P	Credits	Pre-requisite
CS102	**Object Oriented Programming using C++**	**0-0-8**	**5**	**Introduction to C Programming**
Course Outcomes (CO)*:				
CO1:	Understand the problem statement using principles of mathematics and engineering sciences.			
CO2:	Identify the OOPs programming constructs to solve the problems by differentiating between efficient and inefficient way of programming.			
CO3:	Determine the bugs in a program and recognize the need of alternate approaches.			
CO4:	Acquire ability for independent and life-long learning in the broadest context of technological change.			

CO5:	Provide solutions to societal, health, safety, legal, and cultural issues through contextual knowledge of professional engineering practice.

*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A

Introduction: Introduction to basic concepts of object-oriented programming, Comparison between procedural programming paradigm and object-oriented programming paradigm, Problem solving strategies Functions in C++: inline functions, default arguments, function prototyping, function overloading, call by reference, call by value & call by pointer, return by reference.Classes and Objects:Specifying a class, Creating class objects, Accessing class members, Access specifiers – public,private,and protected, Objects and memory, Static members, Static objects, constant member function, constant objects, friend functions, friend class, Passing Object as an argument (by value, by reference, by address, Returning object from a function. Constructors and Destructors: Need for constructors and destructors, Copy constructor, Dynamic constructors, Destructors, Constructors and destructors with static members. Operator Overloading and Type Conversion:Defining operator overloading, Rules for overloading operators, Overloading of unary operators, binary operators(+,-,/), binary operators using friend functions, manipulation of strings using operators Overloading(>,<,= =) , Type conversion: Basic type to class type, Class type to basic type, Class to class type.Dynamic Memory Management & pointers:Understanding pointers, Accessing address of a variable, Declaring & initializing pointers, Accessing a variable through its pointer, Pointer arithmetic, Pointer to a pointer, Pointer to a function, Dynamic memory management - new and delete Operators, Pointers and classes, Pointer to an object, Pointer to a memberthis Pointer, Possible problems with the use of pointers - Dangling/wild pointers, Null pointer assignment, Memory leak and allocation failures. Inheritance: Introduction, Defining derived classes, Forms of inheritance (single, multilevel, multiple, hybrid & hierarchical), Ambiguity in multiple and multipath inheritance with constructor.Virtual base class: Overriding member functions, Order of execution of constructors and destructors. Virtual Functions and Polymorphism: Concept of Binding: Early binding and late binding, Virtual functions, Pure virtual functions, Abstract classes, Virtual destructors & polymorphism. Exception Handling: Review of traditional error handling, Basics of exception handling, Exception handling mechanism, throwing mechanism, catching mechanism, Rethrowing an exception, Specifying exceptions. Templates and Generic Programming: Function templates, Class templates, overloading of template functions. Introduction to the Standard Template Library: CONTAINERS: STL Components(Container, Algorithms and Iterators) Sequence Container: vector(push_back(), pop_back(), back(), size(),empty()), list (push_front(), pop_front(), front(), size(), empty()) dequeue (push_back(), pop_back(), push_front(), pop_front(), size(), empty()) Associative Container: set(Insert(), erase(),Size(),Empty(),Count(),Clear()) multiset (Insert(), erase(), Size(),Empty(), Count(), Clear()) map(Insert(), erase(),Size(), Empty(), Count(), Clear()) multimap (Insert(), erase(), Size(), Empty(), Count(), Clear()) Derived Container: stack, queue, priority_queue ALGORITHMS: count(), count_if(), find(), find_if(), copy(), fill(), remove(), remove_copy(), replace(), replace_copy(), reverse(), reverse_copy(),

unique(), unique_copy(), max(), max_element(), min(), min_element(), ITERATORS: input, output, forward, VECTORS: back(), begin(), clear(), empty(), end(), erase(), pop_back(), push_back(), console I/O: Concept of streams, input/ Output using Overloaded operators >> and << and Member functions of I/O stream classes. Data Files management:,File streams, Hierarchy of file stream classes, Error handling during file operations, Reading/Writing of files, Accessing records randomly.

Suggested Books:

- E Balagurusamy, Object Oriented Programming with C++, 4th Edition, Tata McGraw Hill.
- Robert Lafore, Object Oriented Programming in C++, Third Edition, Galgotia 2008.
- Herbert Schildt, The Complete Reference C++, Second edition, Tata McGraw Hill.
- Stroustrup, Bjarne, The C++ Programming Language, Pearson Education.
- Lippman, S.B. and Lajoie, J., C++Primer, Pearson Education.

Course Code	Course Name	L-T-P	Credits	Pre-requisite
ME102	**Engineering Graphics**	**3-1-0**	**4**	**NIL**
Course Outcomes (CO)*:				
CO1:	Improve the technical writing, basic sketching and drawing.			
CO2:	Use engineering scale effectively			
CO3:	Use dimensioning effectively.			
CO4:	Use development of surfaces.			
CO5:	Communicate through Engineering Graphics.			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				

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 dimentioning, 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.

Suggested Books:

- **"**Engineering Drawing", P.S. Gill; Eleventh edition, S.K. Kataria& Sons.
- "Engineering Drawing", R. K. Dhawan; 2014 Edition, S. Chand and Company.

Course Code	Course Name	L-T-P	Credits	Pre-requisite
ME152	**Manufacturing Practices**	**0-0-4**	**2**	**NIL**
Course Outcomes (CO)*:				
CO1:	The students will understand the working of engines and simple machines			
CO2:	The students will gain knowledge about different processes involved in manufacturing process			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				

Introduction to manufacturing set up and course requirement; work culture; safety requirements; fire, firefighting & accident handling; and first aid. Hands on practice in the following works area: Carpentry Shop, Fitting Shop, Sheet Metal Shop, Machine Shop, Welding Shop, Electrical & Electronic Shop, Computer Work Bench. Carpentry Shop: Various types of timber and practice boards, defects in timber, seasoning of wood; tools, wood operation and various joints; exercises involving use of important carpentry tools to practice various operations and making joints. Fitting Shop: Introduction of fitting practice and tools used in fitting shop; exercise involving marking, cutting, fitting practice (Right Angles), Male-Female mating parts practice, trapping practice. Sheet Metal Shop: Development of surfaces of various objects; sheet metal forming and joining operations, joints, soldering and brazing; exercises involving use of sheet metal forming operations for small joints. Machine Shop: Introduction to various machine tools, grinders etc; cutting tools and operations; exercises involving lathe, various tools used on lathe, drilling m/c, grinder etc. Welding Shop: Introduction to different welding methods; welding equipment; electrodes; welding joints; welding defects; exercises involving use of gas/ electric arc welding. Electrical & Electronic Shop: Electrical: Introduction to electrical wiring; Testing tools and apparatus. Electronic: Introduction to electronic components (Diode, Resistor, Transistors, Capacitors, LED's, PCB's etc) Preparation of PCBs involving soldering applied to electronic applications. Introduction to tools & test apparatus; Troubleshooting of electronic circuits. Computer Bench Work: Introduction to computer Hardware & peripherals Parts: Motherboard, Processor, Socket types, Input/output ports, Memory (primary, secondary), hard disc, CD/DVD drive, key board, mouse, SMPS. Assembling/Dissembling and Fault identification: SMPS function and power distribution, testing (using multi meter), part connectivity, error correction and detection. Introduction to advance technology and current wireless technologies (laptop component identification, Bluetooth, Wi Fi RF, IRDA etc.)

Suggested Books:

- Workshop/lab manual.
- A course in Workshop technology Vol I & II by Raghuwanshi B.S.; Dhanpat Rai & Sons, New Delhi.
- Production Technology by Jain R.K.; Khanna Publishers, New Delhi.
- Manufacturing Practice, By Singh, S; S.K. Kataria& Sons, New Delhi
- Basic Electronics by NN Bhargava; TTTI
- Computer Fundamental by PK Sinha; BPB Publication.
- Computer Hardware Bible by Winn L Rosch; Bible Publication

Course Code	Course Name	L-T-P	Credits	Pre-requisite
ME153	**Engineering Graphics Lab**	**0-0-2**	**1**	**NIL**

Course Outcomes (CO)*:	
CO1:	Students would know the basics commands of the AutoCAD and their practical application.
CO2:	Possess an ability to use various draw and modify commands to achieve practical industrial drawings.
CO3:	They would be able to understand the usage of various drawing aids to achieve required drawings.

*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A

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 implementing of coordinate systems.

Suggested Books:

- **"**Engineering Drawing", P.S. Gill; Eleventh edition, S.K. Kataria& Sons.
- "Engineering Drawing", R. K. Dhawan; 2014 Edition, S. Chand and Company.

Course Code	Course Name	L-T-P	Credits	Pre-requisite
CS114	**Data Structures**	**0-0-8**	**4**	**Introduction to C Programming**

Course Outcomes (CO)*:	
CO1:	After understanding the basic types for data structure, students will be able to implement different real world applications.
CO2:	Students will be able to determine time and memory complexity of basic algorithm constructs.
CO3:	Implement algorithms for the creation, insertion, deletion, and traversal of each data structure.

CO4:	Problems based on searching and sorting algorithms.
CO5:	Formulate new solutions for programming problems or improve existing code using learned algorithms and data structures
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A	

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.

Suggested Books:

- Seymour Lipschutz, Data Structures, Schaums' Outlines Indian Adapted Edition 2006, Tata McGraw-Hill.
- Tanenbaum, Augenstein, &Langsam, Data Structures using C and C++, Prentice Hall of India, Second edition.
- RichardGilberg, Behrouz Forouzan, Data Structures, Second edition.

12.3 Programme Core Courses

S. No.	Course Code	Name of the Course	Credits
1	EC105	Digital Electronics & Logic Design	3
2	EC106	Digital Electronics & Logic Design Lab	1
3	EC107	Analog Electronics	3
4	EC108	Analog Electronics Lab	1
5	EC109	Microprocessor & Microcontroller	3
6	EC110	Microprocessor & Microcontroller Lab	1
7	EC111	Signals & Systems	3

8	EC113	Measurement and Virtual Instrumentation lab	1
9	EC135	Network Analysis & Control Systems	3
10	EC114	Microelectronic Circuits	3
11	EC115	Microelectronic Circuits Lab	1
12	EC118	Digital Signal Processing	3
13	EC119	Digital Signal Processing Lab	1
14	EC129	Application development using Python	4
15	EC137	Embedded system& IoT	3
16	EC138	Embedded system & IoT Lab	1
17	CS115	Operating Systems	4
18	EC123	Analog and Digital Communication	3
19	EC124	Analog and Digital Communication Lab	1
20	EC251	Database Management System	4
21	EC139	Introduction to CCNA routing and switching	4
22	AM104	Numerical Methods and Statistical Techniques	3

Course Code	**Course Name**	**L-T-P**	**Credits**	**Pre-requisite**
EC105	**Digital Electronics and Logic Design**	**3-1-0**	**3**	**Basics of Electronics Engineering**
Course Outcomes (CO)*:				
CO1:	Understand the basics of difference between analog and digital circuits and their applications.			
CO2:	To implement simple logical operations required for the designing of digital circuits and understand common forms of number representation.			
CO3:	Reduction of Boolean expressions for the designing of minimized logical circuits.			
CO4:	Design and implementation of combinational circuits.			
CO5:	Design and implementation of sequential circuits and their application.			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				
Introduction to Digital Concepts: Digital and Analog systems, logic levels & Pulse waveform. Logic Gates: 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. Error detecting codes: Parity, checksum, block parity. Error correcting codes: 7-bit Hamming code, alphanumeric codes: ASCII code. Boolean algebra: Laws of Boolean algebra and De Morgan's Theorem. Minimization of Boolean expression. Boolean expression and logic diagram, converting AND/OR/Invert Logic to NAND/NOR logic. Boolean Functions and their representation: Sum of Product (SOP), Product of Sum (POS), canonical forms. Karnaugh map (upto 5 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, Code Converters Parity bit generators and checkers. Sequential circuits: Classification of sequential circuits, Flip flops SR, JK, T, D, Race around condition and Master slave flip flops Flip flop excitation table, Conversion of flip flops. Shift Registers: SIPO, SISO, PISO and PIPO. Counters: Asynchronous counters, design of asynchronous counters, effects of propagation delay in ripple 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.

Suggested Books:

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

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC106	**Digital Electronics & Logic Design Lab**	**0-0-2**	**1**	**Basics of Electronics Engineering**

Course Outcomes (CO)*:	
CO1:	To understand the digital logic and create various systems by using these logics.
CO2:	To develop an understanding of design and simulation of digital logic circuits.
CO3:	To get a basic understanding of layout of electronic circuits.
CO4:	To use the Multisim tool for design and simulation.

*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A

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. In How many ways one bit of information can be stored in computers. Design and verify at least three different methods using sequential logic circuits. 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. Suppose there is a need to store 4 bit of data. Which device is required for this purpose also show the transfer of data in SISO, SIPO, PISO and PIPO forms. Implement a circuit and verify its operation that requires power-supply, inputs (push buttons/DIP switches) and outputs (LED/7-segment display.

