Academic Programme Guide

of

Bachelor of Engineering
Electronics and Communication Engineering

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

CHITKARA UNIVERSITY
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1. General Information

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

1.1 Programme Educational Objectives (PEOs):

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

1.2 Programme Outcomes (POs):

The graduating students would be able to

PO1: Possess an ability to apply the knowledge of mathematics science, engineering fundamentals, and engineering specialization to the solution of complex engineering problems.
PO2: Possess an ability to identify, formulate, review research literature, and analyze complex engineering problems using first principles of mathematics, natural sciences, and engineering sciences.
PO3: Possess an ability to design solutions for complex engineering problems and design system components or processes to meet the specific needs with appropriate consideration of the public health and safety, the cultural, societal, and environmental sustainability.
PO4: Possess an ability to use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions
PO5: Possess an ability to create, elect, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

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

1.3 PEOs - Mission mapping

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

University Mission:

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

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

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

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

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

1.4 Programme Constitution:

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

1.5 Placement Opportunities:

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

2. Eligibility for Admission

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

3.Programme Duration

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

Table 1: Duration of the Programme

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

4.Pedagogical Aspects

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

5.Programme Structure

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

Special Courses

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

IOHE: IOHE is a real experience at the industry. This may or may not be in a specific skill set. Head 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 Head 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.

.

Table 2: Course Scheme

Year 1, Semester – 1

Code	Subject	L-T-P	Credit
AML5101	Engineering Mathematics I	5-0-0	5
ECL5101	Basics of Electronics Engineering.	3-1-0	4
ECP1101	Basics of Electronics Engineering Lab	0-0-2	1
MEL4102	Engineering Graphics	3-1-0	4
MEP1102	Engineering Graphics Lab	0-0-2	1
PYL5101	Engineering Physics	3-1-0	4
PYP1101	Engineering Physics Lab	0-0-2	1
HUL2101	Disaster Management	1-0-0	1
GEL4101	Environmental Science	4-0-0	4
	Total		25

Year 1, Semester – 2

Code	Subject	L-T-P	Credit
AML5102	Engineering Mathematics II	4-1-0	5
CS101	Introduction to C Programming	0-0-10	5
EEL4103	Basics of Electrical Engineering	3-1-0	4
EEP1103	Basics of Electrical Engineering .Lab	0-0-2	1
CHL4101	Engineering Chemistry	4-0-0	4
CHP1101	Engineering Chemistry Lab	0-0-2	1
MEW2101	Manufacturing Practice	0-0-4	2
ASE3101	Engineering Exploration	3-0-0	3
	Total		25

Year 2, Semester – 3

Course Code	Courses	L-T-P	Credits
ECL4207	Digital Electronics & Logic Design	3-1-0	4
ECP1207	Digital Electronics & Logic Design Lab	0-0-2	1
CS102	Object Oriented Programming using C++	0-0-10	5
HUL3301	Human Rights & Values	3-0-0	3
GEW2401	Engineering Economics Analysis	2-0-0	2
CSP3213	Introduction to Linux	3-0-0	3
CSL3203	Computer Networks	3-0-0	3
CSP2203	Computer Networks Lab	0-0-4	2
CSL4207	Operating system	3-1-0	4
	Total		27

Year 2, Semester – 4

Course Code	Courses	L-T-P	Credits
ECL4214	Analog Electronics	3-1-0	4
ECP1214	Analog Electronics Lab	0-0-2	1
ECL4208	Control Systems	3-1-0	4
ECP2203	Measurement & Virtual Instrumentation Lab	0-0-2	1
ECL4205	Network Analysis & Synthesis	3-1-0	4
ECL4212	Analog & Digital Communication	4-0-0	4
ECP1206	Analog & Digital Communication Lab	0-0-2	1
CS109	Core Java	4-1-0	5
HUL2401	Cyber security	2-0-0	2
	Total		26

Year 3, Semester – 5

Course Code	Courses	L-T-P	Credits
ECL4204	Signals & Systems	3-1-0	4
ECL4314	Linear Integrated Circuits	3-1-0	4
ECP1314	Linear Integrated Circuits Lab	0-0-2	1
ECL4315	Microprocessor & Microcontroller	3-1-0	4
ECL4303	Microelectronic Circuits	3-1-0	4
ECP2303	Microelectronic Circuits Lab	0-0-4	2
ECP1315	Microprocessor & Microcontroller Lab	0-0-2	1
ECL4316	Wireless & Mobile Communication	3-1-0	4
	Total		24

Year 3, Semester – 6

Course Code	Courses	L-T-P	Credits
	Department Elective-I	2-0-0	2
	Department Elective-II	3-0-0	3
ECL4317	Digital Signal Processing	3-1-0	4
ECP1305	Digital Signal Processing Lab	0-0-2	1
ECL4322	Electromagnetic Waves & Antenna	3-1-0	4
ECL4311	VLSI Design	3-1-4	6
ECP2313	VLSI Design Lab		
GTI4301	Numerical Ability & Logical reasoning	3-1-0	4
	Open Elective I/Lab	4-0-2	5
ECP3204	Integrated Project IV	0-0-2	2
	Total		31

Open Elective Courses

Course Code	Courses	L-T-P	Credits
CSA3211	Data Analytics	5-0-0	5
CSL5349	Essential Programming Concepts	4-1-0	5
CSL5210	Data Structures	4-0-2	5
CSP2210	Data Structures Lab		
CSL4318	Advanced Programming Concepts	4-1-0	5
CSL4320	Advanced Object Oriented Programming	4-1-0	5
CSP2332	Advance Networking Concepts	4-1-0	5

Department Elective I

Course Code	Courses	L-T-P	Credits
ECL4409	Audio and Speech Processing	2-0-0	2
CLP2305	Industry Interface	2-0-0	2
CLL3301	Life Skills-I	2-0-0	2

Department Elective II

Course Code	Courses	L-T-P	Credits
ECL4414	Analog Layout Design	3-0-0	3
ECL4413	Digital Design using FPGA	3-0-0	3
ECL3312	IOT and Embedded Systems	3-0-0	3
ECL3313	VLSI design and Verification	3-0-0	3
HUL3303	Project Management	3-0-0	3
HUL3302	Digital Marketing and Entrepreneurship	3-0-0	3

Integrated project

Course Code	Course Name	L-T-P	Credits
ECP3204	Integrated project	0-0-4	2
ECP3204-1	Integrated project in Analog Layout Design	0-0-4	2
ECP3204-2	Integrated project in Digital Design using FPGA	0-0-4	2
ECP3204-5	Integrated Project in IOT & Embedded	0-0-4	2
ECP3204-6	Integrated project in VLSI design and verification	0-0-4	2
ECP3204-3	Integrated project in Networking	0-0-4	2
ECP3204-4	Integrated project in Advance Wireless communication	0-0-4	2

Year 4, Semester – 7

Course Code	Course Name	L-T-P	Credits
	Department Elective III	3-0-0	3
	Department Elective IV	3-0-0	3
	Department Elective V	3-0-0	3
	Department Elective V Lab	0-0-2	1
ECL4401	Embedded System Design	3-1-0	4
ECP2401	Embedded System Design Lab	0-0-2	1
ECP6401	Major Project	0-0-8	4
	Total		19

Department Elective III

Course Code	Course Name	L-T-P	Credits
CSL3308	Artificial Intelligence and Expert System	3-0-0	3
ECL4407	Optical Communication	3-0-0	3
ECL4319	Information Theory and Coding	3-0-0	3

Department Elective IV

Course Code	Course Name	L-T-P	Credits
ECL4406	Mechatronics	0-0-6	3
ECP1406	Mechatronics Lab		
EC262	Machine Learning	3-0-0	3
ECL4411	Wireless Sensor Networks	3-0-0	3

Department Elective V

Course Code	Course Name	L-T-P	Credits
ECL4403	Microwave and Satellite Communication	3-0-0	3
ECP1403	Microwave and Satellite Communication Lab	0-0-2	1
ECL4404	Digital Image Processing	3-0-2	4
ECP1404	Digital Image Processing Lab		
ECL4412	Advance Wireless Communication	3-0-2	4
ECP1412	Advance Wireless Communication Lab		

For 1-year Internship

Course Code	Title of the Course	Credits
ECT9411	CO-OP Project At Industry: Module- I	22

Year 4, Semester – 8

For 1-year Internship

Course Code	Title of the Course	Credits
ECT9412	CO-OP Project At Industry: Module- II	22

For 6-months Training

Course Code	Title of the Course	Credits
ECT9401	Industry Oriented Hands On Experience	25

* The student have a choice to opt for department elective III (3 credits) and department elective IV (3 credits) or to choose entrepreneurial skill development /startup activity (6 credits).

Course Code	Course Name	L-T-P, Credits
ER101	CEED Acceleration Program(CAP) Cohort-II-Module I	(0-0-6), 3 credits
ER102	CEED Acceleration Program(CAP) Cohort-II-Module II	(0-0-6), 3 credits
GC	Generic Course Offered by the University	Max credits to be earned 6***

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

6. Assessment and Evaluation

The evaluation will be continuous and the weightage of various components are as given in Table 3 (For Theory courses) and in Table 4 (for Practical Courses), Table 5 (for Integrated Projects) and Table 6 (for Programming courses).

Table 3: 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 4: Evaluation Components for Practical Courses

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

Table 5: 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 6: 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 7:

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.

8. Grading System

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

a) Letter Grades

Table 7: 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 later 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.

b) Non-letter Grades: Audit Courses will be graded as Excellent, Good, Fair or Poor.

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

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

In case the grades are not received by the University as per the time schedule the, the Dean of department may make a specific authorization for the Course coordinator to report GA (Grade Awaited). The dean of department will also simultaneously advise Dean Examination about the

estimated time by which the grades will be received. Whenever the report GA appears in the grade sheet, permission for further registration of such a student will be decided by Dean of School.

The Cumulative Grade Point Average (CGPA) denotes the overall performance of a student in all courses in which he is awarded letter grades. It is the weighted average of the grade points of all the letter grades received by the student from the time of his entry into the University.

Calculation of CGPA:

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

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

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

Example to Understand the Calculation of SGPA

Suppose a student is registered in four courses 'W', 'X', 'Y' and 'Z' in a particular semester as mentioned below in the Column - I of the table. Column - II in the table 10 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 8: Number of credits and courses

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

Thus, the total GPA of the student would be =

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

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

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

9. Promotion and Registration

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

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

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

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

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

10. Migration/Credit Transfer Policy

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

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

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

11. Eligibility to Award the Degree

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

(i) Cleared all Courses prescribed for the program
(ii) Earned the minimum credits required for the program as described in the "APG"
(iii) Obtained the minimum CGPA 4.5 for the award of degree in the UG programs
(iv) Satisfied all requirements of these regulations.
The minimum credits to be earned are given in table 9

Table 9: Minimum credits to be earned for award of degree in BE

Course / Year	BE in Electronics and Communication Engineering
Year I	50
Year II	53
Year III	55
Year IV	44
Total	**202**

It is mandatory for the student to earn minimum 202 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 student can earn more credits if he avails opportunity offered by university in the form of Generic Courses*** (GC) that falls in category of extracurricular activities/NCC/NSS/vocational courses/sports etc.

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

(i) Satisfied all rules of evaluation
(ii) No case of indiscipline or unfair means is pending against him.

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

12. Programme Overview

This undergraduate program in Electronics and Communication Engineering prepares the students for the ever expanding field of Electronics and Communication Engineering. The curriculum is directed towards the major applications such as wireless communications, embedded systems and IoT, Robotics, and VLSI. We believe that, many creative opportunities exist at the boundaries of CSE and ECE, so accordingly we planned the cross-training schedule for the students across disciplinary boundaries. Initially in the curriculum of ECE there are many courses in common with the CSE program. Thereafter, the foundation program for the 3 & 4 year is structured into different verticals to allow customization by individual students based on their own personal perspectives

Year 1, Semester – 1

AML5101	Engineering Mathematics- I	(5-0-0), 5 Credits

Course Learning Outcomes (CLO):

CLO1: Define vector space, subspace, basis, dimension and spanning set of a vector space.

CLO2: Compute eigen values, eigenvectors, inverse and rank of matrices.

CLO3: Explain geometry of a complex plane and state properties of analytic functions.

CLO4: Skilled to calculate the Taylor and Laurent series of a function of complex variable about a given point.