Suggested Books:

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

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC107	**Analog Electronics**	**3-1-0**	**3**	**Basics of Electronics Engineering**
Course Outcomes (CO)*:				
CO1:	Develop the Ability to understand the design and working of BJT amplifiers			
CO2:	To be able to design BJT based circuits and observe the amplitude and frequency responses of common amplifiers.			
CO3:	To design and develop the audio and power amplifiers using re and hybrid equivalent models.			
CO4:	To develop the skill to build, and troubleshoot analog circuits.			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				

BJT introduction and operation, Common Base Configuration, Common Emitter Configuration D.C Biasing: operating point, DC analysis of BJT in CE configuration: Fixed Bias configuration, Emitter Bias Configuration, Voltage Divider Bias configuration, Emitter Follower Configuration, Common Base configuration. BJT transistor modeling and small signal ac equivalent circuit. The re transistor model in CE configuration: Voltage divider bias to calculate phase relationships. Two stage RC- Coupled BJT amplifier to calculate voltage gain, input impedance and output impedance. Hybrid Equivalent model: Complete Hybrid Equivalent model, Approximate Hybrid equivalent circuit of Common emitter with Fixed Bias and voltage Divider Bias Configuration. 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, Depletion type MOSFET: Construction and characteristics, Enhancement type MOSFET: Construction and characteristics.

Suggested Book(s)

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

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC108	**Analog Electronics lab**	**0-0-2**	**1**	**Basics of electronics engineering lab**
Course Outcomes (CO)*:				
CO1:	To be able to read and interpret electronic datasheets and diagrams.			
CO2:	To be able to measure the electronics & electrical parameters of an amplifier like voltage gain, input & output impedance.			
CO3:	To design, construct and troubleshoot transistor based amplifier complex electronic circuits.			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				

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).

Suggested Book(s)

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

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC109	**Microprocessor and Micro-controller**	**3-1-0**	**3**	**Digital Electronics and Logic Design**
Course Outcomes (CO)*:				
CO1:	After completing the course students will be able to differentiate between the real time applications of microprocessor and a microcontroller.			
CO2:	The student will be able to design a memory and I/O interface aspects for an 8085-based computer systems.			
CO3:	Students will develop the knowledge regarding architecture and peripheral configuration of STM32L476.			
CO4:	Students will be able to write embedded C code to develop applications using I/O ports, timers and other peripherals of a microcontroller.			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				
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.

Suggested Books:

- Ramesh S. Gaonkar, "Microprocessor Architecture, Programming and Applications with 8085", Prentice Hall, 2002.
- Geoffrey Brown, "Discovering the STM32 Microcontroller", Indiana University, 2016.
- Joseph Yiu, "The Definitive Guide to ARM Cortex- M3 and Cortex- M4 Processors", Elsevier, First Edition(2014)
- 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	Pre-requisite
EC110	**Microprocessor and Microcontroller Lab**	**0-0-2**	**1**	**Digital Electronics and Logic Design**

Course Outcomes (CO)*:

CO1:	After the completion of this lab course students will be able to handle the technical issues during the programming and also able to evaluate possible causes of discrepancy in practical experimental observations.
CO2:	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.
CO3:	Student will be able to understand how to Interface the external devices to the controller according to the user requirements to create novel products and solutions for the real time problems

*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A

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.

Suggested Books:

- Ramesh S. Gaonkar, "Microprocessor Architecture, Programming and Applications

with 8085", Prentice Hall, 2002.
- Geoffrey Brown, "Discovering the STM32 Microcontroller", Indiana University, 2016.
- Joseph Yiu, "The Definitive Guide to ARM Cortex- M3 and Cortex- M4 Processors", Elsevier, First Edition(2014).
- 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	Pre-requisite
EC111	**Signals and Systems**	**3-1-0**	**3**	**NIL**
Course Outcomes (CO)*:				
CO1:	Categorize various types of signals and systems as continuous/ discrete.			
CO2:	Apply various transforms in analysis of systems with different input signals.			
CO3:	Interpretation of the behaviour of Linear time invariant systems (Continuous & Discrete) in terms of system stability and response.			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				

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.

Suggested Books:

- 'Signals and Systems' by A NagoorKani, ISBN: 978-0-07-015139-0, McGraw Hill Education, First Edition, Copyright © 2010.
- Signals and Systems' by Tarun Kumar Rawat, ISBN: 978-0-19-806679-8, Oxford University Press, First Edition, Copyright © 2010.
- `Principles of Linear Systems and Signals' by B. P. Lathi, ISBN: 978-0-19-

806227-1, Oxford University Press, First Edition, Copyright © 2009.

- 'Digital Signal Processing' by S Salivahanan, C Gnanapriya, 2nd edition, Tata McGraw-Hill, ISBN:9780070669246, 2, 2013.

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC113	**Measurement and Virtual Instrumentation lab**	**0-0-2**	**1**	**NIL**
Course Outcomes (CO)*:				
CO1:	The students will be able to design any instrumentation based project.			
CO2:	The students will be able to simulate any type of signals and check performance of any circuit based on these simulated signals.			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				

Introduction to LabVIEW software: LabVIEW components, function pallette, control pallete, 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. Analysis of the operation of DC positional servo system and investigate the effect of damping and supply voltage on its response. Analysis of the operation of an AC position servo-system and obtain effects of supply voltage and system parameter on its transient response.

Suggested Books:

- Lab Manual prepared by faculty of ECE Department.
- LabVIEW based advanced instrumentation system by S. Sumathi and P. Surekha, springer.

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC135	**Network Analysis & Control Systems**	**3-1-0**	**3**	**NIL**
Course Outcomes (CO):**				
CO1:	Develop the skill of network reduction and circuit analysis using Kirchhoff's law and network simplification theorems			
CO2:	Understand the operation of automatic control systems employed in various real life applications.			
CO3:	Carry out both time domain as well as frequency domain analysis of control systems using Laplace transform and different plots.			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				

Circuit Analysis and DC Theorems: The circuit, Energy Sources, Kirchhoff's Voltage Law, Voltage division, Kirchhoff's current law, Current division, Mesh Analysis, Super Mesh Analysis, Nodal Analysis, Super node analysis, source transformation technique, wye-delta transformation, DC theorems: Network theorems for independent DC source -Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum Power Transfer theorem for DC circuits, Time and Frequency domain analysis: Impedance diagram, phasor diagram, series circuits, parallel circuits, complex admittances, complex Impedances, Laplace transform of some useful functions, Analysis of RLC circuits using Laplace transform, Analysis of RL, RC circuits using Laplace transform, Introduction and Mathematical Modeling, The control System, , Open loop control system, closed loop systems with real time applications, transfer function, Mathematical modeling Mechanical(translational) & electrical system, control system components-potentiometer, synchro, tachometer, Block diagram Algebra. Time Domain Analysis, Classification or time responses, system time response, analysis of steady state error, Type of input and steady state error, Analysis of first order system. Stability Concept of stability, Routh-Hurwitz criterion, Routh's stability criterion, Applications, Advantages and limitations of Routh's criterion, Root locus concepts, construction root locii, Gain margin and Phase margin.

Suggested Book(s)

- Network Analysis and Synthesis by Sudhakar Sham Mohan, Tata McGraw Hill Publication Fourth Edition, 2004**.**
- Control Systems' by Samarjit Ghosh, 2nd edition, Pearson Education, ISBN 978-81-317-5837-3.

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC114	**Microelectronic Circuits**	**(3-1-0)**	**3**	**Analog Electronics**
Course Outcomes (CO)*:				
CO1:	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.			

CO2:	Design digital as well as analog circuits using CMOS technology.
CO3:	Students will apply the concept of IC fabrication to create layouts of digital circuits.
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A	

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.

Suggested Book(s)

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

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC115	**Microelectronic Circuits lab**	**0-0-2**	**1**	**Analog Electronics lab**
Course Outcomes (CO)*:				
CO1:	Students will acquire hands on experience of industry oriented circuit designing tools.			
CO2:	Students will be able to design different digital and analog circuits and verify the same through simulation on cadence design tool.			
CO3:	Capable of designing layouts of the designed circuit in accordance with layout design rules.			

*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A
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, Common Gate). Design Analysis of MOS based Analog Multiplier. **Suggested Book(s)** • Sung-Mo Kang and Yusuf Leblebici, "CMOS Digital Integrated Circuits Analysis and Design", Tata McGraw Hill, 3rd Edition, 2005. • Richard C. Jaeger, Travis N. Blalock, "Microelectronic Circuit Design", McGraw-Hill, 4th edition, 2011. • Donald A Neamen, "Semiconductor Physics and Devices", Mc Graw- Hill, 4th edition,2011. • Neil H. E. Weste and Kamran Eshraghian, "Principles of CMOS VLSI design", Pearson, 3rd edition, 2005.

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC118	**Digital Signal Processing**	**3-1-0**	**3**	**Signal and Systems**
Course Outcomes (CO)*:				
CO1:	Identify different types of discrete signals, implement these signals on different systems using z transform, Discrete Fourier Transform and Fast fourier Transform.			
CO2:	Student can apply knowledge to design and filters and implement them for signal processing applications.			
CO3:	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			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				
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, Overview of TMS320 Family DSP Processors.

Suggested Books:

- Digital Signal Processing' by Salivahan and Gnanapriya, fifth reprint-2013 Tata McGraw- Hill Education private limited.
- Digital signal processing, 3rd edition by Sanjit K. Mitra, Tata McGraw Hill, 2001
- Digital Signal Processing' by John G. Proakis, Dimitris G. Manoiaias, Prentice Hall of India pvt. Ltd., 4th edition.

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC119	**Digital Signal Processing Lab**	**0-0-2**	**1**	**Signal and Systems**
Course Outcomes (CO)*:				
CO1:	To understand and analyze the different types of signals in time domain and frequency domain.			
CO2:	To design and implement the characteristics of the digital filters (FIR and IIR).			
CO3:	Can apply skill of programming using MATLAB to develop the computation of Transforms and convolution .			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				

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.

Suggested Books:

- Digital Signal Processing' by Salivahan and Gnanapriya, fifth reprint-2013 Tata McGraw- Hill Education private limited.

- Digital signal processing, 3rd edition by Sanjit K. Mitra, Tata McGraw Hill, 2001
- Digital Signal Processing' by John G. Proakis, Dimitris G. Manoiaias, Prentice Hall of India pvt. Ltd., 4th edition.

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC129	**Application Development using Python**	**0-0-8**	**4**	**NIL**
Course Outcomes (CO)*:				
CO1:	Choose the appropriate Python programming constructs to solve the problems.			
CO2:	Demonstrate the advantages and disadvantages of specific techniques to be used.			
CO3:	Differentiate between efficient and inefficient way of programming.			
CO4:	Determine and demonstrate bugs in a program and recognize needed basic operations.			
CO5:	Formulate new solutions for programming problems or improve existing code to program effectively.			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				

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.

Suggested Books:

- Kenneth A. Lambert, The Fundamentals of Python: First Programs, 2011, Cengage Learning, ISBN: 978-1111822705.
- T.R. Padmanabhan, Programming with Python, Springer, 1st Ed., 2016

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC137	**Embedded System and IoT**	**3-1-0**	**3**	**NIL**
Course Outcomes (CO)*:				
CO1:	The students would be able to understand fundamental concepts and technologies related to embedded system and IoT based devices.			
CO2:	The students would be able to understand the fundamentals of RTOS and application development techniques.			
CO3:	The students would be able to understand the various communication and networking protocols used for developing IoT enabled devices.			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				

Introduction to embedded systems: embedded system, embedded system v/s general computing system, core of the embedded system, embedded hardware units and devices in the system, design process in embedded system, embedded firmware design approaches, embedded firmware development languages. Processor and memory organization, instruction level parallelism, performance metrics of a processor. Devices and communication interfaces: timer and counting devices, watchdog timer, real time clock, serial communication protocols: uart, spi, i2c. Bluetooth, Zigbee, USB. RTOS fundamentals: Interrupts: Basics, Interrupt request, Role of Interrupt handler, Interrupt vector table, Context switching during Interrupts, Nesting of Interrupts, Shared-Data problem, Solving shared-data problem with and without disabling Interrupts, Atomic and Critical Section of the code, Interrupt latency Software Architectures: Round-robin architecture without and with Interrupts, Function-Queue-Scheduling architecture Real-Time Operating System (RTOS): Basic concepts: Task and task states, Task control block, Role of scheduler, Preemptive and Non preemptive RTOS, Shared-Data problem in RTOS, Semaphores and Solving shared data problem with Semaphores, Semaphore types: binary, counting and mutex, Concept of Reentrancy and Reentrant Function, Problem of priority inversion and priority inheritance protocol. Introduction to IoT: Introduction, Physical design of IoT, Logical design of IoT IoT enabling technologies: Wireless Sensor Networks, Cloud Computing, Big data analytics, Communication Protocols, Embedded System IoT levels and deployment templates, M2M, Difference between IoT and M2M. Protocols for IoT Messaging Protocols for IoT: MQ Telemetry Transport (MQTT) and Constrained Application Protocol (CoAP). Addressing Protocols for IoT: IPv4, IPv6 and URI.

Suggested Books

- Embedded Systems - Architecture, Programming and Design' by Raj Kamal, Second Edition, Third Edition, Mc-Graw Hill Education. ISBN: 978-93-329-0149-0
- An Embedded Software Primer' by David E Simon, Pearson. ISBN: 978-02-016-1569-2
- Introduction to Embedded Systems' by Shibu KV, Mc Graw Hill Education. ISBN: 978-93- 392-1968-0
- 'Internet of Things: A Hands-On Approach' by ArshdeepBahga and Vijay

Madisetti, Universities Press. ISBN: 978-81-7371-954-7

- 'Internet of Things' by S.K. Vasudevan, A.S. Nagarajan and R.M.D. Sundaram, Wiley. ISBN: 978-81-265-7837-5

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC138	**Embedded system & IoT lab**	**0-0-2**	**1**	**NIL**
Course Outcomes (CO)*:				
CO1:	Design the various application-oriented embedded system and IoT devices.			
CO2:	Implement different communication and networking protocols used for developing IoT enabled devices.			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				

Program using STM32L475E IOT Discovery kit for LED Blinking. Program using STM32L475E IOT Discovery kit for controlling LED with push button. 3 Introduction to Tera Term and Programfor printing Hello World on Tera Term. Program using STM32L475E IOT Discovery kit for reading the analog values from potentiometer and display the values on Tera Term. Study the temperature and humidity sensor (HTS221) available on STM32L475E IOT Discovery kit and Program for reading the temperature and humidity values using STM32L475E IOT Discovery kit. Study the barometer sensor (LPS22HB) available on STM32L475E IOT Discovery kit and Program for reading the pressure values using STM32L475E IOT Discovery kit. Study the 3D accelerometer sensor (LIS3MDL) available on STM32L475E IOT Discovery kit and Program for reading the 3D accelerometer sensor values using STM32L475E IOT Discovery kit. b) Study the 3D gyroscope (LSM6DSL available on STM32L475E IOT Discovery kit and Program for reading the 3D gyroscope sensor values using STM32L475E IOT Discovery kit. c) Study the High-performance 3-axis magnetometer sensor (LIS3MDL) available on STM32L475E IOT Discovery kit and Program for reading the 3-axis magnetometer sensor values using STM32L475E IOT Discovery kit. Program using STM32L4 Discovery kit IOT node for display time and date using RTC. Program using STM32L4 Discovery kit IOT node for Bluetooth low energy (BLE)-Heart Rate. Program using STM32L4 Discovery kit IOT node for Wi -Fi HTTP server. b) Program using STM32L4 Discovery kit IOT node for Wi- Fi Client server. Program using STM32L4 Discovery kit IOT node for Pelion LWM2M communication protocol. Program using STM32L4 Discovery kit IOT node for Amazon web services.

Suggested Books

- Embedded Systems - Architecture, Programming and Design' by Raj Kamal, Second Edition, Third Edition, Mc-Graw Hill Education. ISBN: 978-93-329-0149-0
- An Embedded Software Primer' by David E Simon, Pearson. ISBN: 978-02-016-1569-2
- Introduction to Embedded Systems' by Shibu KV, Mc Graw Hill Education. ISBN: 978-93- 392-1968-0
- 'Internet of Things: A Hands-On Approach' by ArshdeepBahga and Vijay

Madisetti, Universities Press. ISBN: 978-81-7371-954-7

- 'Internet of Things' by S.K. Vasudevan, A.S. Nagarajan and R.M.D. Sundaram, Wiley. ISBN: 978-81-265-7837-5

Course Code	Course Name	L-T-P	Credits	Pre-requisite
CS115	**Operating systems**	**0-0-8**	**4**	**NIL**
Course Outcomes (CO):**				
CO1:	Students will be able to identify different types of Operating System and their components			
CO2:	Design and implementation of new system calls for any open source operating system			
CO3:	Implementation of existing resource management algorithms in Linux operating system			
CO4:	Students will be able to identify various system security and protection issues			
CO5:	Students will be able to completely administer the system using various Operating systems (Windows and Ubuntu) for managing its resources			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				

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.

Suggested books:

- Operating System Concepts Essentials, 9th Edition by AviSilberschatz, Peter Galvin, Greg Gagne, Wiley Asia Student Edition.
- Operating Systems: Internals and Design Principles, 5th Edition, William Stallings, Prentice Hall of India.

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC123	**Analog and Digital Communications**	**3-1-0**	**3**	**NIL**
Course Outcomes (CO)*:				
CO1:	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.			
CO2:	The students would be able to analyze design aspects of generation and detection techniques of AM and FM signals as used in broadcast radio and TV transmissions.			
CO3:	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.			
CO4:	They would possess an ability to apply knowledge of various digital modulation schemes to improve performance of advanced digital cellular communication systems.			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				

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).

Suggested books:

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

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC124	**Analog and Digital Communication Lab**	**0-0-2**	**1**	**NIL**
Course Outcomes (CO)*:				
CO1:	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			
CO2:	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.			
CO3:	The students would be able to evaluate binary and M-ary shift keying digital modulation and demodulation techniques for digital cellular applications			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				

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.

Suggested books:

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

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC251	**Database Management System**	**0-0-8**	**4**	**NIL**
Course Outcomes (CO)*:				
CO1:	Design and implement database system by implementing SQL commands for RDBMS and analyze database requirements to determine the entities involved in the system and their relationship to one another			
CO2:	Describe relational algebra expression and tuple relation expression from queries			
CO3:	Implement the concept of normalization and functional dependency while designing the databases			
CO4:	Apply the concept of transaction, concurrency control, security and recovery in database			
CO5:	Implement procedures, functions, cursors and triggers and become proficient in PL/SQL programming			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				
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.

Suggested Books:

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

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC139	**Introduction to CCNA Routing and Switching**	**4-0-0**	**4**	**NIL**
Course Outcomes (CO)*:				
CO1:	Understand different topologies and small networks by following the			

	down-top approach from physical layer to application layer.
CO2:	Formulate functioning of different protocols (e.g. IP, TCP, UDP, WWW, http, email, DNS) of layered networking model.
CO3:	Analyze basics concepts of routing, switching, and advanced technologies.
CO4:	Students will be able to design simple networks using the application-driven paradigm.

*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A

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 routerIP addressing: IPv4 Network Addresses- structure and characterstics, 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, communicationprocess 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.

Suggested Books:

- 'CCNA Cisco Certified Network Associate Study Guide', by Todd Lammle, Wiley, 6th edition
- ‘Computer Networks’ by Andrew S. Tanenbaum, Pearson Education, Fourth Edition.
- CCNA Routing and Switching 200-125 official cert guide
- 'Computer Networking: A Top-Down Approach', by James Kurose and K.W. Ross, Pearson Education, 3rd Edition.

Course Code	Course Name	L-T-P	Credits	Pre-requisite
AM104	**Numerical Methods and Statistical Techniques**	**3-1-0**	**3**	**Engineering Mathematics-I,**

				engineering Mathematics-II
Course Outcomes (CO):**				
CO1:	Understand various methods of modelling and solve mathematical equations by various methods.			
CO2:	Understand statistical methods for data analysis and sampling techniques.			
CO3:	Students will be able to apply numerical integration and find best curve fitting for given data.			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				
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). **Suggested Book(s):** • 'Numerical Methods' by, E. balagurusamy, TMH • 'Advance Numerical Analysis with programming in C++' by Chitkara University Publication.				

12.4 Programme Elective Courses

S. No.	Course Code	Name of the Course	Credits
1	EC116	Linear Integrated Circuits	4
2	EC117	Linear Integrated Circuits lab	
3	EC125	Digital VLSI Design	4
4	EC126	Digital VLSI Design LAB	

5	EC201	Analog Layout Design	4
6	EC203	Bio-medical electronics	4
7	EC204	Digital Image Processing	4
8	EC205	Digital Image Processing Lab	
9	EC206	Digital System Design	4
10	EC207	Digital System Design Lab	
11	EC208	Electronic System design	4
12	EC211	High Speed VLSI Design Circuits	4
13	EC212	High Speed VLSI Design Circuits Lab	
14	EC213	Information Theory and Coding	4
15	EC214	Introduction to MEMs	4
16	EC215	Introduction to mobile technology	4
17	EC217	IOT and Industrial Application	4
18	EC220	Low Power VLSI System Design	4
19	EC221	Low Power VLSI System Design lab	
20	EC222	Microwave and Satellite communication	4
21	EC223	Microwave and Satellite communication lab	
22	EC224	Mixed Signal Circuit Design	4
23	EC226	Optical communication systems	4
24	EC230	Python for Data Science	4
25	EC233	Speech and audio Processing	4
26	EC234	VLSI Design and Verification	4
27	EC235	VLSI Design and Verification lab	
28	EC236	Wearable technology and reality	4
29	EC237	Sensor and Communication Protocol	4
30	EC239	Advance Wireless Communication	4
31	EC241	Cloud Computing for IoT	4
32	EC242	Nano Electronics	4
33	EC243	Wireless Sensor Networks	4
34	EC244	IC fabrication and Technology	4
35	EC262	Machine learning	4
36	EC248	Data extraction & Visualization	4
37	EC249	IoT application development	4
38	EC250	Web Development for Iot	4
39	EC258	Core JAVA	4
40	EC259	Data analytics	4
41	EC260	Business Statistics	4
42	EC261	Introduction to Web technologies	4
43	EC263	Advanced Machine learning	4
44	EC264	Big Data Analytics with Ecosystem	4
45	EC266	Cloud computing & Virtualization	4
46	EC267	Advanced Web technologies (server side)	4

47	EC268	Android Application development	4
48	EC269	Artificial Intelligence & expert system	4

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC116	**Linear Integrated Circuits**	**3-1-0**	**3**	**Analog Electronics**
Course Outcomes (CO)*:				
CO1:	To be able to design Op-amp based circuit to give specified gain.			
CO2:	To compute component values to design different Op-amp based applications such as arithmetic building blocks, filters, waveform generators.			
CO3:	To develop practical skills for building and testing circuits using analog ICs.			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				

Unit-1: Fundamentals of Op-Amp: Operational Amplifier, Block Diagram. Schematic symbol, Integrated Circuits, types of Integrated Circuits. Ideal Op Amp, equivalent circuit, Ideal voltage transfer curve, open loop Op Amp configurations: differential, inverting and non- inverting. Unit-2: Op-Amp ideal circuits: Block Diagram representation of feedback configurations, 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. Current to voltage converter. 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, 555 Timer as an Astable and Mono stable multivibrator. VCO and Phase Locked Loops: Operating Principles only.

Suggested Book(s)

- "Op-AMPS and Linear Integrated Circuits", by Ramakant A. Gayakwad, Prentice-Hall, 4th edition, 2008.
- “Linear Integrated Circuits”, by T.L Singal, PBS Education, 1st edition, 2015.
- “Linear Integrated Circuits”, by S. Salivahanan, V S KanchannaBhaaskaran, Tata

McGraw-Hill, 1st Edition, 2008.
- "Linear Integrated Circuyits", by D. Roy Choudhary, Sahil B. Jain, New Age Techno press, 4th edition, 2010.

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC117	**Linear Integrated Circuits Lab**	**0-0-2**	**1**	**Analog electronics lab**

Course Outcomes (CO)*:

CO1:	To be able to select an appropriate IC for an industrial and domestic applications by interpreting electronic datasheet.
CO2:	To be able to design an op amp based circuit such as filters, oscillators, generators, converters and can solve problems related to it.
CO3:	To be able to troubleshoot and replace the defective parts of op amp based electronic circuits.
CO4:	To develop appropriate communication skills, particularly technical reports through the laboratory.

*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A

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 summing, 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.

Suggested Book(s)

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

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC125	**Digital VLSI Design**	**3-1-0**	**3**	**Digital Electronics and Logic Design**
Course Outcomes (CO)*:				
CO1:	Students will get a clear understanding of VLSI design flow and different types of design styles which are used for integrated circuit design			
CO2:	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			
CO3:	Students will acquire skills to identify the faults associated in VLSI circuits and various techniques to test the ICs.			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				

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.

Suggested Book(s)

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

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC126	**Digital VLSI Design lab**	**0-0-2**	**1**	**Digital Electronics & Logic Design Lab**
Course Outcomes (CO)*:				

CO1:	Students will be able to use digital design tools such as Xilinx/Vivado for implementing digital circuits
CO2:	Conduct experiments to evaluate the performance of digital circuits with respect to time.
CO3:	Design and simulate the sequential circuits such as registers, counters and state machines using ISE design tool.
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A	

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.

Suggested Book(s)

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

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC201	**Analog layout Design**	**0-0-8**	**4**	**Analog Electronics, Microelectronics**
Course Outcomes (CO):**				
CO1:	Enhance the skills of integrated circuit design for designing layouts of complex circuits.			
CO2:	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.			
CO3:	Able to apply different matching techniques in layouts of analog circuits and apply those techniques to design high quality and noise tolerant layout			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				

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, Parasitics associated with layout design, Layout optimization for minimum parasitics 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,

Suggested Books:

- The Art of Analog layout' by Alan Hastings, 2001, ISBN 0-13-087061-7, Prentice Hall
- CMOS circuit design, layout & simulation' by R. Jacob Baker,3rd Edition, Wiley
- Analog Integrated Circuit Design' by Tony Chan Carusone, David A. Johns, Kenneth W. Martin,2nd Edition, ISBN 978-0-470-77010-8, Wiley

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC203	**Biomedical Electronics**	**0-0-8**	**4**	**NIL**
Course Outcomes (CO):**				
CO1:	Understand the fundamental principles of Biomedical circuit .			
CO2:	To analyze bio electronic circuits using oscilloscopes and other electronic			

	test equipment.
CO3:	Apply knowledge of biomedical electronic circuits to solve problems in the areas of biomedical signals.
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A	
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. **Suggested Books:** • W.F. Ganong, Review of Medical Physiology, 8th Asian Ed, Medical Publishers, 1977. • J.G. Websster, ed., Medical Instrumentation, Houghton Mifflin, 1978. • A.M. Cook and J.G. Webster, eds., Therapeutic Medical Devices, Prentice-Hall, 1982.	

Course Code	**Course Name**	**L-T-P**	**Credits**	**Pre-requisite**
EC204	**Digital Image Processing**	**3-1-0**	**3**	**Digital Signal Processing**
Course Outcomes (CO):**				
CO1:	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			
CO2:	Students will develop the knowledge to analyze the different images in the frequency domain using various transforms			
CO3:	Students will be able to realize the importance of filters for the images and also they will be able to differentiate between the different types of filters.			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				
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, Image Segmentation: Detection of Discontinuities, Point, Line and Edge detection. Edge linking and Boundary Detection, Thresholding, Image compression.