Differentiation: Geometrical interpretation of derivative, Indefinite and definite (integration by substitution, by parts, by partial fraction), Reduction formulae sine and cosine (with limit 0 – $\pi/2$). Matrices: Review of matrices and determinants, Elementary operations, rank, Inverse of matrix(using rank), Normal form(using rank), Cayley Hamilton theorem(without proof), Solution of a system of linear equations by using rank, Characteristics equations, Eigen values and vectors. Partial Differentiation & its Applications: Introduction to Partial Derivatives: Function of several variables, Limit and continuity Partial Differentiation, Euler's Theorem, Total derivatives, 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. Multiple Integration and its Applications: 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 , Improper integrals of first and second kind , Special Functions: Beta and Gamma functions. Introduction to Scalars and Vector: 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 , Stokes's Theorem (without proof) and applications , Gauss Divergence Theorem (without proof) and applications.

Recommended Books:

1. The Engineering Mathematics, 2nd Edition, Chitkara University Publication, Vol. I.
2. Srimanta Pal & Subodh C. Bhunia, Engineering Mathematics, Edition 2015, Oxford University"
3. Grewal B.S, Higher Engineering Mathematics,Khanna Publisher".
4. Raman B.V ,Higher Engineering Mathematics, TMH Ist edition".

ECL5101	Basics of Electronics Engineering	(3-1-0), 4 Credits

Course Learning Outcomes (CLO):

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

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

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

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

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

Introduction to Electronic Components-What is electronics, Modern Trends and applications of Electronics in Communication and Entertainment, Defense, Industry, Medical Sciences and Instrumentation. Passive Circuit Components: Resistor (Types of resistors: Fixed and Variable, Color Coding of Resistors), Capacitor (Fixed Capacitors: Electrolytic, Ceramic, Plastic, Mica, Paper; Variable Capacitor) , Inductors : Fixed and variable. Diodes and its applications-Semiconductor Theory (Doping, Energy Band Structure, Classification of Semiconductors). Theory of PN junction diode, Diode Equation, V-I Characteristics of a pn junction diode under forward and reverse bias, pn diode applications. Zener diode, Breakdown in zener diode (Avalance and Zener), V-I Characteristics of Zener diode. Varactor diode and its characteristics. Opto-Electronic Devices: Photodiode, Light Emitting Diode (LED). Bipolar Junction Transistors-: Introduction of Bipolar Junction Transistor (BJT), Construction of BJT, BJT Biasing, Operation of NPN and PNP BJT, Types of BJT Configurations, Types of Transistor Amplifier Configurations : Common Emitter (CE), Common Base (CB), Common Collector (CC); Transistor Parameters (Input Impedance, output impedance, forward current gain, reverse voltage gain) in CE and CB configurations. Input and Output Characteristics of CE, CB and CC Configurations, Comparison of CB, CE and CC Configurations. Rectifiers-Half Wave, Full Wave and Bridge Rectifier (Circuit diagram , Waveforms, Derivation of average and rms value of voltage, ripple factor, Peak Inverse Voltage, dc power, Efficiency). Digital Electronics-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), Universal Gates, Realization of logical expression using basic and Universal gates. Signal, Types of Signals (Analog and digital), Block diagram of a Communication System, Modulation (Basic Principle), Need for Modulation, Sampling and Quantization of Signal, Encoding of quantized signal. IC 555 Timer, Functional Block diagram of 555, 555 as waveform generator (Astable Mode, Monostable Mode).

Recommended Books:

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

ECP1101	Basics of Electronics Engineering Lab	(0-0-2), 1 Credits

Course Learning Outcomes (CLO):

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

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

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

CLO4 Skill of explaining the basics of electronics fundamentals

Familiarization with basic electronic components. 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 breakdown voltages of 6 V,8V and 12 V. 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 and pnp transistors in common emitter configuration and plot their input and output characteristics. Analyze the truth tables of various logic gates. 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 in forward biasing. Plot and analyze V-I characteristics of Avalanche photo diode. Plot and analyze V-I characteristics of PIN diode. Plot and analyze V-I characteristics of tunnel diode. Plot and analyze V-I characteristics of Varactor diode.

Recommended Books:

1. Bobrow, Fundamentals of Electrical Engineering, Edition Second 2005, Oxford University Press.'
2. Kothari D P and Nagrath I J ,'Basic Electrical Engineering, Edition Third 2009, Tata McGraw Hill.'
3. Ravish R Singh ,Basic Electrical and Electronics Engineering', 2009, Tata McGraw Hill.'
4. Milton Kaufman, Handbook for Electronics Engineering Technicians.

MEL4102	Engineering Graphics	(3-1-0), 4 Credits

Course Learning Outcomes (CLO):

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

CLO2: Skill to use engineering scale effectively

CLO3: Use dimensioning effectively.

CLO4: Use development of surfaces.

Drawing Techniques: - Various types of lines, principles of dimensioning, size and location dimensions, symbols, conventions, scales (plane and diagonal) and lettering as per IS code of practice (SP-46) for general Engg. Drawing. Practice of drawing various types of lines and dimensioning exercises. Drawing exercises pertaining to Symbols, Conventions and exercises on lettering techniques free hand printing of letters and numerals in 5 mm sizes, vertical and inclined. Projection of Points and Lines: - Concept of horizontal and vertical planes. First and third angle projections; projection of points and lines, true lengths of lines and their horizontal and vertical traces. Projection of Planes: - projection of planes and their traces. Projection of Solids:- Projection of Right solids; solids of rotation and polyhedrons etc, Projection of solids with cases when (a) inclined to one ref plane and (b)inclined to both ref planes. Sectioning of solids: - Principles of sectioning, types of sectioning, and their practice on projection of solids, sectioning by auxiliary planes. Isometric projections and Orthographic projections: - Concept of isometric views; isometric scale and exercises on isometric views. Practice in orthographic projections. Development of Surfaces: - Development of surfaces of cylinders, cones, pyramids and prisms.

Recommended Books:

1. P.S. Gill ,Engineering Drawing, Eleventh edition, S.K. Kataria & Sons.
2. R. K. Dhawan; Engineering Drawing, 2014 Edition, S. Chand and Company.
3. N. D. Bhatt,Engineering Drawing, 2014 Edition, S. Chand and Company.
4. Shanker Prasad Dey,Engineering Drawing, 207 Edition, vikas publisher

MEP1102	Engineering Graphics Lab	(0-0-2), 1 Credits

Course Learning Outcomes (CLO):

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

CLO2: Skill to use engineering scale effectively

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

Recommended Books:

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

PYL5101	Engineering Physics	(3-1-0), 4 Credits

Course Learning Outcomes (CLO):

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

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

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

CLO4: Evaluate and analyze scientific measurement and error analysis.

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

Laser: Introduction, characteristics laser action, stimulated absorption, spontaneous emission, stimulated emission, Population inversion and pumping, Einstein's coefficient (no derivation), various level lasers, two level, three level, four level, Ruby laser, Helium-Neon laser, Carbon dioxide laser, Semiconductor laser, concepts of Holography. Fiber Optics: Basic principle of optical fibre, 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. Electrodynamics: Vector and scalar fields, Gradient, divergence, curl and their physical interpretation, Gauss's theorem and Stoke's theorem (Statement only), Equation of continuity, Maxwell's equations in free space, Propagation of electromagnetic waves in free space. Special theory of relativity: Frames of reference, postulates of special theory of relativity, Galilean transformation equations. Lorentz's transformation equations, inverse Lorentz's transformation equations (no derivation), length contraction, time dilation Relativistic velocity addition formula, Variation of mass with velocities (concept only), Mass energy relation. Quantum Mechanics: Introduction to Quantum Mechanics, Group velocity and phase velocity (No relation), De-broglie waves, Uncertainty principle (statement only), Wave function and its significance, Normalised wave function, Schrodinger wave equations (Time dependent and Time Independent), Particle in a one dimensional box. Electronic Properties of Solids: Free electron theory (quantum theory) density of states, Fermi energy, Fermi Dirac function, Band theory of solids (introduction): metals, semiconductors, insulator, doping Intrinsic and extrinsic semiconductors, carrier concentration of semiconductors (no derivation), Hall effect (Quantitative idea). Magnetic Materials: Magnetic materials, terminology and classification, Magnetic moments of an atom; orbital, spin and total, Lande's g-factor, Ferromagnetism and related phenomena, the domain structure, the hysteresis loop,Types of magnetic materials: soft magnetic materials, hard magnetic materials. Superconductivity: Superconductivity, introduction, Meissner effect, critical field, Critical current and Isotope effect, Types of superconductors: type-I superconductors, type II superconductors, London equations, penetration depth, Cooper pair and BCS theory, high temperature superconductors.

Recommended Books:

1. The Engineering Physics' second edition by Chitkara University Publication.'
2. H. K. Malik and A. K. Singh, Engineering Physics , Tata McGraw Hill Publishing company.'
3. Arthur Beiser ,Concepts of Modern Physics , Tata McGraw Hill Publishing company.'
4. D.K. Bhattacharya and P. Tandon, Engineering Physics , Oxford University Press.'

PYP1101	Engineering Physics Lab	(0-0-2), 1 Credits

Course Learning Outcomes (CLO):

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

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

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

CLO4: Skill to design, perform, document and analyze advanced experiments in physics.

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 a optical fibre. To determine attenuation & propagation losses in optical fibres.

Recommended Books:

1. S K Srivastava. Theory and Experiments.
2. Neeraj Mehta, Applied Physics for Engineers, PHI Learning.
3. Robert Resnick , Introduction to Special theory of Physics, Wielly.
4. Arthur Beiser, Concepts of Modern Physics, McGraw-Hill Science.

HUL2101	Disaster Management	(1-0-0), 1 Credit

Course Learning Outcomes (CLO):

CLO1: Increase the knowledge and understanding of the disaster phenomenon, its different contextual aspects, impacts and public health consequences.

CLO2: 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.

CLO3: 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.

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.

Recommended Books:

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

GEL4101	Environmental Sciences	(4-0-0), 4 Credits

Course Learning Outcomes (CLO):

CLO1: Understand the transnational character of environmental problems and ways of addressing them, including interactions across local to global scales.

CLO2: Apply systems concepts and methodologies to analyze and understand interactions between social and environmental processes.

CLO3: Reflect critically about their roles and identities as citizens, consumers and environmental actors in a complex, interconnected world.

CLO4: Skill to demonstrate proficiency in quantitative methods, qualitative analysis, critical thinking, and written and oral communication needed to conduct high-level work as interdisciplinary scholars and/or practitioners..

The multidisciplinary nature of environmental studiesDefinition, Scope and Importance; Need for Public Awareness. Natural Resources:Renewable and non-renewable resources Associated problems: Forest resources, use and over, exploitation, deforestation, timber extraction, mining, dams and other effects on forest and tribal people. Water resources: Use and over utilization of surface and ground water, floods, drought, conflicts over water, dams , benefits and problem. Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources. Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. Energy resources: Growing energy needs, renewable and non-renewable energy sources, Uses of various alternate energy sources. Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. Role of an individual in conservation of natural resources Equitable use of resources for sustainable lifestyles. Ecosystems - Concept of an ecosystem, Structure and function of an ecosystem. Producers, consumers and decomposers. Food chains, food webs and Ecological pyramids. Energy flow in the ecosystem, Biogeochemical cycles. Ecological succession. Introduction, types, characteristic features, structure and function of the following ecosystem: a. Forest ecosystem, b. Grassland ecosystem, c. Desert ecosystem, d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries. Biodiversity and its conservation: Introduction - Definition: genetic, species and ecosystem diversity. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values. Bio-geographical classification of India. Biodiversity at global, National and local levels, India as a mega diversity nation, Hot-spots of biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife, man wildlife conflicts, Endangered and endemic species of India. Conservation of biodiversity: in-situ and ex-situ conservation of biodiversity. Environmental Pollution: Definition, Cause, effects and control measures of : a. Air pollution, b. Water pollutionc. Noise pollution, d. Soil pollution e. Marine pollution, f. Thermal pollution,g. Nuclear hazards. Solid waste Management: Causes, effects and control measures of urban wastes and industrial wastes. E-waste introduction. Role of an individual in prevention of pollution. Disaster management: floods, earthquake, cyclone and landslides. Social Issues and the Environment: From Unsustainable to Sustainable development -Urban problems related to energy, Environmental ethics: Issues and possible solutions. Water conservation, rain water harvesting, and watershed management. Resettlement and rehabilitation of people; its problems and concerns. Climate change, global warming, acid rain. Ozone layer depletion, nuclear accidents and holocaust; Case Studies, Wasteland reclamation – Consumerism and waste products. Environment Protection Act. Water (Prevention and control of Pollution) Act. Air (Prevention and Control of Pollution) Act ,Wildlife Protection Act**,** Forest Conservation Act.

Issues involved in enforcement of environmental legislation, Public awareness. Human Population and the Environment: Population growth, variation among nations, Population explosion - Family Welfare Program. Environment and human health, HIV/AIDS,Human Rights, Value Education. Women and Child Welfare, Role of information Technology in Environment and human health.

Recommended Books:

1. Erach Bharucha ,Textbook of Environmental Studies for Undergraduate Courses' , First Edition, University Grants Commission, Universities Press (India) Private Limited.'
2. Manish Randhawa ,The Basics of Environmental Sciences' , First edition, Chitkara University publications.'
3. V K Singh , Environmental Sciences' , new age international publications.'
4. Sughanda Mishra and Dhirendra Kumar , Concepts of Environmental Sciences' , new age international publications.

Year 1, Semester – 2

AML5102	Engineering Mathematics- II	(4-1-0), 5 Credits

Course Learning Outcomes (CLO):

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

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

CLO3: Possess an ability to recognize and find families of solutions for most real physical

CLO4: Processes such as heat transfer, elasticity, quantum mechanics, water flow and others, which are governed by partial differential equations subject to boundary conditions.

Pre-Requisite: Differentiation, Integration, Multiple Integral. Fourier Series: Introduction, Fourier Series on Arbitrary Intervals, Half-range cosine and sine series, Fourier Transform with properties, Parseval's Identity. Ordinary Differential Equations: Differential equations of first order and first degree–exact, linear and Bernoulli, Clairauts, Application to orthogonal trajectories. Secondand 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, Applicationto RLCcircuit. 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. Laplace Transform: Laplace Transform, Inverse transforms properties, Transforms of derivatives and integrals, Unit step function, Dirac's delta function, Applications to differential equations.

Recommended Books:

1. The Engineering Mathematics, 1st Edition, Chitkara University Publication, Vol. II.'
2. B V Ramana ,Higher Engineering Mathematics, Edition 2009, McGraw Hill.'
3. Dr.H.C.Taneja AdvancedEngineeringMathematics,(Vol. I &Vol.II,I.K.International.
4. A. Ganesh and G. Balasubramanian, Engineering Mathematics-II, McGraw Hill.

CS101	Introduction to C Programming	(0-0-10), 5 Credits

Course Learning Outcomes (CLO):

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

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

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

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

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

Introduction, Data Types and Operators, 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( ), Operators: Arithmetic, Relational, Logical, Assignment, Conditional, bitwise, sizeof, Precedence of operators and their associativity. Control Statements: Selection control Statements: if, if – else, Switch. Iteration control Statements: while, do – while, for, Nested loops, Continue, break. Introduction to complexity analysis Functions and Pointers: 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, void pointer generic pointer. Function parameter passing mechanisms: call by value, call by reference. Recursion. Storage classes: auto, register, static, extern Arrays: Types of Arrays, 1-D Arrays: Introduction, Need & Importance Dynamic memory Allocation in c Initialization of arrays, inputting values, assigning Values Passing 1-D to Function Representing 1-D arrays as pointer Arrays of pointers, pointer to an array Function pointer in C Multi-Dimensional Arrays: Declaration of 2-D Array, Initialization of 2-D Array, passing 2-D array to function Representing 2-D arrays as pointer 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: Introduction, Reading and writing strings Pointers and Strings Passing string to a function, Structure and Union: 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. Bit Fields in c. Enum in c. typedef. Command line arguments in C.

Recommended Books:

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

EEL4103	Basics of Electrical Engineering	(3-1-0) , 4 Credits

Course Learning Outcomes (CLO):

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

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

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

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

DC Circuits: Introduction to DC Circuits and related terminology, Series and Parallel combination of resistances, Kirchhoff's Laws: KVL and KCL, Mesh or loop Analysis and Nodal Analysis. Magnetic Circuits**:** Definitions of Magnetic quantities, Magnetic Circuit, Comparison between Electric and Magnetic Circuits Magnetic Effect of Electric Current, Current carrying conductor in magnetic field, Law of EMI, Induced EMF: self-inductance, 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 Machines Transformer: Principle, Construction, Working. DC Motor: Principle, Construction, Working. Three Phase Induction Motors: Principle, Construction, Working. Electrical measuring instruments and transducers**:** Electrical Measuring instruments: Classification of instruments, Basic principles of indicating instruments, Moving Iron instruments-Attraction type, Moving coil instruments-permanent magnet type. Electrical Transducers Introduction, Types of transducer: LVDT, RTD. Thermocouple, Thermistor, Piezoelectric transducer, Photoelectric transducer.

Recommended Books:

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

EEP1103	Basics of Electrical Engineering Lab	(0-0-2), 1 Credit

Course Learning Outcomes (CLO):

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

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

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

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

To study the use of multi-meter and testing of various components. Verification of Kirchoff's current law in DC circuits, Verification of Kirchoff's voltage law 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, start and reverse the direction of rotation of a 3- phase induction motor, Measurement of temperature using RTD, Measurement of displacement using LVDT. to study the current – time characteristics of MCBs / Fuse.

Recommended Books:

1. D C Kulshreshtha',Basic Electrical Engineering , Tata McGraw Hill, 2009.
2. V. K Mehta and Rohit Mehta, Basic Electrical, S.Chand.
3. C L Wadhwa, Basic Electrical Engineering, Publisher: New Age International .
4. Nagrath, I and Kothari, Basic Electrical Engineering, Mc Graw hill publisher.

CHL4101	Engineering Chemistry	(4-0-0), 4 Credits

Course Learning Outcomes (CLO):

CLO1: Develop innovative methods to produce soft water for industrial use and potable water at cheaper cost.

CLO2: Substitute metals with conducting polymers and also produce cheaper biodegradable polymers to reduce environmental pollution.

CLO3: Design economically and new methods of synthesis nano materials.

CLO4: Apply their knowledge for protection of different metals from corrosion.

CLO5: Have the skill of converting solar energy into most needy electrical energy efficiently and economically to reduce the environmental pollution.

Water Technology : Introduction, Sources of water, Impurities in water, Hard and soft water, Units of hardness (Numericals included), Specification for boiler feed water, Boiler problems: Scale and sludge formation, Caustic embrittlement, Priming and Foaming, Boiler corrosion due to oxygen and carbon dioxide, External treatment: Lime –soda process (Numericals included), Zeolite process, Ion exchange process, Internal treatment (different types of conditioning), Specification of water for domestic use, Treatment for domestic use(break point chlorination); Treatment of brackish water(reverse osmosis, electrodialysis using ion selective membrane). Water quality parameters: Acidity, alkalinity, BOD, COD, Dissolved oxygen, Conductivity, pH. Polymer Sciences: Elementary ideas about polymers, Classification of polymers, Types of polymerization, Chemical reaction for the synthesis of polymers: Teflon, Polyester (Dacron), Nylon6,6; PMMA ,Novolac, Phenol formaldehyde resin(Bakelite), PC(Polycarbonate). Synthesis and Application of rubbers – Buna-N, Buna-S and Poly isoprene. Introduction and Application of Electro active , Conducting and Biopolymers. Battery Technology: Introduction to electrolytic and electrochemical cell, EMF of cell, Relationship between emf and thermodynamic properties (ΔH, ΔS, ΔG). Numerical based on EMF of cells and thermodynamic parameters. Electroless plating, Preparation of PCB (Printed circuit board), Dry cell, lead storage batteries. Applications and function of batteries used in Laptops: Lithium ion battery and Nano batteries. Batteries used in rockets & submarine: Fuel cell (hydrogen-oxygen alkaline fuel cell, molten carbonate fuel cell, Phosphoric acid fuel cell). Batteries used in electronic devices :Solar cell. Liquid Crystal Technology: Introduction, Characteristics of liquid crystals: Director and Effect of temperature on order parameter. Classification of liquid crystal: Smectic liquid crystal (Smectic A,B,C), Nematic liquid crystal, Cholesteric liquid crystal, Molecular arrangement in various types of liquid crystals. Principle of liquid crystal Display (LCD) , Application of polymer dispersed liquid crystals (PDLCs). Phase Equilibrium: Introduction, Gibbs phase rule, Application of phase rule in one component system, Water system, Carbon dioxide system, Sulfur system Condensed phase rule, Two component system, Eutectic mixture, Lead silver system. Two component system: Potassium iodide -water system, Ferric chloride water system and Iron-Carbon system. Corrosion and its control: Introduction, Causes of corrosion, effects of corrosion, Types and mechanism of corrosion, Direct chemical (dry) corrosion. Electrochemical (wet) corrosion, Pilling Bedworth ratio. Comparison of Chemical and electrochemical corrosion. Types of electrochemical corrosion, Other forms of corrosion (Underground or soil corrosion, Microbial corrosion, Erosion corrosion, Intergranular ,Crevice, atmospheric corrosion), Passivity of corrosion, Factors influencing corrosion: Nature of the metal, Nature of corroding environment, Prevention of corrosion, Use of protective measurements: Cathodic protection.

Green Chemistry and Green Engineering: Weapons for mass destruction and chemistry for peaceful work., Principles of green chemistry and Green Engineering, Green Chemistry in India (examples of Microwave assisted synthesis),Traditional synthesis of adipic acid and urethane.

Recommended Books:

1. The Engineering Chemistry' - Chitkara University Publication.
2. O. G.Palanna ,Engineering Chemistry', 2009, Tata McGraw- Hill publishing house.
3. B. Sivasankar ,Engineering Chemistry' , 2008, Tata McGraw Hill Publishing House.
4. Gilbert W. Castellan, Physical Chemistry' 3rd edition, Narosa Publishing House.

CHP1101	Engineering Chemistry Lab	(0-0-2), 1 Credit

Course Learning Outcomes (CLO):

CLO1: Develop innovative methods to produce soft water for industrial use and potable water at cheaper cost.

CLO2: Substitute metals with conducting polymers and also produce cheaper biodegradable polymers to reduce environmental pollution.

CLO3: Design economically and new methods of synthesis nano materials.

CLO4: Skill to apply their knowledge for protection of different metals from corrosion.

Water Technology: Determination of total hardness, permanent hardness and temporary hardness by Complexometric method. Determination of residual chlorine in water.Determination of dissolved oxygen in the given water sample.To determine Biological Oxygen Demand in the given water sample.Green chemistry and Green Engineering: To draw the chemical equations of Traditional and Green synthesis of Adipic acid using CHEM SKETCH. LC- Technology: To study the electro-optic behavior of liquid crystal cell.Polymers and synthesis, Preparation of Bakelite using phenol-formaldehyde.Preparation of urea –formaldehyde resin.Preparation of copper ammonia ComplexInstrumental Analysis, To determine the acid strength by using pH meter.To determine the acid strength by using conductometer, To determine the surface tension by drop number method using Stalgamometer, To determine the % moisture, volatile, ash and carbon content of coal sample by proximate method.

Recommended Books:

1. J Mendham,Rc Denney Vogel's, Textbook of quantitative chemical analysis' , Sixthedition, Pearson Publications .'
2. V. Alexeyev ,Quantitative Analysis, Third edition, MIR publications.'
3. T.W Graham Solomons, Craig B.Fryhle Solomons and Fryhle',Eighth edition,WileyPublications.'
4. F G Mann,B C Saunders Practical Organic Chemistr , Fourth edition ,Pearson Publications.'

MEW2101	Manufacturing Practice	(0-0-4), 2 Credits

Course Learning Outcomes (CLO):

CLO1: The students will be skilled to understand the working of engines and simple machines

CLO2: The students will gain knowledge about different processes involved in manufacturing process that enhances employability.

Introduction to manufacturing set up and course requirement; work culture; safety requirements; fire, fire fighting & 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.).

Recommended Books:

1. Raghuwanshi B.S ,A course in Workshop technology Vol I &.; Dhanpat Rai & Sons , New Delhi.'
2. Jain R.K ,Production Technology, Khanna Publishers, New Delhi.
3. Singh, S ,Manufacturing Practice, S.K. Kataria & Sons, New Delhi.
4. Lalit Narayan, Computer Aided Design and Manufacturing, PHI Publisher.

Year 2, Semester – 3

ECL4207	Digital Electronics and Logic Design	(3-1-0), 4 credits

Course Learning Outcomes (CLO):

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

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

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

CLO4: Skill to design and implementation of combinational circuits.

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

Introduction to Digital Concepts:Digital and Analog systems . Logic Gates with their symbol 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. 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. Reduction using Karnaugh map . Digital IC families(DTL,TTL,ECL,MOS and CMOS):. 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.

Recommended Books:

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

ECP1207	Digital Electronics & Logic Design Lab	(0-0-2), 1 credit

Course Learning Outcomes (CLO):

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

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

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

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

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

Logic gate is a basic building block of a digital circuit. So verify the truth tables of all the logic gates on trainer kit using TTL ICs. Also verify them using multsim. 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. 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.

i) Suppose one input is to be selected from n inputs. Implement the circuit using IC 74150.

ii) A circuit distributes one input into n output lines. Design the circuit using IC 74154.