Suggested Books:

- Rafael C. Gonzalez & Richard E. Woods, Digital Image Processing, Pearson Education (2nd edition)
- Anil K. Jain, Fundamentals of Digital Image Processing, Prentice Hall, Pearson Education (ISBN 81-297-0083-2)

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC205	**Digital Image Processing Lab**	**0-0-2**	**1**	**Digital Signal Processing**

Course Outcomes (CO):**	
CO1:	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.
CO2:	The Students will be able to apply the different techniques for the enhancement and filtering of images.
CO3:	Students will be able to understand the relevant aspects of digital image representation and their practical Implications.

*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A

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

Suggested Books:

- Rafael C. Gonzalez & Richard E. Woods, Digital Image Processing, Pearson

Education (2nd edition).

- Anil K. Jain, Fundamentals of Digital Image Processing, Prentice Hall, Pearson Education (ISBN 81-297-0083-2).

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC206	**Digital System Design**	**3-1-0**	**3**	**Digital Electronics & Logic Design**

Course Outcomes (CO):**

CO1:	The students completing this course are expected to understand the structure of various number systems and its application in digital design.
CO2:	Students will be able to design the appropriate truth table from a description of a combinational logic function
CO3:	Students will be able to analyze and design various combinational and sequential circuits like Comparators, Multiplexers, Encoders etc.
CO4:	Students will be able to design the synchronous circuits like Pulse train generator, Pseudo Random Binary Sequence generator

*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A

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 andFull 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, Rippleand 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 Modeling, Synthesis and Simulation VHDL constructs and codes for combinational and sequential circuits.

Suggested Books:

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

edition, 2012.

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC207	**Digital System Design Lab**	**0-0-2**	**1**	**Digital Electronics & Logic Design Lab**
Course Outcomes (CO):**				
CO1:	The students will be able to apply the knowledge to represent digital values in different logic families, including characterization of the noise margins.			
CO2:	Students will be able to apply the knowledge to simulate and implement combinational and sequential circuits using VHDL systems.			
CO3:	Students will be able to practically implement and evaluate combinational and sequential logic designs using various metrics: switching speed, gate count , and energy dissipation and power.			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				

To verify the Truth-tables of all logic gates along with the construction of combinational circuits using universal gates. To realize and verify the Half & full adder circuits using logic gates. To realize 4-bit binary-gray & gray-binary converters. To realize comparator circuit for two binary numbers of 2-bit each. To realize Full adder & full subtractor circuits using 8x3 encoder. To design Full adder & full subtractor circuits using 8x3 demultiplexer. To design and verify the Truth tables of all flip-flops. To design Mod-6/Mod-9 synchronous up-down counter. To write and execute VHDL program for combinational & sequential circuits for Half/Full adder and subtractor, 4 bit binary – gray and gray to binary converter, for a 2 bit binary comparator circuit, 8x3 encoder and 8x3 demultiplexer for full adder and subractor operations. To write VHDL program for universal shift-register operations.

Suggested Books:

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

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC208	**Electronic System Design**	**0-0-8**	**4**	**NIL**
Course Outcomes (CO):**				
CO1:	After the completion of this course students get familiarization with data storage elements along with their applications			

CO2:	Students will able to get the idea about the different trends and limitation of CMOS technology scaling
CO3:	Students will acquire the knowledge regarding the various digital interfacing systems like UART, SPI and I2C
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A	
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. **Suggested Books:** • Kang, S. and Leblebici, Y., CMOS Digital Integrated Circuits – Analysis and Design, Tata McGraw Hill (2008) 3rd ed. • Unsalan,C and Tar,B.,Digital system design with FPGA, McGraw Hill Education(India) Pvt Ltd(2018).	

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC211	**High Speed VLSI Design**	**3-1-0**	**3**	**Microelectronics**
Course Outcomes (CO):**				
CO1:	Students will be able understand the need High Speed Circuits Design in the era of modern technology.			
CO2:	Apply the Method of Logical Effort in digital circuits to design high speed circuits.			
CO3:	Students will have an exposure of the types of Dynamic logic styles and their applications in high speed Integrated circuit designing.			
CO4:	Students will have an experience on Clocking strategies and Clocking styles in various types of digital circuits.			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				
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.

Suggested Books:

- Sung-Mo (Steve) Kang, Yusuf Leblebigi, "CMOS Digital integrated circuit analysis and design", by Tata Mcgraw-Hill, (2007).
- Chung-Kang Cheng, John Lillis,Shen Lin and Norman H.Chang, "Interconnect Analysis and Synthesis",AwileyInterscience Publication(2000).
- L.O.Chua, C.A.Desoer, and E.S.Kuh, "Linear and Nonlinear circuits",McGraw-Hill,1987.

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC212	**High Speed VLSI Design Lab**	**0-0-2**	**1**	**Microelectronics**
Course Outcomes (CO):**				
CO1:	Students will be able to design high speed VLSI circuits practically with different			
CO2:	Calculate delay associated with logic gates using industry oriented design tools			
CO3:	Student will get practical skills to analyze delay and latching condition in Clock based circuits using EDA tools			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				

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 latchs and calculate delay, Race condition in digital circuits, clock jitter, clock skew in digital logic, delay estimation using asynchronous clock

Suggested Books:

- Sung-Mo (Steve) Kang, Yusuf Leblebigi, "CMOS Digital integrated circuit analysis and design", by Tata Mcgraw-Hill, (2007).
- Chung-Kang Cheng, John Lillis,Shen Lin and Norman H.Chang, "Interconnect Analysis and Synthesis",AwileyInterscience Publication(2000).
- L.O.Chua, C.A.Desoer, and E.S.Kuh, "Linear and Non linear circuits",McGraw-Hill,1987.

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC213	**Information Theory and Coding**	**4-0-0**	**4**	**NIL**
Course Outcomes (CO):**				
CO1:	Design the channel performance using Information theory			
CO2:	Comprehend various error control code properties			
CO3:	Apply linear block codes for error detection and correction			
CO4:	Apply convolution codes for performance analysis & cyclic codes for error detection and correction.			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				

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.

Suggested Books:

- T L Singal, Digital Communication, ISBN: 978-93-392-1952-9, McGraw Hill Education, First Edition, Copyright © 2015.
- 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.
- Gravano, An Introduction to Error Control Codes, ISBN: 978-0-199-23678-7, Oxford University Press, 1st edition, 2007.
- Richard B. Wells, Applied Coding and Information Theory for Engineers, Pearson Education, 1st edition, 2009.

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC214	**Introduction to MEMS**	**0-0-8**	**4**	**Nil**
Course Outcomes (CO):**				
CO1:	Develop the basic understanding of micro sensors and actuators with their types and applications in real world.			
CO2:	Learn about the fabrication processes involved in designing of micro devices and employing them in real world applications			
CO3:	Understand how micro manufacturing is done and what are the various design considerations in developing microdesign systems			

*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A
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. **Suggested Books:** • MEMS and Microsystem Design and Manufacture, by Tai-Ran Hsu, Tata McGraw Hill Publication. • VLSI Technology by S.M. Sze, Tata McGraw Hill Publication.

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC215	**Introduction to Mobile Technology**	**0-0-8**	**4**	**NIL**
Course Outcomes (CO):**				
CO1:	Students will gain complete knowledge about mobile network elements, Service Flow and the operation of mobile networks			
CO2:	Understand the function of service provider operational support system and anatomy of a cell site.			
CO3:	Students will learn about various technologies of mobile networks including FWA, GSM architecture, UMTS and LTE.			
CO4:	Students will acquire basic knowledge about API and RESTfull web services.			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				
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: Websockets, HTTP requests, Restful API, Mobile OS and their possibilities and limitations. **Suggested Books:** □ Wilkinson, N. Next generation networks services: Technologies and strategies. Chichester: John Wiley & Sons, 2002. 196 p. ISBN 0-471-48667-1 □ Stallings, W. Wireless communications and networks. Upper Saddle River: Prentice Hall, 2002. 584 p. ISBN 0-13-040864-6				

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC217	**IoT and Industrial Applications**	**4-0-0**	**4**	**NIL**
Course Outcomes (CO)*:				
CO1:	The student would be able to interpret the concept of industrial IoT.			
CO2:	To design IIoT aaplication using the communication protocols			
CO3:	The student would be able to highlight the key attributes of industry 4.0			

	and its charactersitics.
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A	
Industrial Internet, Key IIoTTechnologies, 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. **Suggested Books:** • Industry 4.0: The Industrial Internet of Things, by Alasdair Gilchrist, Apress publication. • Industrial sensors and control in communication networks, by Dong-seong Kim Hoatrang-Dang, Springer publication.	

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC220	**Low power VLSI System Design**	**3-1-0**	**3**	**Microelectronics**
Course Outcomes (CO):**				
CO1:	Identify the requirement of low power system design and physics of power dissipation in microelectronic devices			
CO2:	Solve the issues for power minimization in ICs and apply them in scaling of ICs			
CO3:	Perform probabilistic power analysis techniques to calculate power required for microelectronic devices and carry power optimization at logic level and circuit level.			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				
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.

Suggested Books

- Kaushik Roy, Sharat Prasad, "Low-Power CMOS VLSI Circuit Design" Wiley.
- Rabaey, Pedram, "Low power design methodologies" Kluwer Academic, 1997.
- Gary K. Yeap, "Practical Low Power Digital VLSI Design", KAP, 2002.

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC221	**Low power VLSI System Design Lab**	**0-0-2**	**1**	**Microelectronics**
Course Outcomes (CO):**				
CO1:	Ability to calculate and analyze power in digital circuits using industry related design tools.			
CO2:	Design memory using EDA tools by applying concepts of power dissipation.			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				

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 latches, 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.

Suggested Books

- Kaushik Roy, Sharat Prasad, "Low-Power CMOS VLSI Circuit Design" Wiley.
- Rabaey, Pedram, "Low power design methodologies" Kluwer Academic, 1997.
- Gary K. Yeap, "Practical Low Power Digital VLSI Design", KAP, 2002.

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC222	**Microwave and Satellite Communication**	**3-1-0**	**3**	**NIL**

Course Outcomes (CO):**	
CO1:	Students will gain complete knowledge about the significance, types and characteristics of various microwave solid state devices
CO2:	Analyze mathematically the operation and working of various tubes or sources for the transmission of the microwave frequencies
CO3:	Students will gain the basic understanding about the principles and working of RADAR.
CO4:	Students will aquire basic understanding of satellite communcation and various design links in satellite communication
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A	

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.

Suggested Books:

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

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC223	**Microwave and Satellite Communication Lab**	**0-0-2**	**1**	**NIL**
Course Outcomes (CO):**				
CO1:	Students will be able to design and use a microwave test bench to analyze various types of microwave measurements.			
CO2:	Students will be able to measure the parameters and characteristics of the various waveguide components.			
CO3:	Acquire an understanding of various characteristics of Microwave Tee's through practical demonstrations.			
CO4:	Students will be able determine the radiation characteristics and gain of an			

	antenna
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A	
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. **Suggested Books:** • Telecommunication Engineering 3rd Edition, by John Dunlop and Smith, CRC Press. • Electromagnetic waves and radiating systems, Zedan and Balmani. • Foundations for Microwave Engineering, R. E. Collin, McGraw Hill. • Satellite Communications, Timothy Pratt, Charles W. Bostian.	

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC224	**Mixed Signal Circuit Design**	**4-0-0**	**4**	**Analog Electronics, DELD**
Course Outcomes (CO):**				
CO1:	Apply knowledge of mathematics and engineering to design CMOS analog circuits to achieve desired performance specifications.			
CO2:	Identify, formulates, and solve engineering problems in the area of mixed-signal design.			
CO3:	Design and implement various types of mixed-signal integrated circuit for real world applications.			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				
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: Cascode 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, 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.

Suggested Books:

- Baker, R.J., Li, H.W. and Boyce, D.E., CMOS: Circuit Design, Layout and Simulation, IEEE Press (2007) 2nd edition
- Gregorian, R. and Temes, G.C., Analog MOS Integrated Circuits for Signal Processing, Wiley (2002)
- Gregorian, R., Introduction to CMOS Op-Amps and Comparators, Wiley (1999)
- Jespers, P.G. A., Integrated Converters: D-A and A-D Architectures, Analysis and Simulation, Oxford University Press (2001)

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC226	**Optical Communication systems**	**4-0-0**	**4**	**NIL**
Course Outcomes (CO):**				
CO1:	Understand the fundamentals, advantages and advances in optical communication system			
CO2:	Acquire a detailed understanding of types, basic properties and transmission characteristics of optical fibers			
CO3:	Understand configuration and architecture of advanced optical communication, advanced system techniques and nonlinear optical effects and their applications			
CO4:	Gain the knowledge of working and analysis of optical amplifiers and important devices/components of the optical communications system			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				

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:

- Optical Fiber Communications by John M Senior; Pearson Education, Third Edition.
- Fiber-Optics Communications Technology by Djafar K. Mynbaev& Lowell L. Scheiner Prentice Hall, 2006.
- Fiber Optics and Optoelctronics by R.P. Khare, Oxford publication, First edition.

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC230	**Python for Data Science**	**0-0-8**	**4**	**Application Development using Python**
Course Outcomes (CO):**				
CO1:	After the completion of this course, students will able to use the most widely used Python packages; including NumPy, Pandas and Matplotlib			
CO2:	Students will practically implement Python packages to Data Analysis and Data Visualization projects			
CO3:	They will able to manipulate and transform data using the Pandas library in Python			
CO4:	Students will learn and understand the versatile features of Python and implementing its various libraries and packages for solving problems related to diverse fields.			
CO5:	Use the techniques, skills, and modern engineering resources and tools necessary for engineering practice.			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				

Introduction and installation: Installation of Jupiter Notebook and packages, Python Basics, Python Lists, Function & Packages, Libraries and Control Statements: NumPy, Matplotlib, Dictionaries &PandasLogic, Control Flow and Filtering, Loops, Data Preparation: Introduction to flat files, Importing data from other file types, Working with relational databases in Python, Importing data from the Internet, Data Ingestion and Extraction: Exploring your data, Tidying data for analysis, Combining data for analysis, Cleaning data for analysis, Data ingestion & inspection, Exploratory data analysis, Extracting and transforming data, Rearrangement of data: Advanced indexing, Rearranging and reshaping data, Grouping data, Concatenating data, Merging data.

Suggested Books

- Mastering Python Data Analysis, PACKT Publications By Magnus Vilhelm Persson, Luiz Felipe Martins.
- Learning to program with python, Richard L. Halterman.

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC233	**Speech and Audio Processing**	**4-0-0**	**4**	**Digital Signal**

				Processing
Course Outcomes (CO):**				
CO1:	To acquire knowledge of audio and speech signals.			
CO2:	To develop understanding of speech generation and recognition models.			
CO3:	To relate human physiology and anatomy with signal processing paradigms.			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				

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 on reflection 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 LPC encoders 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.729 standards.

Suggested Books:

- "Digital Speech" by A.M. Kondoz, Second Edition (Wiley Students Edition), 2004.
- "Speech Coding Algorithms: Foundation and Evolution of Standardized Coders", W.C. Chu, Wiley Inter science, 2003.

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC234	**VLSI Design and Verification**	**3-1-0**	**3**	**Digital VLSI Design**
Course Outcomes (CO):**				
CO1:	Students will be able to design and verify an Integrated circuit in VLSI field.			
CO2:	Students will learn to create test bench using the concept of procedural statements and routines			
CO3:	Apply concepts of OOP and randomization in writing test bench with system Verilog.			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				

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, 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.

Suggested Books:

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

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC235	**VLSI Design and Verification Lab**	**0-0-2**	**1**	**Digital VLSI Design**
Course Outcomes (CO):**				
CO1:	Students will get practical experience of writing test bench for digital circuits in system Verilog.			
CO2:	Students will get skills of writing test bench using procedural statements, routines and OOP to verify a VLSI chip.			
CO3:	Design test bench blocks by applying randomization method using EDA tools.			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				

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 Fibonacci 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.

Suggested Books:

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

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC236	**Wearable technology and reality**	**(4-0-0)**	**4**	**NIL**
Course Outcomes (CO)*:				
CO1:	To identify products where smart textiles can be applied.			
CO2:	To identify different mechanisms for energy harvesting and transmission			
CO3:	To outline the human body applications designed using wearable sensors.			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				

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.

Suggested books:

- "Wearable Sensors" Fundamentals, Implementation and Applications, Edited by Edward Sazonov and Michael R. Neuman.
- "Wearable Electronics Sensors for Safe and Healthy Living" Edited by Subhas Chandra Mukhopadhyay.

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC237	**Sensor & Communication Protocol**	**(0-0-8)**	**4**	**NIL**
Course Outcomes (CO)*:				
CO1:	Understand fundamental concepts of sensor technology.			
CO2:	Understand networking techniques for data communication in IoT enabled devices and system.			
CO3:	Comprehend different communication technologies for efficient connectivity in IoT devices.			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				

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, WiFi, LoRaWAN, 6LoWPAN, Near Field Communication (NFC).

Suggested Books:

- 'Sensors and Transducers' by D. Patranabis, PHI Learning Private Limited.
- 'Introduction to Data Communications and Networking' by B. Forouzan, Tata McGraw Hill, Fourth Edition, 2004.
- 'Introduction to Networks Companion Guide', by Cisco Networking Academy.

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC239	**Advance Wireless Communication**	**0-0-8**	**4**	**NIL**
Course Outcomes (CO):**				
CO1:	The students would be able to demonstrate knowledge and understanding on existing digital cellular systems and standards across the world.			
CO2:	The students would have an ability to recognize the need of 3G/4G cellular networks and evolve its architecture.			
CO3:	The students would possess the capability for evolving technological path for higher user performance in cell phone technology			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				

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.

Suggested books:

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

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC241	**Cloud computing for IoT**	**4-0-0**	**4**	**NIL**
Course Outcomes (CO)*:				
CO1:	Deploy the sensor and user data in the Cloud for different types of applications.			
CO2:	To apply the analytics in the Cloud to extract information.			
CO3:	To interpret the security protocols used in IoT application development.			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				

Cloud computing models and services, Creation of virtual machine and docker containers, cloud architectures and resource management, Mobile cloud and inter-cloud mashup services. Case studies on Building predictive analytics for IoT. Introducing Machine learning services, making your sensor speak, making image and video analysis, build a simple predictive analytics for your IoT project, Introducing IoT security, understanding IoT risks, secure communication between IoT cloud and IoT device, authentication and authorization.

Suggested Books:

- Learning AWS IoT, by Agus Kurniawan, Packt publishing, 2018
- Big Data Analytics for cloud, IoT and Cognitive Learning, by Kai Hwang and Min Chen, Wiely publishers, 2017.

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC242	**Nano-Electronics**	**4-0-0**	**4**	**Analog Electronics**
Course Outcomes (CO):**				
CO1:	The students would possess an ability to apply the in-depth knowledge of electronic device fabrication techniques			
CO2:	The students would be able to demonstrate technical skills to adopt academic and research-oriented career.			
CO3:	The students would possess an ability to Interact scientifically with researchers in R&D deptt of semiconductor industry for professional development			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				

Introduction to nanotechnology, MESO structures, Basics of Quantum Mechanics: Schrodinger equation, Density of States. Particle in a box Concepts, Degeneracy. Band Theory of Solids. Kronig-Penny Model. Brillouin Zones. Shrink-down approaches: Introduction, CMOS Scaling, The nanoscale MOSFET, Finfets, Vertical MOSFETs, limits to scaling, system integration limits (interconnect issues etc.), Resonant Tunnelling Diode, Coulomb dots, Quantum blockade, Single electron transistors, Carbon nanotube electronics, Band structure and transport, devices, applications, 2D semiconductors and electronic devices, Graphene, atomistic simulation.

Suggested Books:

- G.W. Hanson, Fundamentals of Nano-electronics, Pearson, 2009.
- W. Ranier, Nanoelectronics and Information Technology (Advanced Electronic Material and Novel Devices), Wiley-VCH, 2003.
- K.E. Drexler, Nanosystems, Wiley, 1992.
- J.H. Davies, The Physics of Low-Dimensional Semiconductors, Cambridge University Press, 1998.
- C.P. Poole, F. J. Owens, Introduction to Nanotechnology, Wiley, 2003.

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC243	**Wireless Sensor Networks**	**4-0-0**	**4**	**NIL**
Course Outcomes (CO):**				
CO1:	The students would be able to formulate network architecture and operating environment			
CO2:	They would possess an ability to design solutions for wireless transmission technology and protocols			
CO3:	The students would possess in-depth knowledge about optimization techniques for efficient operation in modern applications including healthcare			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				

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.

Suggested Books:

- Wireless Sensor networks: Technology, Protocols & Applications' by KazemSohraby, Daniel Minoli, TaiebZnati, Wiley India Pvt Ltd.
- 'Protocols & Architectures for Wireless Sensor Networks' by Holger Karl & Andreas Willig, John Wiley,2005

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC244	**IC fabrication and Technology**	**4-0-0**	**4**	**Microelectronics**
Course Outcomes (CO):**				
CO1:	Understand the fabrication technology of IC Technology.			
CO2:	To understand and analyze operation of MOS Transistor.			
CO3:	To learn the basic MOS technology to design physical process of VLSI Design flow.			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				

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. Vapor 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 equipments. 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.

Suggested Books:

- S.M.Sze, "VLSI Technology (2nd edition)" , McGraw Hill, 1988
- S. M. Sze, Semiconductor Devices – Physics and Technology, 2nd Edition, Wiley, 2010
- Donald A. Neamen 'Semiconductor Physics and Devices' McGraw-Hill.

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC262	**Machine Learning**	**3-1-0**	**4**	**NIL**
Course Outcomes (CO):**				
CO1:	Understand and implement classical models and algorithms in machine learning as well as python programming concepts			
CO2:	Analyze the data, identify the problems			
CO3:	Choose the relevant models and algorithms to turn available data into valuable and useful Information			
CO4:	Expose students to new techniques and ideas that can be used to improve the effectiveness of current AI tools			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				

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.

Suggested Books

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

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC248	**Data Extraction and Visualization**	**0-0-8**	**4**	**NIL**
Course Outcomes (CO):**				
CO1:	After the completion of this course students will possess knowledge regarding general concepts of data mining along with basic methodologies and applications.			
CO2:	Students will be able to understand how to analyze and display data using Tableau.			
CO3:	Students will be able to understand how the Level of Detail (LOD) expressions are used to run complex queries.			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				

SQL MODULE:Introduction to SQL: Table Basics, Types of SQL Language, Selecting Data, Select Clause, Group By, Having Clause, Order By, Creating Tables, DDL Commands: Implementing DDL commands (CREATE, ALTER, DROP, RENAME), DML Commands: DML commands (DELETE, INSERT, SELECT(Logical, Relational, like and arithmetic), UPDATE), Functions: Single-Row Functions, Group Functions, Clause: Implementing group functions (having, group by, order by), Data Manipulation: Inserting into a table, Updating Records, Deleting Records, Manipulation, Combining Conditions & Boolean Operators, In and Between, Mathematical Functions, Table Joins**. TABLEAU MODULE: Introducing** Tableau 10.0,Purpose and Advantages over other existing tools, Data Visualization, Download and Install Tableau, Managing Files in Tableau: Tableau Product Family, Environment Setup, connecting to data, file types, Import different file formats in Tableau, Tableau Toolbars: Tableau Toolbar Button Reference, Optimization of data access and its security, Field Types: Dimensions and Measures, Blue and Green, Data Types in Tableau, creating your first report, Data Granularity using marks card, Field Types: Dimensions and Measures, Blue and Green, Data Types in Tableau, creating your first report, Data Granularity using marks card, Graphical Visualization and Mata Data: Tableau Area Chart, Joins and Union, Data blending, Managing Metadata, Visual Analytics, Groups and Sets: Highlighters, Intro to graphs, Sorting, Filtering and Grouping, simplifying large number of dimensions using groups, Sets, Conditional Sets for dynamic representations, Data Trends Prediction: Forecasting Clustering, Trend Lines, Reference Lines, Parameters, Built in functions in Tableau, Calculated Fields: Table Calculations, moving averages / running total / relative percentages, LOD Expressions: LOD (level of detail) expression, Complex Queries involving multiple dimensions, adding dimensions to an already created aggregate value, Dashboard and Case Studies: Case studies, creating a dashboard layout, Designing dashboard for devices, Background image.

Suggested Books

- Tableau Your Data!: Fast and Easy Visual Analysis with Tableau Software.
- Introduction to PL/SQL by Ivan Bayross, BPB Publication , Third Edition.

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC249	**IoT Application Development**	**0-0-8**	**4**	**NIL**
Course Outcomes (CO)*:				
CO1:	Implement various application development techniques used for designing IoT enabled devices.			
CO2:	Utilize Cloud based services for IoT devices			
CO3:	Apply data analysis techniques for cloud computing applications.			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				
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. **Suggested Books:** • Internet of Things: A Hands-on-approach, by ArshdeepBagha and Vijay Madisetti, Orient Blackswan publisher, 2015. • Learning AWS IoT, by Agus Kurniawan, Packt publishing, 2018.				

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC250	**Web Development for IoT**	**(0-0-8)**	**4**	**NIL**
Course Outcomes (CO)*:				
CO1:	The student would be design dynamic web forms for acquiring and processing the user and sensor data.			
CO2:	The student would be able to interpret the IoT architecture and building blocks of various domains			
CO3:	To design Interactive forms using Java script with a focus on Internet of Things.			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				
A Complicated Ecosystem, Definitions and History, The Client-Server Model, Working in Web Development, Internet Protocols, Domain Name System, Uniform Resource Locators Hypertext Transfer Protocol, Web Browsers, Web Servers. A Very Brief History of HTML, HTML Syntax, Semantic Markup, Structure of HTML Documents, Quick Tour of HTML, HTML5 Semantic Structure Elements, Introduction to CSS, CSS Syntax, Location of Styles, Selectors, The Cascade: How Styles Interact, The Box Model, CSS Text Styling. HTML Tables and Forms, Introducing Tables, Styling tables, Introducing Forms, Form Control Elements, Table and Form Accessibility Micro formats, Digital Representation of Images, Color Models, Image Concepts, File Formats, Audio and Video. JavaScript Design Principles, Where Does JavaScript Go?, Variables and Data Types, JavaScript Output, Conditionals, Arrays, Objects, Functions, Object Prototypes, The Document Object Model				

(DOM), Modifying the DOM, Events, Event Types Forms, Extending JavaScript with jQuery, jQuery Foundations, Event Handling in jQuery, DOM Manipulation, Effects and Animations, AJAX, Asynchronous File Transmissions. What is a Server-Side Development? A Web Server's Responsibilities, Quick Tour PHP, Program Control, Functions, PHP Arrays and Superglobal, Arrays, $_GET and $_POST Superglobal Variables, $_SERVER Array, $_FILES Array, Reading/Writing Files, PHP Classes and Objects, Object-Oriented Overview, Classes and Objects in PHP, Object-Oriented Design. Databases and Web Development, SQL, NoSQL, Database APIs, managing an MYSQL Database, Accessing MySQL in PHP, Case Study Schemas, Sample Database Recipes, Web Application Design, Real-World Web Software Design, Principle of Layering, Software Design Patterns in the Web Context, Data and Domain Patterns, Presentation Patterns.