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).

Recommended Books:

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

CS102	Object Oriented Programming using C++	(0-0-10), 5 credits

Course Learning Outcomes (CLO):

CLO1: Skilled to understand the problem statement using principles of mathematics and engineering sciences.

CLO2: Identify the OOPs programming constructs to solve the problems by differentiating between efficient and inefficient way of programming.

CLO3: Determine the bugs in a program and recognize the need of alternate approaches.

CLO4: Acquire ability for independent and life-long learning in the broadest context of technological change.

CLO5: Provide solutions to societal, health, safety, legal, and cultural issues through contextual knowledge of professional engineering practice for employability.

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 operator using friend functions, manipulation of strings using operator 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 member, this 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, Re-throwing 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.

Recommended Books:

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

HUL3301	Human Rights & Values	(3-0-0), 3credits

Course Learning Outcomes (CLO):

CLO1: After completing the course students will be able to Identify constitutional or national values, social, professional, religious and aesthetic values.

CLO2: Students will be able to link value education towards professional and employment ethics.

CLO3: Students will be able to understand about national issues and international cooperation.

CLO4: Students will be able to follow personal development and creation of a positive personality.

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.

Recommended Books:

1. Col KK Sharma, Human Value Education and Human Rights, Chitkara Business School, 2014
2. R. S. Naagarazan, Professional Ethics and Human Values, New Age Publishers, 2006
3. Grose, D. N, A text book of value education, Dominant Publishers and Distributors, 2005.
4. Beitz, C.R., 2009. The idea of human rights. OUP Oxford.

GEW2401	Engineering Economics Analysis	(2-0-0), 2credits

Course Learning Outcomes (CLO):

CLO1: Understand the theoretical and conceptual basis of economics (e.g., time value of money, interest, inflation rates, etc.) upon which engineering projects analysis is built.

CLO2: Posses a set of practical tools to make systematic and informative decisions when evaluating an engineering project with various uncertainties

CLO3: Have critical thinking skills, problem solving abilities, and familiarity with the project evaluations procedures essential to various engineering fields.

CLO4: Be able to demonstrate the capacity for critical thought, team work, resourceful study, and effective communication

Introduction to Economics- Flow in an economy, Law of supply and demand, Concept of Engineering Economics – Engineering efficiency, Economic efficiency, Scope of engineering economics- Element of costs, Marginal cost, Marginal Revenue, Sunk cost, Opportunity cost, Break-even analysis- V ratio, Elementary economic Analysis – Material selection for product Design selection for a product, Process planning. Make or buy decision, Value engineering – Function, aims, and Value engineering procedure. Interest formulae and their applications –Time value of money, Single payment compound amount factor, Single payment present worth factor, Equal payment series sinking fund factor, Equal payment series payment Present worth factor- equal payment series capital recovery factor-Uniform gradient series annual equivalent factor, Effective interest rate, Examples in all the methods. Rate of return method, Examples in all the methodsReplacement and Maintenance analysis – Types of maintenance, types of replacement problem, determination of economic life of an asset, Replacement of an asset with a new asset – capital recovery with return and concept of challenger and defender, Simple probabilistic model for items which fail completely. Depreciation- Introduction, Straight line method of depreciation, declining balance method of depreciationSum of the years digits method of depreciation, sinking fund method of depreciation/ Annuity method of depreciation, service output method of depreciation-Evaluation of public alternatives- introduction, Examples, Inflation adjusted decisions – procedure to adjust inflation, Examples on comparison of alternatives and determination of economic life of asset.

Recommended Books:

1. Chan S.Park, Contemporary Engineering Economics, Prentice Hall of India, 2002.
2. www.springer.com/us/book/9780387970486

CSP3213	Introduction to LINUX	(3-0-0), 3 credits

Course Learning Outcomes (CLO):

CLO1: Understand the Installation and working with Linux Operating System.

CLO2: Acquire theoretical knowledge about the Elementary difference between Linux, UNIX, DOS & Windows OS.

CLO3: Understand the Simple and Administrative Commands.

CLO4: Programming skills with shell script.

Linux Foundation, Linux Requirements, Linux Philosophy and Components, Linux History, Linux Community, Linux Terminology, Linux Distributions.Installation: Configuration & Customizations of Unix/Linux, Linux Structure and Installation, Linux file-system basics, The boot process, Linux Distributions Installation.Introduction to GCC compiler: Compilation of program, Execution of program.Study basic & User status Unix/Linux Commands: Purpose commands: man, help, history, who, whoami, id, uname, tty, usermod.System Configuration from the Graphical Interface: System, Display, Time and Date Settings, Network Manager, Installing and Updating SoftwareCommand-line Operations: Command Line Mode Options, Basic Operations, Installing Software, terminals, types of terminals, switching between terminals.Working with Files: cat, cp, mv, rm.Compressing files- tar, gzip, compress, uncompress, fileDirectory oriented commands: cd, pwd, mkdir, rmdir, ls and its options.Searching: Search file or directory in directory structure using find and locate command with various options, wildcards. Mounting- mount, umount. USB, CD/DVD.GCC: Working with GCC compiler, debugging, time-stamping, compiling object files etc.File system: Introduction to File system, File system Architecture, Comparing Files and File Types. Text Editors- Basic Editors: nano and gedit, More Advanced Editors: vi and emacs.Communication-oriented commands: echo, host, nslookup, ipcalc, ping, traceroute, netstat. whois, finger, ifconfig, telnet, wget, ip, route, iptables, write, mesg, mail.Managing Users: Adding user, removing user using the sudo command.Local Security Principles: Understanding Linux Security, Understand the Uses of root, Using the sudo Command, Working with Passwords, permissions modification using chmod, Chown, chgrp.Network Operations: Introduction to Networking, Browsers, graphical and non- graphical browser, Transferring Files, Process oriented commands-ps, pstree, kill, killall (with all their options), Process scheduling-at, cron.Regular expressions, redirections & Filters in Linux: Simple filters viz. more, wc, diff, sort, uniq, etc., grep, > , >Bash Shell Scripting- Features and Capabilities, Syntax, Constructs using expr, tr. Simulating an array using eval.Write Script to find out biggest number from given three nos. Nos are supplies as command line argument. Print error if sufficient arguments are not suppliedAdvanced Bash Shell Scripting: String Manipulation, Boolean Expressions, File Tests, Case Structure, Debugging.Write Script, using case statement to perform basic math operation as Follows- addition, subtraction, multiplication, division Write script to print given numbers sum of all digit, For eg. If no is 123 it's sum of all digit will be 1+2+3 = 6 Printing- Configuration, Printing Operations.

Recommended Books:

1. Purcell, John. (2017).Linux the Complete Reference. (7th ed). McGraw Hill.
2. Blum, Richard. (2016). Linux Command Line and Shell Scripting Bible. (3rd ed). BPB Publication.

3. Das, Sumitabha. (2014). Your Unix - The Ultimate Guide. (4th ed). Tata McGraw-Hill.
4. Goerzen, John. (2016).Linux Programming Bible. (8th ed).IDG Books.
5. Sobell, Mark G.(2013). A Practical Guide to Linux. (2nd ed). Pearson Education.
6. kanetkar, Yashwant. (2017).Unix Shell programming. BPB Publications.

CSL3203	Computer Networks	(3-0-0), 3 credits

Course Learning Outcomes (CLO):

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

CLO2: Acquire theoretical knowledge about the different network technologies

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

CLO4: Identify various system security and protection issues.

CLO5: Administer the system for managing its resources.

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

Recommended Books:

1. B. Forouzan, 'Introduction to Data Communications and Networking' , Tata McGraw Hill, Fourth Edition, 2004
2. Andrew S. Tanenbaum ,'Computer Networks' , Pearson Education, Fourth Edition.
3. Bhavneet Sidhu,'Computer Networks' , Khanna publisher, Fourth Edition'
4. Sunjay Sharma,' Advanced Computer Networks' , Katson publisher.

CSP2203	Computer Networks Lab	(0-0-4), 2 credits

Course Learning Outcomes (CLO):

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

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

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

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

CLO5: Skilled to simulate and design network.

1. Consider the problem of designing a small network of computers. To accomplish this goal, Ethernet lines must be constructed and run between the machines. The construction costs for each possible link are based approximately on distance. Besides distance, the costs also reflect some restrictions due to physical boundaries. To connect all the machines in the office at minimal cost, try different configurations to connect them like (star, mesh, ring, bus) with the help of various other networking devices like (switch, repeater, hub, bridge).
2. You have just started a new business. You need to have three to four workstations available for your employees who simply need to share some files and a printer, but you don't have a large budget. Security is not a major concern, but costs are. What type of network would be the most appropriate for your situation?
3. Let us assume that Johnson & Co. is a small business firm with five departments each having twenty-five employees. Assuming each employee has a computer and each department has a printer, Johnson & Co. will need 125 nodes for computers and five for printers. It is also assumed that one department requires token ring, another requires fiber, and the rest of the departments requires 10 or 100 Mbs Ethernet. The network number assigned to Johnson & Co. is 201.222.5.0. The network administrator decides to create smaller networks, one for each department. This decision is based on different topology requirements for different departments, simplifying cabling, and easy administration of the network.
4. Mr. Amit wants to connect Advertising department with Sales department. At First, he did not require WAN devices as both departments were having same Network Addresses .But Later on, he has to introduce Layer 3 devices because Network addresses were changed of both departments. Simulate the previous and present scenario using suitable commands to verify the connectivity.
5. CEO of company ABC needs a system with network configuration that can communicable only with machines of managers of different departments. The path for communication between source and destination should be set by static routing.
6. Mr. Gunit is feature-riffic and hence he wants to configure the routers with the protocol having much features. He does not scare off the complexities of the protocol to be implemented but he is certain about one thing that the protocol should be open and not proprietory. Perform the following as per his need:
   - Simulate a topology.
   - Implement small and medium sized networked dynamic routing protocol.

- Routing updates are multicast.
- Minimize broadcast traffic.
- Send periodic routing updates.
- Hint: This routing protocol is distance vector style

7. Perform the following as per scenario mentioned in experiment 6:
   - Simulate a topology.
   - Implement dynamic routing protocol that sends no Broadcasts and consumes less bandwidth and supports multiple network layer protocols.
   - Send partial updates as needed.
   - Hint: Hybrid Distance Vector/Link State algorithm
8. Perform the following as per scenario mentioned in experiment 6:
   - Simulate a topology.
   - Implement loop free dynamic routing protocol.
   - Balance the network traffic using multiple paths.
   - Send immediate routing updates rather than periodically.
   - Hint: This protocol supports VLSM, CIDR, and supernetting.
9. A company has only one public IP address but several private IP address dynamically assigned by the DHCP server for all its computers. NAT application (Router, Firewall) would change the source address (private IP address) on every outgoing packet from the internal computers in to the single public IP address. But it assigns a different source port for packets coming from each computer, so that while the packets return with a single public IP address, it can still remember which packet needs to go to which computer (Every IP address has source IP, destination IP and associated port numbers). Of course, while coming back, the packets are re-assigned with its respective private IP address of the computer it needs to go to and the public IP address is discarded by the NAT application. This process is managed by a port mapping table managed by the NAT application, for all the incoming and outgoing packets from a network. Perform the following tasks based on mentioned scenario:
   - Design a topology consisting of a private and public network, and configure NAT.
   - Provide NAT table for every incoming and outgoing packet.
   - Display all NAT translations.
   - Allow internal users to connect to internet.
   - Allow internet to access internal devices.
10. In the mentioned scenario above:
    - Implement standard and extended ACL.
    - Create an ACL to permit and deny a specific host, protocol.
    - Bind ACL to an interface.

Recommended Books:

1. Michaelle Conrrede, Ccna The Ultimate Beginner's Guide, Cisco Certified Network.'
2. Doug Lowe, Networking All-In-One For Dummies ,.'
3. John Snowden, Linux For Beginners.'
4. Russell Scott, Computer Networking.'

CSL4207	Operating System	(3-1-0), 4 credits

Course Learning Outcomes (CLO):

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

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

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

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

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

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

Recommended Books:

1. AviSilberschatz, Peter and Galvin Greg Gagne Operating System Concepts Essentials, 9th Edition , Wiley Asia Student Edition

2. Operating Systems: Internals and Design Principles, 5th Edition, William Stallings, Prentice Hall of India.
3. Peterson, James L., and Abraham Silberschatz. *Operating system concepts*. Addison-Wesley Longman Publishing Co., Inc., 1985.
4. Silberschatz, A., Peterson, J. L., & Galvin, P. B. (1991). *Operating system concepts*. Addison-Wesley Longman Publishing Co., Inc.

Year 2, Semester – 4

ECL4214	Analog Electronics	(3-1-0), 4credits

Course Learning Outcomes (CLO):

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

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

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

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

Introduction to BJT, Construction and Working of Common Base Configuration and 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. 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.

Recommended Books:

1. Robert L. Boylestad and Louis Nashelsky ,Electronic Devices and Circuit Theory' , Pearson Publication, 10th Edition, 2009.
2. Albert Malvino, Electronics Principles, Mc Graw Hill, 7th Edition, 2006.
3. J.B. Gupta , Electronic Devices and Circuits ,Katson.
4. Jacob Millman & Christos C. Halkias Sedra & Smith, ntegrated electronics : Analog and Digital Circuit and system, McGraw Hill.

ECP1214	Analog Electronics Lab	(0-0-2), 1credit

Course Learning Outcomes (CLO):

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

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

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

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

Recommended Books:

1. Robert L. Boylestad and Louis Nashelsky ,Electronic Devices and Circuit Theory' , Pearson Publication, 10th Edition, 2009.
2. Albert Malvino, Electronics Principles, Mc Graw Hill, 7th Edition, 2006.
3. J.B. Gupta , Electronic Devices and Circuits ,Katson.
4. Jacob Millman & Christos C. Halkias Sedra & Smith, ntegrated electronics : Analog and Digital Circuit and system, McGraw Hill.

ECL4208	Control Systems	(3-1-0), 4 credits

Course Learning Outcomes (CLO):

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

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

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

CLO4: Skilled to solve automation solutions to real world problems

The control System, , Open loop control system, closed loop systems with real time applications, transfer function of Mechanical, translational, rotational, electrical system, control system components potentiometer, synchro, tachometer, Block diagram Algebra, Mason's Gain formula, transfer function of Signal flow graphs using block diagram , State variable approach: advantage and disadvantages, basic concepts.Classification or time responses, system time response, analysis of steady state error , Type of input and steady state error ,Steady state error for type 0,1,2 systems , Analysis of first order system, second order system, effect of damping ratio on second order system, time response specifications, Concept of stability ,Routh-Hurwitz criterion, Routh's stability criterion.Root locus concepts ,construction root locii, Frequency response, Methods in frequency response, Advantages and disadvantages in frequency response.Polar plots, Bode plots, Nyquist stability criterion, Nyquist analysis.Realization of basic compensators (lead) with advantages and disadvantages, Introduction to basic actions of controllers, Proportional controller, Integral controller, PI,PD,PID controller**.**

Recommended Books:

1. Samarjit Ghosh ,Control Systems', 1st edition, Pearson Education, ISBN-81-317-0828-4.
2. K. Ogata ,Modern Control Engineering' , 4th edition, Pearson, ISBN-81-7808-579-8.
3. B.C.Kuo ,Automatic Control Systems' , 7th edition, PHI,ISBN-81-203-0968-5.
4. I J Nagrath and M Gopal, Control Systems Engineering, Anshan 2008 publisher.

ECP2203	Measurement & Virtual Instrumentation Lab	(0-0-2), 1 credits

Course Learning Outcomes (CLO):

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

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

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

CLO4: Skilled to work on interfacing hardware with software.

CLO5: Skilled for the creation of new projects.

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

Recommended Books:

1. S. Sumathi and P. Surekha ,LabVIEW based advanced instrumentation system S. Sumathi and P. Surekha, springer.
2. Alan S. Morris, Reza Langari, Measurement and Instrumentation Theory and Application 2020 Edition, Elsevier publisher.
3. Tarun Kumar Rawat ,Signals and Systems' Tarun Kumar Rawat, ISBN: 978-0-19-806679-8, Oxford University Press, First Edition, Copyright © 2010.
4. S Salivahanan, C Gnanapriya ,Digital Signal Processing' , 2nd edition, Tata McGraw-Hill, ISBN:9780070669246,2, 2013.

ECL4205	Network Analysis & Synthesis	(3-1-0), 4 credits

Course Learning Outcomes (CLO):

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

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

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

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

The circuit, Energy Sources, Kirchhoff's Voltage Law, Voltage division, Kirchhoff's current law, Current division, Introduction, tree, Co-tree, twigs and links, incidence matrix(A), Incident matrix and KCL, Link currents-Tie set matrix, Cut set and tree branch voltage, Mesh Analysis, Mesh equations by inspection method, Super Mesh Analysis, Nodal Analysis, Nodal equations by inspection method, Super node analysis, State Equation for networks, Source transformation technique, Wye-delta transformation ,Superposition theorem for DC, Thevenin's theorem for DC and AC circuits, Nortan's theorem for DC and AC circuits, Reciprocity theorem for DC circuits, Maximum Power Transfer theorem for DC and AC circuits, Impedance diagram, phasor diagram, series circuits, parallel circuits, Steady state and Transient response ,DC Response of RL circuit, DC Response of RC circuit, DC Response of RLC circuit, Sinusoidal Response of RL circuit, Sinusoidal Response of RC circuit, Sinusoidal Response of RLC circuit, Laplace transform of some useful functions, Frequency Domain analysis of RLC circuits (Application of Laplace transform in circuit analysis).Two port Network, Open circuit impedance parameters, Short circuit admittance parameters, Transmission parameters, Classification of filters, filter Networks, Equations of Filter Networks (characteristic impedance, propagation constant), Pass band and stop band filters (k type).

Recommended Books:

1. Sudhakar Sham Mohan ,Network Analysis and Synthesis Sudhakar Sham Mohan, Tata McGraw Hill Publication Fourth Edition, 2004.
2. W H Hayt, J E Kemmerly, S M Durbin ,Engineering Circuit Analysis' W H Hayt, J E Kemmerly, S M Durbin,Tata McGraw Hill Publication, Seventh Edition, 2006.
3. D.Roy Choudhury ,Networks and Systems: D.Roy Choudhury; New Age International, edition 2nd, 2012.
4. Valkenburg, Network Analysis, phi publication**.**

ECL4212	Analog & Digital Communication	(4-0-0), 4 credit

Course Learning Outcomes (CLO):

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

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

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

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

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

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 Superheterodyne Receiver. Receiver Characteristics. FM Modulators and Transmitters – Methods of FM Generation; FM Receivers and Demodulators – FM Super heterodyne Receiver, Amplitude Limiter, Pre-emphasis and De-emphasis, FM Demodulators – Types. Digital versus Analog Transmissions, Sampling Theorem, Practical Aspects of Sampling. Classification of Pulse Modulation Techniques, Pulse Amplitude Modulation. Pulse Code Modulation – PCM System Block Diagram, PCM Encoding and Efficiency, Transmission Bandwidth of PCM, Quantization of Signals. Delta Modulation, Slope Overload and Granular Noise, Comparison of PCM and DM Techniques. Need and Properties of Line Codes, Line Encoding Techniques. Multiplexing in Telecommunication Networks – Fundamentals of TDM System, Synchronous and Asynchronous TDM, Comparison of TDM and FDM. Types of Digital Modulation, ASK, FSK and PSK. QPSK and Offset QPSK, Gaussian Minimum Shift Keying (GMSK)

Recommended Books:

1. T L Singal, Analog and Digital Communications, ISBN: 978-0-07-107269-4, McGraw Hill Education, First Edition, Copyright © 2012.'
2. B P Lathi and Zhi Ding, Modern Digital and Analog Communication Systems, ISBN: 978-0-19-807380-2, Oxford University Press, International 4th Edition, Copyright © 2010.'
3. T. L. Singal, Electronic Communications, ISBN: 978-93-82782-16-2, Chitkara University Publications, First Edition, Copyright © 2014.'

4. R P Singh and S D Sapre, Communication Systems: Analog and Digital, ISBN: 978-1-25-900460-5, McGraw Hill Education, Third Edition, Copyright © 2012.

ECP1206	Analog & Digital Communication Lab	(0-0-2), 1 credit

Course Learning Outcomes (CLO):

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

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

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

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

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

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

Recommended Books:

1. T L Singal, Analog and Digital Communications, ISBN: 978-0-07-107269-4, McGraw Hill Education, First Edition, Copyright © 2012.'
2. B P Lathi and Zhi Ding, Modern Digital and Analog Communication Systems, ISBN: 978-0-19-807380-2, Oxford University Press, International 4th Edition, Copyright © 2010.'
3. T. L. Singal, Electronic Communications, ISBN: 978-93-82782-16-2, Chitkara University Publications, First Edition, Copyright © 2014.'
4. R P Singh and S D Sapre, Communication Systems: Analog and Digital, ISBN: 978-1-25-900460-5, McGraw Hill Education, Third Edition, Copyright © 2012.

CS109	Core Java	(4-1-0), 5 credit

Course Learning Outcomes (CLO):

CLO1: Implement the concept of object-oriented techniques and methodologies using Java

CLO2: Use Exception Handling concepts for a Robust Application in Java.

CLO3: Demonstrate an understanding of Java Input and Output

CLO4: Develop applications using multithreading concept of Java.

CLO5: Skilled to Use and Implement several Data structures using Collection Framework.

.

Introduction: History and goals of Java, Fundamentals of OOPs, Overview of JDK, JVM, Garbage Collection, Working with Java Data Types, Using Operator Looping Constructs & Arrays: Decision Constructs, Using Loop Constructs, Creating and Using Arrays (1D, 2D, Multidimensional) Jagged Arrays, Command Line Arguments. Practice Problems Strings: Introduction, Immutable String, Methods of String class, StringBuffer class &StringBuilder class, toString method, StringTokenizer class. Classes, objects and methods: defining a class, Access Control, Method overloading, constructors, constructor overloading, use of this and static. Working with Inheritance: Inheritance Basics & Types, using super, Method Overriding, Dynamic method dispatch, final keyword. Abstract: Methods & Classes, Packages & Interfaces. Exception Handling: Exception handling fundamentals, Exception types, try and catch, multiple catch clauses, nested try, throw, throws and finally, Creating custom Exception. Practice problems. IO Streams: Stream Classes: Byte Streams, Character Streams, StreamTokenizer. Practice Problems 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, Collection Classes, Iterator, Working with Maps: Map Interfaces & Classes, Comparators, Arrays, Vector, Stack, Dictionary, Hashtables. JDBC Connectivity

Recommended Books:

1. Schildt, Herbert. (2016). Java: The Complete Reference. (9th Ed.). McGraw-Hill.
2. Bayross, Ivan (2016). Web Enabled Commercial Application Development using HTML, JavaScript, DHTML and PHP (4th ed)., BPB Publications.
3. Robbins, Niederst.(2012). Learning web designing: a beginner's guide to HTML, CSS, JavaScript. and web graphics". (4th ed).Oreilly Publication.

HUL2401	Cyber Security	(2-0-0), 2credits

Course Learning Outcomes (CLO):

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

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

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

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

Recommended Books:

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

Year 3, Semester – 5

ECL4204	Signal and Systems	(3-1-0), 4credits

Course Learning Outcomes (CLO):

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

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

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

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

Introduction to Signals and Systems Signal – Continuous Time, Discrete Time and Digital; System – Continuous and Discrete Time; Frequency Domain Analysis of Continuous and Discrete Time Signals and Systems; Importance of Signals and Systems, Continuous Time Signals and Systems Introduction; Standard Continuous Time Signals; Classification of Continuous Time Signals and their Mathematical Operations; Continuous Time System – Mathematical Equation, Response of LTI Continuous System in Time Domain; Classification of Continuous Time Systems, Laplace Transform Introduction; Region of Convergence; Properties and Theorems of Laplace Transform; Poles and Zeros of Rational Functions of s; Inverse Laplace Transform; application Laplace transform for solving electrical circuits, Fourier Series and Fourier Transform of Continuous Time Signals Review of Fourier series, Fourier Coefficients of Signals with Symmetry; Fourier Series and Fourier Transform Analysis of some important Continuous Time Signal Waveforms; Relation between Fourier and Laplace Transform, Discrete Time Signals and Systems Discrete and Digital Signals; Standard Discrete Time Signals; Sampling of Continuous Time Signals; Classification of Discrete Time Signals and their Mathematical Operations; Discrete Time System – Mathematical Equation, Response of LTI Discrete System in Time Domain; Classification of Discrete Time Systems; Discrete Convolution; Correlation, Cross correlation and Autocorrelation, Z Transform Introduction, ROC, Summary of Properties of Z transform, Poles and zeros of rational function of Z, Inverse Z transform.

Recommended Books:

1. A Nagoor Kani ,Signals and Systems’ , ISBN: 978-0-07-015139-0, McGraw Hill Education, First Edition, Copyright © 2010.
2. Tarun Kumar Rawat ,Signals and Systems’ Tarun Kumar Rawat, ISBN: 978-0-19-806679-8, Oxford University Press, First Edition, Copyright © 2010.
3. B. P. Lathi ,Principles of Linear Systems and Signals’ , ISBN: 978-0-19-806227-1, Oxford University Press, First Edition, Copyright © 2009.
4. S Salivahanan, C Gnanapriya ,Digital Signal Processing’ , 2nd edition, Tata McGraw-Hill, ISBN:9780070669246,2, 2013.