Suggested Books:

- Fundamentals of web development, Randy Connolly, Ricardo Hoar, Pearson publications
- 'Web Enabled Commercial Application Development Using HTML, JavaScript, DHTML and PHP' by IvanBayross, 4th Edition, BPB Publications.
- 'The Complete Reference HTML & XHTML' by Thomas Powell, 4th Edition, Tata McGraw-Hill Company Limited.

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC258	**Core JAVA**	**0-0-8**	**4**	**Object Oriented Programming using C++**
Course Outcomes (CO):**				
CO1:	Implement the concept of object-oriented techniques and methodologies using Java			
CO2:	Use Exception Handling concepts for a Robust Application in Java.			
CO3:	Demonstrate an understanding of Java Input and Output.			
CO4:	Develop applications using multithreading concept of Java.			
CO5:	Use and Implement several Data structures using Collection Framework			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				
Introduction to Object Oriented Programming: Benefits and application of OOP, basic concepts and characteristics of OOP, abstraction, data hiding, static and dynamic binding, encapsulation, inheritance and polymorphism, procedural programming vs object-oriented programming. Objects and Classes: Basics of objects and classes, structure of a class, definition of class members, member variable and member function, role of constructors and methods in class, define an object. Introduction to Java: Java introduction, history and goals of Java, fundamentals of Java, overview of JDK, JVM, garbage collection. Java Basics: identifiers, keywords, Java data types & operators. Control Statements: decision constructs, using loop constructs, command line arguments. Working with Arrays: creating and using arrays (1-D, 2-D and multi-dimensional arrays), jagged arrays. Access Control Modifiers:				

access control, method overloading, constructors, constructor overloading, use of this and static. Inheritance: working with inheritance, inheritance basics & types, using super, method overriding, dynamic method dispatch, final keyword. Abstract Methods & Classes, Packages & Interfaces: built-in packages and user defined packages, interfaces: declaration, implementation, extending classes and interfaces. Strings, StringBuffer, StringBuilder & StringTokenizer: introduction, immutable string, methods of String class, StringBuffer class & StringBuilder class, toString method, StringTokenizer class. Exception Handling: exception handling fundamentals, exception types, try and catch, multiple catch clauses, nested try, throw, throws and finally, creating custom exception. Multithreading: Java thread model, main thread, creating thread by implementing runnable and extending thread class, creating multiple threads, using isAlive() and join(), thread priorities, synchronization. Generics: introduction, generic example, generic class, generic method, generic constructor and generic interfaces. Collections Framework: introduction, collection interfaces, list, queue, set (Overview), Collection classes, ArrayList, LinkedList, Iterator, working with maps (Overview), comparable & comparator, arrays, vector, stack. IO Streams: stream classes, byte streams, character streams, stream tokenizer. JDBC Connectivity: introduction, architecture, establishing JDBC database connection.

Suggested Books

- Head First Java, O'Reilly Publication
- OCA Java SE 8 Programmer I Study Guide (Exam 1Z0-808) (Oracle Press) by Edward G. Finegan, Robert Liguori.
- OCA/OCP Java SE 7 Programmer I & II Study Guide (Exams 1Z0-803 & 1Z0-804) by Kathy Sierra

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC259	**Data Analytics**	**0-0-8**	**4**	**NIL**
Course Outcomes (CO):**				
CO1:	Apply knowledge of dispersion on grouped and ungrouped data cases.			
CO2:	Evaluate discrete and continuous probability distributions to various business problems.			
CO3:	Perform Test of Hypothesis as well as calculate confidence interval for a population parameter.			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				

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

Suggested Books

- Microsoft Business Intelligence Tools for Excel Analysts (WILEY)

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC260	**Business Statistics**	**0-0-8**	**4**	**NIL**
Course Outcomes (CO):**				
CO1:	After completing this course, the students will be able to understand and apply the basic concepts of statistical analysis			
CO2:	Students will be able to understand and apply the concepts of hypothesis testing			
CO3:	Implement the design of experiments like random block design and completely randomized design			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				

Introduction to Data Analysis Using Excel: Introduction to spread sheets Introduction to spreadsheets, reading data, manipulating data. Basic spreadsheet operations and functions. Spreadsheet Functions to Organize Data: Introduction to some more useful functions such as the IF, nested IF, VLOOKUP and HLOOKUP functions in Excel. Introduction to Filtering, Pivot Tables, and Charts: Introduction to the Data filtering capabilities of Excel, Construction of Pivot Tables to organize data, Introduction to charts in Excel. Advanced Graphing and Charting: Constructing various Line, Bar and Pie charts. Using the Pivot chart features of Excel, Basic Data Descriptors, Statistical Distributions, and Application to Business Decisions: Basic Data Descriptors, Statistical Distributions, Box Plot and Standard Deviation Descriptive Measures of Association, Probability, and Statistical Distributions. The Normal Distribution, Probability density function and area under curve. Working with Distributions (Normal, Binomial, Poisson), Population and Sample Data. Business Applications of Hypothesis Testing and Confidence Interval Estimation: Introduction Confidence Interval, t-distribution, Application of Confidence Interval: Confidence Interval for a Population Proportion, Sample Size Calculation. The Logic of Hypothesis Testing, conducting a Hypothesis Test, the Four Steps, Single Tail and Two Tail Hypothesis Tests, Guidelines, Formulas and an Application of Hypothesis Test. Type I and Type II Errors in a Hypothesis Test. Hypothesis Test - Differences in Mean: Introducing the Difference-In-Means Hypothesis Test Application: Difference-In-Means Hypothesis Test, Equal & Unequal Variance Assumption. The Paired t-Test for Means

Suggested Books

- Dowdy, S., Wearden, S. and Chilko, D., Statistics for Research, Wiley series (2004). 2nd ed.
- Walpole, R.E., Myers, R.H., Myers, S.L. and Ye, K., Probability and Statistics for Engineers and Scientists, Dorling Kindersley (2007). 7th ed.

- Jhonson, R.A, Gupta C. B., Miller and Freund's Probability and Statistics for Engineers, Dorling Kindersley (2007). 7th ed.
- Meyer, P.L. Introductory Probability and Statistical Applications, Addison Wesley (1970).
- Medhi, J., Stochastic Processes, New Age International, 2005.
- Goon, Gupta, Das, Gupta, Fundamental of Statistics, Vol II, Wold Press, 1999.

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC261	**Introduction to Web Technologies (client side)**	**0-0-8**	**4**	**NIL**
Course Outcomes (CO):**				
CO1:	Identify the basis of designing a Web site; create Web pages, links, images, tables and pages layouts in HTML			
CO2:	Describe and identify the use of JavaScript and successfully place it into Web pages and also recognize the uses of JavaScript			
CO3:	Use JavaScript to manipulate elements in the DOM to change appearance and visibility			
CO4:	Describe how intended website design features will specifically benefit a target user group content strategy			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				

Web programming and HTML5: Introduction to web programming, client server architecture, DNS, latest trends, static and dynamic content, WWW3C standards, difference between HTML & HTML5, Basics of HTML5, understanding document tags, HTML5 formatting: Formatting tags e.g. font, Bold, italic, super script, subscript, delete, mark etc., HTML5 Quotations: q tag, blockquote, Code, abbreviation, address, cite, bi-directional override tag, header, footer and output Tag, meta data and meta tag, Lists: Ordered, Unordered, Definition List, Introduction to LINK: anchor element, internal linking and external linking, attribute of anchor tag, Images: image basics, image tag, Image alignment, image map and all the attributes of image and map, Table: Table tag with attributes like width, alignment, cell spacing, cell padding, cell alignment, borders rules , rows, cells, rowspan, colspan, header, footer, body sections, captions and background images, HTML Frames: Introduction to frameset tag, frame tag, iframes and respective attributes, Form: Creating form, add labels, text box, check box, radio buttons, password, pull down menus and button to a form , Use of clickable image as a submit button, pass information between forms (action ,method), DHTML and CSS: Introduction to DHTML, introduction to CSS3, ways to Insert CSS in HTML document (External Style Sheet, Internal Style Sheet, Inline Styles), CSS id and class, div and span tag, CSS background: background color, background image (repeat horizontally or vertically, set position and no-repeat), CSS Text: text color, text alignment, text decoration, CSS Font: style, family, Size, CSS lists, CSS Links, CSS Tables: Table borders, collapse borders, table width and height ,table text alignment, table padding, table color, CSS border: style, width, color, CSS margin: margin, padding, JavaScript: History of JavaScript, Different Implementations, Determining the Document

Object Model, Uses for JavaScript, Incorporating JavaScript in HTML documents, Basic JavaScript Syntax, Data Types and Variables, Calculations and Operators, Control Structures: Do While, While, For and For In, If Else, Switch, Break and Continue; Labels, built-in functions, user-defined functions, accessing an element by its id. Writing text to a document, Dialogue box, Event Handling: onblur, onchange, ondbclick, onclick, onfocus, onkeydown, onkeyup, onkeypress, onload, onunload, onmouseover, onmouseout, onmousedown, onmouseup, onmousemove, onreset, onselect, onsubmit, JavaScript Errors and Troubleshooting, Document Object Model: History of the DOM, Understanding the Document Object Model, DOM Node Properties: childnodes, firstnode, lastnode, nodename, nodetype, nodevalue, parent node, DOM node Methods: appendchild() and remove child(), createnode(), text type node creation, node removal, traversing document's Node, JavaScript Objects: name, maths, string ,date, array, Form Validation: Data validation and constraint validation in HTML forms

Suggested Books

- 'Web Enabled Commercial Application Development using HTML, JavaScript, DHTML and PHP' by Ivan Bayross, 4th Edition, BPB Publications.
- 'The Complete Reference HTML & XHTML' by Thomas Powell, 4th Edition, Tata McGraw-Hill Company Limited.
- 'HTML 4.0' by E. Stephen Mack, Janan Platt, Anaya Multimedia publication.
- 'Mastering HTML, CSS & JAVA Script Web Publishing' by Laura Lemay, Rafe Coburn, Jennifer Kyrnin, 7th edition, SAMS publication.
- 'Learning web designing: a beginner's guide to HTML, CSS, JavaScript, and Web graphics' by Niederst Robbins, 4th Edition, Oreilly Publication.
- HTML5 Black Book : Covers Css3 JavaScript Xml Xhtml Ajax Php And Jquery by Kogent Learning Solutions Inc.

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC263	**Advanced Machine Learning**	**4-0-0**	**4**	**NIL**
Course Outcomes (CO):**				
CO1:	Possess knowledge regarding basic components of intelligent systems.			
CO2:	Develop an ability to design a Neural Network model for a given problem			
CO3:	Knowledge regarding components of convolutional neural network for the task of object recognition, computer vision and Natural Language processing			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				

Introduction: Building intelligent machines, limits of traditional computer programs. Neural Network: The neuron, linear perceptrons as neurons, Artificial Neural Network, feed forward NN, activation function, softmax output layer. Training Feed Forward Neural Network: Gradient descent algorithm, delta rule and learning rates, Backpropagation algorithm, relationship between forward and backward propagation stochastic gradient descent. Convolutional NN: convolution layer, Max layer, full architecture of CNN. Applications of Deep Learning: Object recognition, sparse coding, computer vision, natural language processing.

Suggested Books

- "Fundamentals of deep learning: Designing next-generation machine intelligence algorithm", 1st edition by Nikhil Buduma, Nicholas Locascio, O' Reilly Media Inc.
- " Grokking Deep Learning" , 1st edition by Andrew W. Trask, Manning Publication Co.

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC264	**Big Data Analytics with Ecosystem**	**4-0-0**	**4**	**NIL**
Course Outcomes (CO):**				
CO1:	Develop concepts about what insights big data can provide through basic understanding of the tools and systems used by big data scientists and engineers.			
CO2:	Understand the basics of using Hadoop with Map Reduce and how to perform predictive modeling and leverage graph analytics to model problems.			
CO3:	Master the concepts of HDFS (Hadoop Distributed File System), YARN (Yet Another Resource Negotiator), & understand how to work with Hadoop storage & resource management			
CO4:	Develop an ability to ask right questions about data, communicate effectively with data scientists, and do basic exploration of large, complex datasets.			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				

Introduction to big data: Introduction, distributed file system, Big Data and its importance, Drivers, Big data analytics, Big data applications. Algorithms, Matrix-Vector, Multiplication by Map Reduce. Introduction to HADOOP: Big Data, Apache Hadoop & Hadoop Ecosystem, MapReduce, Data Serialization. HADOOP Architecture: Architecture, Storage, Task trackers, Hadoop HADOOP ecosystem and yarn: Hadoop ecosystem components, Hadoop 2.0 New Features NameNode High Availability, HDFS Federation, MRv2, YARN, Running MRv1 in YARN.