ECL4314	Linear Integrated Circuits	(3-1-0), 4 credits

Course Learning Outcomes (CLO):

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

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

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

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

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

Unit-1: Introduction to Op-Amp: Operational Amplifier, Block Diagram, 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: various parameters and 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 and Second order filters, 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.

Recommended Books:

1. Ramakant A. Gayakwad, "Op-amps and Linear Integrated Circuits", Prentice-Hall , 3rd edition.
2. T.L Singal, “Linear Integrated Circuits”, PBS Education, 1st edition.
3. S. Salivahanan, V S Kanchanna Bhaaskaran, “Linear Integrated Circuits” Tata McGraw-Hill, Year of Publication 2008.
4. Mohammad Tehranipoor, Hassan Salmani, Xuehui Zhang, ‘Integrated Circuit Authentication’ ,springer.

ECP1314	Linear Integrated Circuits Lab	(0-0-2), 1 credit

Course Learning Outcomes (CLO):

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

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

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

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

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

To investigate the application of negative feedback Operational Amplifier as Inverting and Non-Inverting configuration. Also verify them using Multisim. To observe the performance parameters of an Operational Amplifier. To observe & study frequency response of an Operational Amplifier. Measurement of Saturation limits of an Operational Amplifier. To design a Differentiator circuit and observe output with different input waveforms using Op-Amp. To design an Integrator circuit and observe output with different input waveforms using Op-Amp. To investigate an application of an OP-Amp as Schmitt trigger. To Calculate the time period and observe the waveform generated of 555 timer using Op-Amp. To observe an application of an Op Amp as 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.

Recommended Books:

1. Ramakant A. Gayakwad, "Op-amps and Linear Integrated Circuits", Prentice-Hall , 3rd edition.
2. T.L Singal, “Linear Integrated Circuits”, PBS Education, 1st edition.
3. S. Salivahanan, V S Kanchanna Bhaaskaran, “Linear Integrated Circuits” Tata McGraw-Hill, Year of Publication 2008.
4. Mohammad Tehranipoor, Hassan Salmani, Xuehui Zhang, ‘Integrated Circuit Authentication’ ,springer.

ECL4315	Microprocessor and Microcontroller	(3-1-0), 4 credits

Course Learning Outcomes (CLO):

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

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

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

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

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

Introduction; Overview of microprocessor (8085) and micro-controller (8051),features and comparison. Intel 8085 Architecture and Programming: Functional Blocks of µP and its architecture, Programming model, Function of 8085 chip pins, Introduction to instruction set, Addressing modes, Assembly language programming for 8085.Hardware Interfacing, Interrupts and serial Communication; Memory and I/O interfacing, Introduction to Interrupts and Serial Communication. Architecture of 8051:Micro-controller and Embedded Processors, Criteria for choosing a micro-controller, Overview of 8051 family, block diagram, Architecture and Instruction Set, Assembly language programming of 8051, Function of 8051 chip pins and I/O port programming, Programming Timers, Interrupts and serial communication with 8051; Programming 8051 Timers, Interrupt Programming, Serial port programming, Interfacing with RS 232.Introduction to 8086 microprocessor and its architecture.

Recommended Books:

1. N. Senthil Kumar, M. Saravanan & S. Jeevananthan, “Microprocessors and Micro-controllers", Oxford University Press, 2010.’
2. Muhammad Ali Mazidi, Janice Gillispie Mazidi and Rolin D.Mckinlay, “The 8051 Microcontroller and Embedded System”, Pearson Education, 2008.’
3. Ramesh S. Gaonkar, “Microprocessor Architecture, Programming and Applications with 8085”, Prentice Hall, 2002.’
4. Douglas V. Hall, “Microprocessors and Interfacing”, Tata McGraw-Hill, Revised Second Edition, 2006.’

ECL4303	Microelectronic Circuits	(3-1-0) , 4 credits

Course Learning Outcomes (CLO):

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

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

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

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

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

Historical Perspectives and 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. Introduction to circuit designing, CMOS Inverter: representation, CMOS working, DC-characteristics, Logic gates designing using CMOS logic, Pseudo nMOS logic, CMOS transmission gates and complementary pass transistor logic, SR Latch circuit, SR flip-flop designing, D Flip Flop designing, CMOS dynamic circuits, Domino logic, NP domino logic, Zipper domino. Introduction to memory design, 1T-DRAM cell working, Read/Write Operation, 6T-SRAM Cell Working, Read/Write Operation, 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,. Small signal model for the MOS Transistor, Common source, Common drain and Common Gate Amplifiers, Introduction to Current mirror circuit , DC Analysis Of MOS Transistor Current Mirror, Changing MOS Mirror Ratio.

Recommended Books:

1. Sung-Mo Kang and Yusuf Leblebici, “CMOS Digital Integrated Circuits Analysis and Design”, Tata McGraw Hill, 3rd Edition, 2005.’
2. Richard C. Jaeger, Travis N. Blalock, “Microelectronic Circuit Design”, McGraw-Hill, 4th edition, 2011.’
3. Donald A Neamen , “Semiconductor Physics and Devices”, Mc Graw- Hill, 4th edition, 2011.’
4. Michael John, Sebastian Smith, “Application Specific Integrated Circuits”, Pearson, 6th edition, 2009.’

ECP2303	Microelectronic Circuits Lab	(0-0-2), 1 credit

Course Learning Outcomes (CLO):

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

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

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

CLO4: Skill of using simulator.

CLO5: Skill of interfacing hardware with software.

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

Recommended Books:

1. Sung-Mo Kang and Yusuf Leblebici, "CMOS Digital Integrated Circuits Analysis and Design", Tata McGraw Hill, 3rd Edition, 2005.'
2. Richard C. Jaeger, Travis N. Blalock, "Microelectronic Circuit Design", McGraw-Hill, 4th edition, 2011.'
3. Donald A Neamen , "Semiconductor Physics and Devices", Mc Graw- Hill, 4th edition, 2011.'
4. 'Michael John, Sebastian Smith, "Application Specific Integrated Circuits", Pearson, 6th edition, 2009.'

ECP1315	Microprocessor & Microcontroller Lab	(0-0-2), 1 credit

Course Learning Outcomes (CLO):

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

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

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

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

CLO5: Skilled to create innovation through microprocessor circuit designing

8085-based experiments: Study of 8085 Microprocessor kit, Addition and subtraction of two 8-bit/ 16-bit numbers, Detection of Even/ Odd numbers, Arranging numbers in ascending/ descending order, Finding 1's and 2's complement of numbers, Multiplication of two 8-bit numbers. Study of 8086 microprocessor kit, addition of two 16-bit numbers with 8086. 8051-based experiments: Introduction to microcontroller kit and Keil software, Introduction to assembly language programming of 8051, simulation of the program for 8051 using keil software, addition of two 8-bit numbers, program to time the events using software delay, Blinking LEDs connected to a port, generate time delay using timers of 8051, display a message on LCD using a look-up table, Transmit and receive a message using serial port of 8051, using the external hardware interrupts of 8051. ATMEGA2560 Micro-controller based experiments: Introduction to ATMEGA2560 architecture, Firebird V platform, AVR Studio and Embedded C programming, Using AVR Bootloader to program Firebird V, A demo buzzer beep application, controlling the motors for moving Firebird V robotic platform in forward, backward, left and right directions, simple I/O operations using buzzer and bargraph LED display, implementing a line follower with real-time sensor reading display on LCD.

Recommended Books:

1. N. Senthil Kumar, M. Saravanan & S. Jeevananthan, "Microprocessors and Micro-controllers", Oxford University Press, 2010.'
2. Muhammad Ali Mazidi, Janice Gillispie Mazidi and Rolin D.Mckinlay, "The 8051 Microcontroller and Embedded System", Pearson Education, 2008.'
3. Ramesh S. Gaonkar, "Microprocessor Architecture, Programming and Applications with 8085", Prentice Hall, 2002.'
4. Douglas V. Hall, "Microprocessors and Interfacing", Tata McGraw-Hill, Revised Second Edition, 2006.'

ECL4316	Wireless and Mobile Communications	(3-1-0), 4 credits

Course Learning Outcomes (CLO):

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

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

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

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

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

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

Recommended Books:

1. T L Singal, Wireless Communications, ISBN: 978-0-07-068178-1, McGraw Hill Education, First Edition, Copyright © 2010.
2. Andrea Goldsmith, Wireless Communications, ISBN: 978-0-52-170416-8, Cambridge University Press, 2nd Edition, Copyright © 2008.
3. Upena Dalal, Wireless Communication and Networks, ISBN: 978-0-19-809888-1, Oxford University Press, First edition, 2014.
4. William C. Y. Lee, Mobile Communications Engineering, ISBN: 978-0-07-025220-2, McGraw Hill Publication, 2nd edition, 2008.

Year 3, Semester – 6

Department Elective I

ECL4409	Audio and Speech Processing	(2-0-0), 2 credits

Course Learning Outcomes (CLO):

CLO1: Isolated words and commands recognition.

CLO2: Skilled to recognize Continues speech.

CLO3: Dialogue systems applications

CLO4: Time and frequency domain text-to-speech synthesis.

Mechanics of Speech, Speech production: Mechanism of speech production, Acoustic phonetics - Digital models for speech signals - Representations of speech waveform: Sampling speech signals, basics of quantization, delta modulation, and Differential PCM - Auditory perception: psycho acoustics; Time domain Methods For Speech Processing, Time domain parameters of Speech signal – Methods for extracting the parameters Energy, Average Magnitude, Zero crossing Rate – Silence Discrimination using ZCR and energy – Short Time Auto Correlation Function – Pitch period estimation using Auto Correlation Function. Frequency Domain Method For Speech Processing, Short Time Fourier analysis: Fourier transform and linear filtering interpretations, Sampling rates - Spectrographic displays - Pitch and formant extraction - Analysis by Synthesis - Analysis synthesis systems: Phase vocoder, Channel Vocoder - Homomorphic speech analysis: Cepstral analysis of Speech, Formant and Pitch Estimation, Homomorphic Vocoders. Linear Predictive Analysis Of Speech, Basic Principles of linear predictive analysis – Auto correlation method – Covariance method – Solution of LPC equations – Cholesky method – Durbin's Recursive algorithm – Application of LPC parameters – Pitch detection using LPC parameters – Formant analysis – VELP – CELP. Application Of Speech & Audio Signal Processing, Algorithms: Dynamic time warping, K-means clustering and Vector quantization, Gaussian mixture modeling, hidden Markov modeling - Automatic Speech Recognition: Feature Extraction for ASR, Deterministic sequence recognition, Statistical Sequence recognition, Language models - Speaker identification and verification – Voice response system – Speech synthesis: basics of articulatory, source-filter, and concatenative synthesis.

Recommended Books:

1. R. Rabiner and R. W. Schaffer, "Digital Processing of Speech signals", Prentice Hall, 1978
2. Ben Gold and Nelson Morgan, "Speech and Audio Signal Processing", John Wiley and Sons Inc., Singapore, 2004
3. Benesty, Jacob, M. Mohan Sondhi, and Yiteng Huang, eds. Springer handbook of speech processing. Vol. 1. Berlin: Springer, 2008.
4. Rosemann, Stephanie, and Christiane M. Thiel. "Audio-visual speech processing in age-related hearing loss: Stronger integration and increased frontal lobe recruitment." Neuroimage 175 (2018): 425-437.

CLL3301	Life Skills –I	(2-0-0), 2 Credits

Course Learning Outcomes (CLO):

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

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

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

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

Know the language-
Grammar Usage- Tenses (Present Tense, Past Tense and Future Tense),Subject Verb Agreement, Modals, Prepositions, Adjectives and Adverbs, Phrasal Verbs, Common Errors in English. Phonetics- Consonants and Vowel sounds, Pronunciation , Diction, Intonation, Word and Sentence Stress, Commonly mispronounced and confusing words Build the Language-Word mapping, Verbal Ability worksheets, Antonyms, Synonyms, Homophones, Idioms and Proverbs, Prefix- Suffix, Crossword Puzzles and Vocabulary Games. Practice the Language- Reading Comprehension Practice, Elevator Speech, Expressing an opinion- Agreement, Disagreement.