Suggested Books

- Big Data Analytics (Set of 4 books) Authors: Manoochehri ,Murthy, Lander, Bradberry Publisher:- TMH
- Hadoop: The Definitive Guide, 4th Edition BY Tom White Publisher:- TMH
- Big Data Fundamentals Authors: Thomas Erl, Wajid Khattak, Paul Buhler Publisher : Pearson

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC266	**Cloud Computing & Virtualization**	**4-0-0**	**4**	**NIL**
Course Outcomes (CO):**				
CO1:	Articulate the main concepts, key technologies, strengths, and limitations of Cloud computing and the possible applications for state-of-the-art Cloud computing			
CO2:	Identify the architecture and infrastructure of Cloud computing, including			

	SaaS, PaaS, IaaS, public Cloud, private Cloud, hybrid Cloud, etc.
CO3:	Identify problems, explain, analyze, and evaluate various cloud computing solutions.
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A	

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 and 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. Fault Tolerance Mechanisms. Security: Vulnerability Issues and Security Threats, Application-level Security, Data level Security, and Virtual Machine Level Security, Infrastructure Security, and Multi-Tenancy Issues. IDS: host-based and network-based, 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.

Suggested Books

- Mastering Cloud Computing, Foundations and Applications Programming by Rajkumar Buyya (The University of Melbourne and Manjrasoft Pty Ltd, Australia), Christian Vecchiola (The University of Melbourne and IBM Research, Australia), S. ThamaraiSelvi (Madras Institute of Technology, Anna University, Chennai, India).
- Cloud Computing: A Practical Approach by Anthony T. Velte Toby J. Velte, Ph.D. Robert Elsenpeter.
- Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance, Tim Mather, Subra Kumaraswamy, Shahed Latif, O'Reilly.

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC267	**Advanced Web Technologies (Server Side)**	**0-0-8**	**4**	**Introduction to Web Technologies**
Course Outcomes (CO):**				
CO1:	Manipulate elements on a webpage and responding to user interactions			
CO2:	Develop web, desktop, and mobile applications			
CO3:	Use Angular JS to develop cross-platform applications			

*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A
Introduction to Server Side Programming, Additional PHP, Database Concepts and Relational Database Design, PHP Database Access, Database Modification, PHP Wrap-up and Midterm, Java Servlets, Java Server Pages (JSPs), Consuming Web Services, Java Database Access (JDBC), Object-relational Mapping (JPA). **Suggested Books** • 'Web Enabled Commercial Application Development using HTML, JavaScript, DHTML and PHP' by Ivan Bayross, 4th Edition, BPB Publications. • 'The Complete Reference HTML & XHTML' by Thomas Powell, 4th Edition, Tata McGraw-Hill Company Limited. • 'HTML 4.0' by E. Stephen Mack, Janan Platt, Anaya Multimedia publication. • 'Mastering HTML, CSS & JAVA Script Web Publishing' by Laura Lemay, Rafe Coburn, Jennifer Kyrnin, 7th edition, SAMS publication. • 'Learning web designing: a beginner's guide to HTML, CSS, JavaScript, and Web graphics' by Niederst Robbins, 4th Edition, Oreilly Publication. • HTML5 Black Book : Covers Css3 Javascript Xml Xhtml Ajax Php And Jquery by Kogent Learning Solutions Inc.

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC268	**Android Application Development**	**0-0-8**	**4**	**Core Java**
Course Outcomes (CO):**				
CO1:	Understand the basics of Android platform and the lifecycle of an application.			
CO2:	Design simple GUI applications using built-in widgets and components, and work with the database to store data locally.			
CO3:	Design and build an original Android from concept to working program and publish an application to the Android Market.			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				
Android Studio Installation, Install JDK, Install Android Studio (Windows), Android Studio Tour, Android Emulator, AVD in Android Studio ,Hardware Device, Hello World Tutorial ,Creating my first APP, Android Overview, Android Basic Blocks, Basic UI Elements, Strings.xml & message localization, Resources and Asset Files, Gradle Dependencies, Android Broadcast Intent and Broadcast Receiver, Debugging, Working with my App, Persisting Application State, Debug Logcat Errors , Introduction, Recyclerview, Adapter &ViewHolder, Fragments, Material Design Elements, Navigation ,Testing with Espresso ,Working with my App, Adding Views Dynamically, Building Layouts for screen configuration changes, Working with Custom Styles & Themes, Android Hierarchical Navigation ,Webview, Custom Views, Permission system, AsyncTask, Threading and Handlers, Using AsyncTask vs. Java Threads (with Handlers), Loaders, AsyncTaskLoader&CursorLoader, Background Services, Android Scheduling task, Working with my App, Access Files in Assets, Access Resources, Save Data and				

Files, SQLite Databases, Content Providers, Loaders, Background Services, Widgets, Notifications, Getting Ready for Deployment, Publish on Play Store.

Suggested Books:

- Mark L Murphy, "Beginning Android", Wiley India Pvt Ltd.
- Android Application Development All in one for Dummies by Barry Burd, Edition: I
- Mobile Apps for Android (IBM ICE)

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC269	**Artificial Intelligence & expert system**	**4-0-0**	**4**	**NIL**

Course Outcomes (CO):**

CO1:	Learning the basic concepts of Artificial Intelligence.
CO2:	Represent Knowledge using propositional calculus and predicate calculus.
CO3:	Use inference rules to produce predicate calculus expression.
CO4:	Demonstrate awareness of informed search and uninformed search techniques.
CO5:	Explain about AI techniques for planning, knowledge representation and management.

*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A

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.

Suggested Books:

- Artificial Intelligence: A modern approach by Stuart Russel, Pearson Education,

2010.
- Artificial Intelligence by Rich and Knight, TMH, 2003.
- Artificial Intelligence: A new synthesis by Nils and Nilson, Elsevier, 1997.
- Artificial Intelligence by Luger, Pearson Education, 2008.
- Artificial Intelligence by Padhy, Oxford Press, 2005.

12.5 Open Elective Courses

S. No.	Course Code	Name of the Course	Credits
1	EC270	Computer Networks	4
2	EC271	Object Oriented Software Engineering	4
3	EC272	Advanced Programming Concepts	4
4	EC273	Computer system Architecture	4
5	EC227	Probability Theory and Random Processes	4
6	GI101	Numerical Ability & logical reasoning	4
7	CL601	Life skills	4
8	EC252	Scientific computing	4
9	EC274	Business Intelligence and data warehousing	4
10	EC228	Project Management	4
11	EC275	Essentials of Information Technology	4

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC270	**Computer Networks**	**0-0-8**	**4**	**NIL**
Course Outcomes (CO):**				
CO1:	Understand the small networks by following the top-down approach from application to physical layer.			
CO2:	Acquire theoretical knowledge about the different network technologies			
CO3:	Understand the functioning of different layers in OSI model and TCP/IP .			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				
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.

Suggested Books:

- **'**Introduction to Data Communications and Networking' by B. Forouzan, Tata McGraw Hill, Fourth Edition, 2004
- 'Computer Networks' by Andrew S. Tanenbaum, Pearson Education, Fourth Edition.

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC271	**Object Oriented Software Engineering**	**0-0-8**	**4**	**OOP using C++**
Course Outcomes (CO):**				
CO1:	Acquire strong fundamental knowledge in science, mathematics, fundamentals of computer science, software engineering and multidisciplinary engineering to begin in practice as a software engineer.			
CO2:	Design applicable solutions in one or more application domains using software engineering approaches that integrate ethical, social, legal and economic concerns.			
CO3:	Deliver quality software products by possessing the leadership skills as an individual or contributing to the team development and demonstrating effective and modern working strategies by applying both communication and negotiation management skill.			
CO4:	Apply new software models, techniques and technologies to bring out innovative and novelistic solutions for the growth of the society in all aspects and evolving into their continuous professional development.			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				
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 Bottom-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.				

Suggested Books:

- R. G. Pressman – Software Engineering, TMH.
- Behforooz, Software Engineering Fundamentals,OUP.
- Ghezzi, Software Engineering, PHI.

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC272	**Advance Programming Concepts**	**0-0-8**	**4**	**Introduction to C Programming, OOP using C++,**
Course Outcomes (CO):**				
CO1:	Students will gain an in-depth knowledge about overall syntax and semantics of C/C++ programs			
CO2:	Students will be able to use an IDE to compile, load, save, and debug a C/C++ program			
CO3:	Students will develop technical thinking and problem solving ability to find an appropriate solution for a problem.			
CO4:	Students willl be able to demonstrate the ability to create test cases to determine that a solution produces expected outputs for given inputs			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				
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, inputting 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.

Suggested Books:

- 'Programming in C: A Practical Approach' by Ajay Mittal, 1st edition, Pearson Publication
- 'Computer concepts and C programming' by Vikas Gupta, 1st edition, Dreamtech press
- 'The C Programming Language' by Dennis Ritchie and Brian. W. Kernighan, 2nd edition, Prentice Hall

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC273	**Computer System Architecture**	**3-1-2**	**4**	**NIL**
Course Outcomes (CO):**				
CO1:	Ability to Understand Basic structure of computer			
CO2:	Ability to perform Computer's Arithmetic Operations			
CO3:	Ability to understand control unit operations			
CO4:	Ability to Design memory organization that uses different word size operations			
CO5:	Ability to understand concept of cache memory technique			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				

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.

Suggested Books:

- V.CarlHammacher, "Computer Organisation", Fifth Edition.
- A.S.Tanenbum, "Structured Computer Organisation" , PHI, Third edition
- Y.Chu, "Computer Organization and Microprogramming", II, Englewood Chiffs, N.J., Prentice Hall Edition
- M.M.Mano, "Computer System Architecture", Edition
- C.W.Gear, "Computer Organization and Programming", McGraw Hill, N.V. Edition.
- Hayes J.P, "Computer Architecture and Organization", PHI, Second edition.

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC227	**Probability Theory and Random Processes**	**3-0-0**	**3**	**NIL**
Course Outcomes (CO):**				
CO1:	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.			
CO2:	Gain advanced and integrated understanding of the fundamentals of and interrelationship between discrete and continuous random variables and between deterministic and stochastic processes.			
CO3:	Analyse the performance in terms of probabilities and distributions achieved by the determined solutions.			
CO4:	Acquire competence in applying statistical methods to solve basic problems in information and communication technology			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				
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, Ergodicity, Covariance Function and their Properties, Spectral Representation, Weiner- Kinchine Theorem, Linear operations, Gaussian Function, Poisson Processes, Low pass and Band-pass Noise Representation. **Suggested Books:** • Probability Theory and Random Processes, S. P. Eugene Xavier, S. Chand and Co. New Delhi, 1998 (2nd Edition). • Probability Theory and Random Signal Principles, Peebles, Tata McGrew Hill Publishers. • Signal Analysis, Papoulis, McGraw Hill N. Y., 1977. • Introduction to Random Signals and Noise, Davenport W. B. Jrs. and W. I. Root, McGraw Hill N.Y., 1954.				

Course Code	Course Name	L-T-P	Credits	Pre-requisite
GI101	**Numerical Ability and Logical Reasoning**	**0-0-8**	**4**	**NIL**
Course Outcomes (CO):**				
CO1:	Enhance the mental and Intellectual ability and critical thinking of the students.			
CO2:	Enhance the student's ability to use numerical data as a tool to make			

	reasonable decisions and solve problems.
CO3:	Interpret, analyze and draw logical conclusions based on numerical data presented in graphs and tables.
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A	

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 thth 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, SeriesCube 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

Suggested Books:

- Copyrighted issue of book by Rishi Gurukul is distributed among students.
- Donald Quantitative Aptitude & Verbal – Nonverbal Reasoning by R.S.Aggarwal, Quantum Cat by Arihant Publications.

Course Code	Course Name	L-T-P	Credits	Pre-requisite
CL601	**Life Skills**	**4-0-0**	**4**	**NIL**

Course Outcomes (CO):**	
CO1:	Choose appropriate phrases to construct sentences and expressions to communicate.
CO2:	Classify and interpret expressions and explain fluently.
CO3:	Draw comparison and exemplify simple and direct exchange of information. To understand phrases and vocabulary related to areas of personal relevance.
CO4:	Participate in conversations on topics that are familiar and demonstrate knowledge of personal interest or pertinent to everyday life.
CO5:	Handle effortlessly a conversation, discussion and make use of idiomatic expressions and colloquialism.
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A	
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. **Suggested 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**	**Pre-requisite**
EC252	**Scientific Computing**	**4-0-0**	**4**	**NIL**
Course Outcomes (CO):**				
CO1:	The students shall be able to exhibit the knowledge of the basic fundamentals of Scientific Computing and Quantum computing			
CO2:	Apply the different menthods used in computing like Wentzel-Kramer-Brillouin Method, Runge-Kutta method, Trapezoidal method to solve the computational problems.			
CO3:	Apply different equations and interpolations to solve the underlying problems in scientific computing			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				
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.

Suggested Books:

- Fundamentals of Scientific Computing by Bertil Gustafsson, Springer-Verlag Berlin Heidelberg, 2011
- Elements of Scientific Computing by Aslak Tveito Hans, Petter Langtangen, Bjorn Frederik, Nielsen Xing Cai, Springer, Berlin, Heidelberg, 2010.

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC274	**Business Intelligence and data warehousing**	**4-0-0**	**4**	**NIL**
Course Outcomes (CO):**				
CO1:	Understand the basic concepts of business intelligence and tools for data warehouse development.			
CO2:	Plan the implementation of a business intelligence system.			
CO3:	Organize big data sets into meaningful structures, incorporating data profiling and quality standards			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				

Data Warehouse Fundamentals: Introduction, OLTP Systems, Characteristics & Functions of Data Warehouses, Advantages and Applications of Data Warehouse, Top- Down and Bottom-Up Development Methodology, Tools for Data warehouse development, Data Warehouse Types. Planning and Requirements: Key Issues in Planning a Data Warehouse, Planning and Project Management in Data Warehouse Construction, Data Warehouse Project. Introduction to Business Intelligence as Analytical System, process of data warehousing to automate analytical processes.