Recommended Books:

1. Shechtman, Zipora, Merav Levy, and Judy Leichtentritt. "Impact of life skills training on teachers' perceived environment and self-efficacy." The Journal of Educational Research 98.3 (2005): 144-155.
2. Coffey, Osa D., and John F. Knoll. Choosing life skills: A guide for selecting life skills programs for adult and juvenile offenders. Office of Correctional Education, 1998.
3. Bastian, Veneta A., Nicholas R. Burns, and Ted Nettelbeck. "Emotional intelligence predicts life skills, but not as well as personality and cognitive abilities." Personality and individual differences 39.6 (2005): 1135-1145.
4. Papacharisis, Vassilios, et al. "The effectiveness of teaching a life skills program in a sport context." Journal of applied sport psychology 17.3 (2005): 247-254.

Department Elective II

ECL4414	Analog Layout design	(3-0-0), 3 credits

Course Learning Outcomes (CLO):

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

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

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

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

CLO5: Switching speed, gate count , and energy dissipation and power.

Introduction to CMOS physical design, Introduction to CMOS technology, Important Processes involved in IC fabrication, Fabrication steps of CMOS inverter, Demo of GDS 3D viewer, Introduction to the layout tool, Drawing-related features and functionality of the tool, Live demo of layout of basic commands, layout design rules, Live demo of virtuoso layout XL, DRC categories, DRC flow using the tool, LVS flow using the tool, Stick diagrams, Digital standard cell layouts, Introduction to standard cells, 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.

Recommended Books:

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

ECL4413	Digital Design using FPGA	(3-0-0), 3 credits

Course Learning Outcomes (CLO):

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

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

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

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

CLO5: Designing of Pseudo Random Binary Sequence generator.

Introduction to PLD, Introduction to FPGA,FPGA Example – Altera Cyclone II, Altera Quartus II,Lab, Overview of the ISE Design ,HDL-Based Design: Overview of HDL-Based Design, Getting Started, Design Description, Design Entry ,Synthesizing the Design Schematic-Based Design: Overview of Schematic-Based Design, Getting Started, Design Description , Design Entry Behavioral Simulation: Overview of Behavioral Simulation Flow, ModelSim Setup, ISim Setup. , Getting Started, Adding an HDL Test Bench , Behavioral Simulation Using Model Sim, Behavioral Simulation Using ISim Design Implementation: Overview of Design Implementation, Getting Started, Specifying Options Creating Timing Constraints, Translating the ,Using the Constraints , Assigning I/O Locations Using the PlanAhead Tool, Mapping the Design, Using Timing Analysis to Evaluate Block Delays After Mapping, Placing and Routing the Design, Using FPGA Editor to Verify the Place and Route, Evaluating Post-Layout Timing, Creating Configuration Data, Command Line Implementation. Timing Simulation: Overview of Timing Simulation Flow, Getting Started, Timing Simulation Using ModelSim Timing Simulation Using Xilinx ISim. Configuration Using iMPACT: Overview of iMPACT Device Support, Download Cable Support ,Configuration Mode Support, Getting Started ,Using Boundary-Scan Configuration Mode , Troubleshooting Boundary-Scan Configuration , Creating an SVF File . HDL and its importance, limitations of HDL, History of HDL, Design methodology, language elements: operators, number formats, identifiers, keywords, gate level modelling, data flow, behavioural modelling Designing of combinational and sequential circuits using symbols: Combinational and Describe the basic slice resources available in Spartan-6 FPGAs, Identify the basic I/O resources available in Spartan-6 FPGAs ,List some of the dedicated hardware features of Spartan-6 FPGAs, Differentiate the Virtex-6 family of devices from the Spartan-6 family, Describe the contents of a Xilinx Targeted Design Platform kit.

Recommended Books:

1. Wolf, Wayne. FPGA-based system design. Pearson Education India, 2004.
2. Ramachandran, Seetharaman. Digital VLSI systems design: a design manual for implementation of projects on FPGAs and ASICs using Verilog. Springer Science & Business Media, 2007.
3. Dubey, Rahul. Introduction to embedded system design using field programmable gate arrays. Springer Science & Business Media, 2008.
4. Chu, Pong P. RTL hardware design using VHDL: coding for efficiency, portability, and scalability. John Wiley & Sons, 2006.

ECL3312	IOT and Embedded Systems	(3-0-0), 3 credits

Course Learning Outcomes (CLO):

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

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

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

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

CLO5: Applications of Embedded system design.

Internet of Things: An Overview: Internet of Things, Characteristics of IoT, Physical Design of IoT, Logical Design of IoT, IoT conceptual Framework. IoT architectural view, Technology behind IoT, Sources of IoT, Applications of IoT. Internet of Things Protocols: Link layer protocols: 802.3, 802.16, 802.11, 802.15.4, Cellular. Network Layer and Transport Layer Protocol: TCP, UDP, IPv4, IPv6, 6LoWPAN, Application Layer Protocols: HTTP, MQTT, CoAP, XMPP, AMQP, DDS, and Web-Socket. Data Communication Models: Request-response, publish-subscribe, push-pull. Exclusive pair, REST-based, web-socket based. IoT and M2M: Introduction to M2M, M2M gateway, Difference between IoT and M2M. Communication in IoT v/s M2M. Prototyping the Embedded devices: Introduction, Embedded computing basics. Sensors and Actuators: Introduction, sensor technology, sensing the real world, analog sensor, digital sensor. Actuator. Sensor Data Communication Protocols: Serial bus communication protocols. Cloud Computing: Introduction, Architecture, characteristics, Deployment Models. Service models, service management. Fog Computing: Introduction, why Fog computing, requirements of fog computing, the architecture of fog computing, working of fog computing. Analytics using IoT Data: Using a case study approach. IoT Privacy and Security: Introduction, Vulnerabilities, security requirements and Threat analysis, security models.

Recommended Books:

1. Marwedel, Peter. Embedded system design: embedded systems foundations of cyber-physical systems, and the internet of things. Springer Nature, 2021.
2. Koulamas, Christos, and Mihai T. Lazarescu. "Real-time embedded systems: Present and future." Electronics 7.9 (2018): 205.
3. Kumar, Korupalli V. Rajesh, et al. "Internet of things and fog computing applications in intelligent transportation systems." Architecture and Security Issues in Fog Computing Applications. IGI Global, 2020. 131-150.
4. Manavalan, Ethirajan, and Kandasamy Jayakrishna. "A review of Internet of Things (IoT) embedded sustainable supply chain for industry 4.0 requirements." Computers & Industrial Engineering 127 (2019): 925-953.

ECL3313	VLSI Design and Verification	(3-0-0), 3 credits

Course Learning Outcomes (CLO):

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

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

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

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

Introduction-IO Statements, Operators and Control Statements, Pointers & Arrays, Pointers,1D & 2D arrays, Dynamic memory allocation, Structures and Recursion, Strings,Structures and Recursion, Basic Digital Design - Logic Gates, Boolean Expression,K-Map Simplification, Understanding Kmap simplification, boolean postulates, optimisation techniques Verilog HDL for Basic Digital designs Introduction to Verilog HDL,types of modelling, Test bench creation Combinational Circuit Design (Digital Design) Solving logical problems through digital design Verilog Design of Combinational circuit Understanding verilog constructs by solving combinational problems Advanced Combinational Design Complex Digital Design Verilog Design of Advanced Combinational circuit Understanding combinatorial loops,design hazards in a design Sequential circuit design Understading of flipflops,shif registers and counters Verilog Design of sequential CircuitsUnderstanding Blocking / non-blocking assignments, Clock/Reset Memory based design & FSM based designDesign of RAM,ROM, Understanding State Machines (Moore,Mealy) Timing Concepts Setup/Hold, Max-Frequency,Clock skew,IO timing FPGA Basics of FPGA, Handson exercises, Basic logic design- FIFO Design Multiclock FIFO Design Arbitration Design of Round Robin Arbiter Register Accessing Designing an register which access data through handshake FSM based packet structuring & clock generation with varying duty cycle Understading the importance of clock in a design Messaging interface Designing an message interface Streaming interface ,Packet Interface Designing a interface to store a variable size packet in memory, Advanced logic design-Multi-clock Designs, Synchronization Methods ,ASIC Design ASIC specific design guidelines, Design for Manufacturability, Clock/Reset Strategy, Die size estimation, Linting Common Design Mistakes, Understanding Lint Errors/Warnings and fixing them Timing Closure STA, Analyzing Timing reports, Fixing Timing issues – Design based/Tool based Area Optimisation Area reduction Methods, RAM based optimization, Using FPGA hard Macros Complex Logic Design Understading the design constructs and procedure to solve complex designs Developing a 4-port Ethernet Switch with FW interface and validating on board, Verfication-Basic design verifcation Basics of Testbench development Using Verilog Verifying FIFO Design Writing testbench module for FIFO design Verifying Round robin Arbitration design Understanding verification concepts Register Accessing Verifying the design FSM based packet structuring & clock generation with varying duty cycle Verifying Messaging interface Streaming interface Verification of Packet Interface System Verilog Language constructs, Practical examples, Assertions System Verilog Tasks and Functions ,UVM methodology Understading Scoreboard, Monitor, Agent, Interface, Transactor, Sequences, Interface Scalable Testbench Development Methodology, Assertions, Assertion for Design, Assertion for Features using System Verilog Coverage driven Verification Randomization, Coverage measurement and strategy /Reset Tree

Synthesis ,Clock/Reset Strategy, STA, Strategies for Fixing Timing Errors using the tool,Power Estimation, Power Libraries, Running test for Power estimation, ECO flow, Estimating changes for ECO, Performing ECO changes and doing Equivalence Checks GDS II generation, Projects- Design and verification of a Media processing algorithm core Design and verification of a Network protocol core Design and verification of a Machine learning algorithm.

Recommended Books:

1. Pucknell, Douglas A., and Kamran Eshraghian. Basic VLSI design. Prentice-Hall, Inc., 1994.
2. Wolf, Wayne. Modern VLSI design systems on silicon. Prentice-Hall, Inc., 1998.
3. Wolf, Wayne. Modern VLSI Design: a systems approach. Prentice-Hall, Inc., 1994.
4. Hill, Frederick J., and Gerald R. Peterson. Computer aided logical design with emphasis on VLSI. John Wiley & Sons, Inc., 1993.

HUL3303	Project Management	(3-0-0),3 credits

Course Learning Outcomes (CLO):

CLO1: Develop, implement and evaluate various stages including planning, scheduling and Execution of projects.

CLO2: Understand risk management, administration, costing and budgeting challenges during projects improve skill as employee and entrepreneur.

CLO3: Identify project goals, constraints and performance criteria in project implementation in entrepreneurship.

CLO4: Understanding of design process.

CLO5: Application in solving the societal issues.

Examining Professional Project Management-Identify Project Management Processes ,Identify Professional and Social Responsibilities, Identify the Interpersonal Skills Required for a Project Manager. Initiating a Project-,Examine the Project Management Context, Examine Project Selection, Prepare a Project Statement of Work, Create a Project Charter, Identify Project Stakeholders. Planning Project Work-Identify Elements of the Project Management Plan, Document Stakeholder Requirements, Create a Scope Statement, Develop a Work Breakdown Structure, Developing Project Schedules-Create an Activity List, Create a Project Schedule Network Diagram, Estimate Activity Resources, Estimate Duration for Project Activities, Develop a Project Schedule, Identify the Critical Path, Optimize the Project Schedule, Establish a Schedule Baseline, Developing Cost Estimates and Budgets-Estimate Project Costs, Estimate the Preliminary, Cost Baseline, Reconcile Funding and Costs ,Planning Project Quality, Staffing, and Communications- Create a Quality Management Plan, Document the Project Roles, Responsibilities, and Reporting Relationships, Create a Communications Management Plan, Analyzing Risks and Planning Risk Responses-Examine a Risk Management Plan, Identify Project Risks and Triggers, Perform Qualitative Risk Analysis, Perform Quantitative Risk Analysis, Develop a Risk Response Plan, Planning Project Procurement- Plan Project Procurements, Prepare a Procurement Statement of Work, Prepare a Procurement Document, Executing Project 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.

Recommended Books:

1. Herold Kerzner, Project Management, wiley publisher.'
2. Stephen Hartley, Project Management,4rth edition.'
3. Rory Burke, Project Management, fifth edition ,wiley publisher.'
4. Dr Ramesh kakad, Project Management, Thakur publisher.'

HUL3302	Digital Marketing and Entrepreneurship	(3-0-0), 3credits

Course Learning Outcomes (CLO):

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

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

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

CLO4: Implement personal skills in their employment.

CLO5: Design strategies to be a entrepreneur.