Suggested Books:

- Microsoft Business Intelligence Tools for Excel Analysts (WILEY)
- Mastering the SAP Business Information Warehouse, Kevin McDonald, Wiley Publications

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC228	**Project Management**	**4-0-0**	**4**	**NIL**
Course Outcomes (CO):**				
CO1:	Develop, implement and evaluate various stages including planning, scheduling and Execution of projects.			
CO2:	Understand risk management, administration, costing and budgeting challenges during projects.			
CO3:	Identify project goals, constraints and performance criteria in project implementation			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				

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 Work-Identifying the Direct and Manage Project Execution Process, Execute a Quality Assurance Plan, Acquire the Project Team, Develop the Project Team, Manage the Project Team, 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.

Suggested Books:

- Project Management: A Systems Approach to Planning, Scheduling, and Controlling, 10th ed. , Harold Kerzner, PhD, ISBN-13: 978-0-470-27870.

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC275	**Essentials of Information Technology**	**4-0-0**	**4**	**NIL**
Course Outcomes (CO):**				
CO1:	Understand the concepts of Information Technology and its current and future developments			
CO2:	Understand the fundamental principles for the effective use of computer-based information systems			
CO3:	Get knowledge about the various applications of Information Technology.			

CO4:	Acquire knowledge about software development tools and relational databases
CO5:	Students will be able to work on Web, database, and graphical user interface (GUI) tools
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A	
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. **Suggested Books:** • R. Kelly Rainer , Casey G. Cegielski , Brad Prince, Introduction to Information Systems, Fifth Edition, Wiley Publication, 2014. • James F. Kurose, Computer Networking: A Top-Down Approach, Sixth Edition, Pearson, 2012.	

12.6 Mandatory Courses

S. No.	Course Code	Name of the Course	Credits
1.	HR101	Human Rights & Values	NC
2.	DM101	Disaster Management	NC
3.	ES101	Environmental Sciences	2
4.	GW	Global Week	NC
5.	CS501	Cyber Security	3

Course Code	Course Name	L-T-P	Credits	Pre-requisite
HR101	**Human Rights & Values**	**2-0-0**	**NC**	**NIL**
Course Outcomes (CO)*:				
CO1:	After completing the course students will be able to Identify constitutional or national values, social, professional, religious and aesthetic values.			
CO2:	Students will be able to link value education towards professional ethics.			
CO3:	Students will be able to understand about national issues and international cooperation.			
CO4:	Students will be able to follow personal development and creation of a positive personality.			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				
Concept of human values and value education Aim of education and value education; Concept of Human values; types of values; Components of value education. Personal development Self-analysis, gender equality, physically challenged, intellectually challenged. Respect to - age, experience, maturity, family members, neighbours, co-				

workers. Character formation towards positive personality Truthfulness, sacrifice, sincerity, self-control, Tolerance Value education towards national and global development national values - Democracy, socialism, secularism, equality, justice, liberty, freedom and fraternity Social Values - Pity, self-control, universal brotherhood. Professional Values - Knowledge thirst, sincerity in profession, ethics, regularity, punctuality and faith. Religious Values - Tolerance, wisdom, character. National Integration and international understanding, Impact of global development on ethics and values Modern Challenges of Adolescent Emotions and behaviour; Comparison and competition; positive and negative thoughts., Adolescent Emotions, arrogance, anger, selfishness, defiance. Therapeutic measures Control of the mind through physical exercise, meditation (Objectives, types, effect on body, mind and soul) and Yog-sadhna. Human rights – general Concept of Human Rights – Indian and International Perspectives; Evolution of Human Rights; Definitions under Indian and International documents Human rights Right to Life and Liberty Right to Equality Right against Exploitation Cultural and Educational Rights Economic Rights Political Rights Social Rights Human rights of women and children Social Practice and Constitutional Safeguards Female Foeticide and Infanticide Physical assault and harassment Domestic violence Conditions of Working Women Institutions for implementation Violation by State Violation by Individual Nuclear Weapons and terrorism Safeguards.

Suggested Book(s):

- Col KK Sharma, Human Value Education and Human Rights, Chitkara Business School, 2014.
- R. S. Naagarazan, Professional Ethics and Human Values, New Age Publishers, 2006.
- Grose, D. N, A text book of value education, Dominant Publishers and Distributors, 2005.

Course Code	Course Name	L-T-P	Credits	Pre-requisite
DM101	**Disaster Management**	**2-0-0**	**NC**	**NIL**
Course Outcomes (CO)*:				
CO1:	To increase the knowledge and understanding of the disaster phenomenon, its different contextual aspects, impacts and public health consequences.			
CO2:	To increase the knowledge and understanding of the International Strategy for Disaster Reduction (UN-ISDR) and to increase skills and abilities for implementing the Disaster Risk Reduction (DRR) Strategy.			
CO3:	To ensure skills and abilities to analyse potential effects of disasters and of the strategies and methods to deliver public health response to avert these effects.			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				
Disasters: Classification, Causes, Impacts: Introduction to Disasters: Concepts, and				

definitions (Disaster, Hazard, Vulnerability, Resilience, Risks). Impacts (including social, economic, political, environmental, health, psychosocial, etc. Differential impacts- in terms of caste, class, gender, age, location, disability). Classification of hazards/disasters and causes. Principles of disaster management: Approaches to Disaster Risk reduction: Disaster cycle - its analysis, Phases, Culture of safety, prevention, mitigation and preparedness, Community based DRR, Components of Disaster Relief: Water, Food, Sanitation, Shelter, and Health, Structural and non-structural measures. Hazard Profile (India), Disaster Risk Management in India: Hazard and Vulnerability profile of India. Institutional arrangements (Mitigation, Response and Preparedness, DM Act and Policy, Other related policies, plans, programmes and legislation), Role of Panchayati Raj Institutions/Urban Local Bodies (PRIs/ULBs), states, Centre, and other stake-holders. Disaster and Development: Inter-relationship between Disasters and Development: Factors affecting Vulnerabilities, impact of Development projects such as dams, embankments, changes in Land-use etc. urban disasters, Waste Management. Global trends in disasters & Adaptation: Global Trends, Complex emergencies, Pandemics Climate change and Adaptation, Relevance of indigenous knowledge, appropriate technology and local resources.

Suggested Books:

- Alexander, D. Natural Disasters, ULC press Ltd, London, 1993.
- Carter, W. N. Disaster Management: A Disaster Management Handbook, Asian Development Bank, Bangkok, 1991.
- Alexander David, Introduction in 'Confronting Catastrophe', Oxford University Press, 2000.
- Chakrabarty, U. K. Industrial Disaster Management and Emergency Response, Asian Books Pvt. Ltd., New Delhi 2007.

Course Code	Course Name	L-T-P	Credits	Pre-requisite
ES101	**Environmental Sciences**	**2-0-0**	**2**	**NIL**
Course Outcomes (CO)*:				
CO1:	To understand 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.			
CO2:	To identify and analyze environmental problems both natural (disasters such as floods and earthquakes) and man-made (industrial pollution and global warming).			
CO3:	Understand the societal and environmental impacts of energy and examine alternative solutions for meeting the growing energy needs			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				
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.

Suggested Books:

- Textbook of 'Environmental Studies for Undergraduate Courses' by ErachBharucha, First Edition, University Grants Commission, Universities Press (India) Private Limited.
- 'The Basics of Environmental Sciences' by Manish Randhawa, First edition, Chitkara University publications.

Course Code	Course Name	L-T-P	Credits	Pre-requisite
GW2001	**G-Visions**		**NC**	**NIL**
Course Outcomes (CO):**				
CO1:	Understand complex dimension of diversity, equity, and inclusion around the world, including language, culture and identity.			
CO2:	Synthesizes knowledge and meaning from multiple sources to enhance decision - making in diverse contexts.			
CO3:	Use technology, human and natural capital, information resources, and diverse ways to solve problems			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				
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.				

Course Code	Course Name	L-T-P	Credits	Pre-requisite
CS501	**Cyber Security**	**3-0-0**	**3**	**NIL**
Course Outcomes (CO)*:				
CO1:	Acquire Information and risk models including confidentiality, integrity and availability			
CO2:	Acquire knowledge on Threats and attacks and exploit vulnerabilities			
CO3:	Gain sufficient knowledge on Cyber security architecture and operations and acquire ability to handle the threats			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				
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.

Suggested Book(s):

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

12.7 Project Work

S. No.	Course Code	Name of the Course	Credits
1	AS101	Engineering Exploration	3
2	EC130	Integrated Project	2
3	EC131	Major Project	4
4	EC132	Seminar	1
5	EC133	Industry Oriented Hands on Experience (Six Month Industrial Training)	15
6	EC134	Co-op Project at Industry: Module I	15
7	EC136	Co-op Project at Industry: Module II	15

Course Code	Course Name	L-T-P	Credits	Pre-requisite
AS101	Engineering Exploration		**3**	**NIL**
Course Outcomes (CO):**				
CO1:	Identify community problems and engineering solutions to them.			
CO2:	Analyze a given problem using process of engineering problem analysis.			
CO3:	Build simple systems using engineering design process			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				
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.

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC130	Integrated Project		**2**	**NIL**
Course Outcomes (CO):**				
CO1:	Identify multi-disciplinary approach required in solving an engineering problem			
CO2:	Analyze a given problem using process of engineering problem analysis.			
CO3:	Build simple systems using engineering design process			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				
The Integrated Projects offered in fourth semester provides the opportunity to the students to apply their knowledge which they learned in first three semesters. Assessment is by means of evaluating seminar presentations, submission of synopsis and project report. 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. The emphasis is necessarily on facilitating student learning in technical, project management and presentation spheres. Electronics and Computer Engineering involves understanding, designing, controlling, and maintaining electronics equipment in addition to software testing and development. The latest projects are aimed to build 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.				

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC131	Major Project	**4-0-0**	**4**	**NIL**
Course Outcomes (CO):**				
CO1:	To apply multidisciplinary approach in solving engineering problems.			
CO2:	Undertake problem identification, formulation and solution.			
CO3:	Design prototype models for the problems solved through engineering design process.			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				
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 Computer Science Engineering involves understanding, designing, controlling, and maintaining electronics equipment. Some of the project areas of this 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 and computer science engineering and incorporate the technological skills that an Electronics Engineering student should possess to improve job prospects.

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC132	Seminar		**1**	**NIL**
Course Outcomes (CO):**				
CO1:	To provide a student with a thorough grounding in the basics of a subject;			
CO2:	To acquire in depth knowledge of a specialized topic where appropriate.			
CO3:	To acquire presentation and communication skills			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				

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 ability to review, prepare and present technological developments happening in the electronics industry and prepare to face placement interview. 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.

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC133	Industry Oriented Hands on Experience (Six Month Industrial Training)	**24 weeks**	**15**	**NIL**
Course Outcomes (CO):**				
CO1:	Understanding of the importance of sustainability and cost-effectiveness in design and developments of engineering solution.			

CO2:	Ability to identify, formulate and model problems and find engineering solution based on a systems approach.
CO3:	Capability and enthusiasm for self-improvement through continuous professional development and life-long learning
CO4:	Ability to communicate efficiently and effectively.
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A	
6 Months Training (IOHE) is essential for Electronics and Computer Science 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 electronics and computers industry in areas of software development as well as process, processing equipments, materials, testing and instruments.	

Course Code	**Course Name**	**L-T-P**	**Credits**	**Pre-requisite**
EC134	Co-op Project at Industry: Module I	**24 weeks**	**15**	**NIL**
Course Outcomes (CO):**				
CO1:	Understanding of the importance of sustainability and cost-effectiveness in design and developments of engineering solution.			
CO2:	Ability to identify, formulate and model problems and find engineering solution based on a systems approach.			
CO3:	Capability and enthusiasm for self-improvement through continuous professional development and life-long learning			
CO4:	Ability to communicate efficiently and effectively.			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				
CO-OP Training is essential for Electronics and Computer Science 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 and computers industry in areas of software development as well as process, processing equipments, materials, testing and instruments.				

Course Code	Course Name	L-T-P	Credits	Pre-requisite
EC136	Co-op Project at Industry: Module II	**24 weeks**	**15**	**NIL**
Course Outcomes (CO):**				
CO1:	Understanding of the importance of sustainability and cost-effectiveness in design and developments of engineering solution.			
CO2:	Ability to identify, formulate and model problems and find engineering solution based on a systems approach.			
CO3:	Capability and enthusiasm for self-improvement through continuous professional development and life-long learning			
CO4:	Ability to communicate efficiently and effectively.			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				
CO-OP Training is essential for Electronics and Computer Science 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 and computers industry in areas of software development as well as process, processing equipments, materials, testing and instruments.				

Course Code	Course Name	L-T-P	Credits	Pre-requisite
ER101	**CEED Acceleration Program(CAP) Cohort-II-Module I**	**0-0-4**	**3**	**NIL**
Course Outcomes (CO):**				
CO1:	Use confidence acquired in oral and visual presentation skills to sell their ideas.			
CO2:	Implement personal skills for sales and marketing and work under pressure.			
CO3:	Develop, implement and evaluate strategies for setting up a business idea.			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				
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	Pre-requisite
ER102	**CEED Acceleration Program(CAP) Cohort-II-Module II**	**0-0-4**	**2**	**NIL**
Course Outcomes (CO):**				
CO1:	Realize entrepreneurship as a career choice and identify resources to do business			
CO2:	Implement entrepreneurial skill to evaluate business idea and start that idea.			
CO3:	Conduct systematic analysis on the practical details before stating business idea.			
*The mapping of CO/PO attainment/Graduate Attributes are at Appendix-A				
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).				