Principles of Digital Marketing: Basics of Marketing, What is Digital Marketing? Comparison of Traditional and Digital marketing. Statistics of Digital Marketing, Benefits of Digital marketing, Latest Digital marketing trends, Digital marketing platforms, Digital Marketing strategy for websites, Career opportunities in digital marketing, Website Designing with WordPress: Types of Websites, Basics of HTML/CSS/JavaScript, WordPress Installation on Server, Understanding the Dashboard, Changing the specific plugins, Search Engine Optimization (SEO): Introduction to SEO, How Do Search engines work? Search Engine Algorithms, Google Algorithm Updates, Google Search Console, Keyword Research Process, Keyword Research Tools, Competition Analysis, On page Optimization strategies, Content development strategy, Title & Meta Tags, Semantic SEO, Rich Snippets Integration, Speed Optimization, Off Page Optimization, Link Building Techniques as per latest standards, Local SEO Strategies, Penguin & Panda update recovery process Reports and SERP Management, Click here for detailed SEO Curriculum, Search Engine Marketing (SEM): Introduction to Paid Marketing, Google Ads (Google AdWords) account and billing settings Types of Campaigns, PPC Campaign Setup, AdGroups and Keywords setup Bidding strategies & Conversion Tracking, AdRank, Quality Score Optimization, Ad Formats & Ad Extensions, Shopping Campaigns, Dynamic search campaigns, Display Ads Campaigns, Remarketing campaigns, Mobile Apps Marketing, Video Marketing, Google Ads (Google AdWords) tools MCC Account, AdWords Editor Tool, 7+ Google Ads certification exam, Social Media Marketing: Introduction to social media marketing, Facebook marketing, Facebook advertising, YouTube marketing, Twitter marketing, LinkedIn marketing, Pinterest marketing, Instagram Marketing Quora Marketing, Document Sharing Site, Click Here for SMM Training Syllabus, Email Marketing: What is Email Marketing, Benefits of email marketing, Basic terminology in email marketing, Email Marketing Softwares,Building email marketing strategy, Building subscriber lists, Designing Newsletters, Types of Campaigns, Reports and analysis.

Recommended Books:

1. Dr Satinder kumar, Digital marketing insight, SPH Publisher.
2. Godfrey Parkin, Digital marketing .
3. Dr Ritika Malik and Ms.Ritika Aggarwal, Digital marketing , SPH Publisher.
4. Jamie Turner, Digital marketing , Vibrant publication.

ECL4317	Digital Signal Processing	(3-1-0), 4 credits

Course Learning Outcomes (CLO):

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

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

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

CLO4: Implementation of signal processing applications in employment

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

Discrete and Fast Fourier Transforms: Introduction, DFT of discrete time signal, 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 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 Multirate Signal Processing Introduction, Decimation and Interpolation Applications of DSP: Introduction, Applications of DSP in Biomedical Signal Processing Radar, Image Processing, Overview of TMS320 Family DSP Processors.

Recommended Books:

1. A. Nagoor Kani ,Digital Signal Processing' , Second edition, 2012, Tata McGraw-Hill Education private limited.
2 S.Salivahanan ,Digital Signal Processing' , third edition-2015 Tata McGraw-Hill Education private limited.
3 John G. Proakis, Dimitris G. Manolakis ,Digital Signal Processing' , Prentice Hall of India Pvt. Ltd., 4th edition.
4 Alan V. Oppenheim and Ronald W. Schafer, Digital Signal Processing ,pearson.'

ECP1305	Digital Signal Processing Lab	(0-0-2), 1 credit

Course Learning Outcomes (CLO):

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

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

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

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

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

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

Recommended Books:

1. A. Nagoor Kani ,Digital Signal Processing' , Second edition, 2012, Tata McGraw-Hill Education private limited.
2. S.Salivahanan ,Digital Signal Processing' , third edition-2015 Tata McGraw-Hill Education private limited.
3. John G. Proakis, Dimitris G. Manolakis ,Digital Signal Processing' , Prentice Hall of India Pvt. Ltd., 4th edition.
4. Alan V. Oppenheim and Ronald W. Schafer, Digital Signal Processing ,pearson.

ECL4322	Electromagnetic Waves & Antennas	(3-1-0), 4 credits

Course Learning Outcomes (CLO):

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

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

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

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

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

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

Recommended Books:

1. Matthew N.O. Sadiku ,Principles of Electromagnetics' ' Matthew N.O. Sadiku, Fourth Edition International version, Oxford University Press.'
2. Fawwaz T. Ulaby ,Electromagnetics for Engineers' ,Pearson Education, Inc. 2005.'
3. Constantine A. Balanis, John Wiley & Sons ,Antenna Theory Analysis and Design' Constantine A. Balanis, John Wiley & Sons, Inc., Second Edition.
4. KD Prasad',Antenna and Wave Propagation' , Satya Prakashan.'

ECL4311/ECP2313	VLSI Design / VLSI design Lab	(3-1-4), 6 credits

Course Learning Outcomes (CLO):

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

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

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

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

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 Behavioral Modeling, Structured Procedures, Timing controls, Conditional Statements, Procedural Assignments, Multiway Branching, Loops, Sequential and Parallel Blocks, Design using Algorithmic State Machine Charts. Introduction Fault Types and Models, Ad Hoc Testable Design Techniques, Scan-Based Techniques, Built-In Self Test (BIST) Techniques

Recommended Books:

1. Verilog HDL Guide' by Samir Palnitkar, Pearson, 2nd Edition,2001.
2. CMOS Digital Integrated Circuits Analysis and Design' by Sung-Mo Kang and Yusuf Leblebici, Tata McGraw Hill Publication, 3rd Edition, 2005.
3. Essentials of Electronics Testing for digital memory & mixed signal VLSI Circuits' by Bushnell and Aggarwal, Kluwer Academic Publishers, 1st Edition, 2002.
4. Verilog HDL synthesis: A Practical Primer' by J. Bhaskar, Star Glaxy Publishing, 2nd edition , 1998.

GTI4301	Numerical Ability and Logical Reasoning	(3-1-0), 4credits

Course Learning Outcomes (CLO):

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

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

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

CLO4: Draw logical conclusions

CLO5: Problem solving strategies.

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

Recommended Books:

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

3. Sternberg, R. J., & Ben-Zeev, T. (Eds.). (1996). The nature of mathematical thinking. Routledge.
4. Carter, Philip. The complete book of intelligence tests: 500 exercises to improve, upgrade and enhance your mind strength. John Wiley & Sons, 2009.

Open Elective I

CSA3211	Data Analytics	(5-0-0), 5 credits

Course Learning Outcomes (CLO):

CLO1: Apply knowledge of dispersion on grouped and ungrouped data cases.

CLO2: Skilled to evaluate discrete and continuous probability distributions to various business problems in entrepreneurship.

CLO3: Perform Test of Hypothesis as well as calculate confidence interval for a population parameter.

CLO4: Calculate confidence interval for a population parameter.

CLO5: Application and its utilization.

Introduction to SAS and SAS Programs, What is Analysis and Analytics, What is SAS and Why SAS Overview of SAS Submitting a SAS Program, SAS Program Syntax, What is Analysis and Analytics, What is SAS and Why SAS Overview of SAS, Submitting a SAS Program, SAS Program Syntax, Sorting and Grouping, Reporting Data, Using SAS Format, Reading SAS Datasets, Reading Excel Data, Reading Raw Files, Reading Database Data, Creating Summary Reports, Combining Datasets, Creating Summary Reports, Combining Datasets, Accumulating total, Creating Accumulating total for a group of data, Transposing Data, Debugging Data, Reading Formatted input, Transposing Data, Debugging Data, Reading Formatted input, Do Loop Processing, Conditional Do Loop Processing, SAS Array Processing, Using SAS Arrays, Overview of SAS Foundation, Purpose of the Macro Facility, Program Flow, Introduction to Macro Variables, Automatic Macro Variables, User Defined Macro Variables, Macro Variable Reference, Introduction to Macro Variables, Automatic Macro Variables, User Defined Macro Variables, Macro Variable Reference, Creating Macro Variables in the Data Step, Indirect Reference to Macro Variables ,Creating Macro Variables in SQL, Macro Programs, Conditional Processing, Parameter Validation, Iterative Processing, Introduction to SQL, Overview of SQL Procedure, Specifying Columns, Specifying Rows, Presenting Data, Summarizing Data, Inner Join, Outer Join, Complex SQL Joins, The Union, Outer Union, Except, Intersect Operator, Creating Tables and Views.

Recommended Books:

1. Shah, Tanveer H. "Big data analytics in higher education." Research Anthology on Big Data Analytics, Architectures, and Applications (2022): 1275-1293.
2. Chang, Hyejung. "Book review: Data-driven healthcare & analytics in a big data world." Healthcare informatics research 21.1 (2015): 61-62.
3. Sun, Zhaohao, and Andrew Stranieri. "The Nature of Intelligent Analytics." Intelligent Analytics With Advanced Multi-Industry Applications. IGI Global, 2021. 1-21.
4. Atzmueller, Martin, Dennis Mollenhauer, and Andreas Schmidt. "Big data analytics using local exceptionality detection." Enterprise Big Data Engineering, Analytics, and Management. IGI Global, 2016. 108-125.

CSL5349	Essential Programming Concepts	(4-1-0), 5 credits

Course Learning Outcomes (CLO):

CLO1: Students will gain an in-depth knowledge about overall syntax and semantics

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

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

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

CLO5: Incorporation of programming in real time applications

Module-1: Structure of a c program, Writing C program, Compilation, Linking & Execution, Using comments , Identifiers: Nomenclature of an Identifier, Variables, Constants, Reserved Keywords Data Types: Introduction , Initialization and Declaration of Data Type, Expressions, Statements, Symbolic Constants, Type Conversion / Type Casting, Input Output in C: Introduction, scanf(), printf( ), Operators : Operations: Arithmetic, Relational, Logical, Assignment, Conditional, sizeof , Precedence. Decision Control Construct :Conditional Statements: if , if – else, Nested if –Else, switch, conditional operator, Looping: Types of Loops: while, do – while, for ,Nested loops, Continue, break. Functions: User defined functions, Recursion , Storage classes, Arrays: Introduction, Need & Importance, Types of Arrays: One Dimensional Arrays, Two Dimensional Arrays, Initialization of arrays ,inputing values ,assigning Values, Multi-Dimensional Arrays , Declaration of an Array , Initialization of an Array, Passing 1d to Function, passing two dimensional array to function, Sparse Matrix, Strings : Reading and writing strings String functions (Predefined), isalpah(),isdigit(),isspace() strcat(),strncat(),strcpy(),strncpy(),strlen(),strncpy, Implementing user defined functions for Strcpy,strlen,strcmp,strlwr,strupr,strcat, Pointers, Introduction to pointer :Pointer expression and pointer arithmetic Assignment, Value finding (dereferencing),Taking a pointer address, Adding an integer to a pointer, Incrementing a pointer, File Handling : File pointer, open file, close file Read data from file, fgetc(), fgets(), fscanf(), fprintf() , writing data from a file, fputc(),fputs(),fprintf(),fwrite() ,Difference between Text Mode, Binary Mode, Detecting End-of-file , Accepting command line arguments, Functions for selecting record randomly fseek(), ftell(), rewind(), Difference between Text Mode, Binary Mode, Detecting End-of-file Accepting command line arguments ,Functions for selecting record randomly fseek(), ftell(),rewind(). PreProcessor Directive And Revision, Structure : Declaring Structure Accessing members of Structure, Copying Structure Accessing Structure elements, Nested Structure Array of structure, passing structure elements to a function individually Passing entire structure to a function. Union: Union Accessing member of Union Unions Inside structure ,Pointer to structure ,Passing pointer of structure to function, Pointers and strings Passing pointer to a function, Representing arrays as pointer, Arrays of pointers, Null pointers, Generic pointer ,Dynamic Allocation of Arrays, Allocating block of memory ,Releasing the used block, To Alter the size of allocated memory ,Allocating memory to single dimensional array, Allocating memory to two dimensional array, PreProcessor Directive And Revision.**Module-2:** 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) Virtual Functions and Polymorphism: Understanding Polymorphism, Base Class Pointer, Virtual Function, Pure Virtual Functions, Abstract Classes, Virtual Destructors, Early vs Late binding. 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. 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 datareading and writing, Accessing records randomly. Standard Template Library: Introduction to the STL Architecture, STL Components, Containers, Algorithms, Iterators, Applications of Container Classes, Using the vector Container, Accessing Elements in a vector Container and Operations on a vector Container.

Recommended Books:

1. Kelley, A., & Pohl, I. (1984). A book on C. Benjamin-Cummings Publishing Co., Inc..
2. Banahan, Mike, Declan Brady, and Mark Doran. "The C book." GBdirect (1991).
3. Cox, Brad J. Object oriented programming: an evolutionary approach. Addison-Wesley Longman Publishing Co., Inc., 1986.
4. Vihman, Marilyn May. Phonological development: The origins of language in the child. Blackwell Publishing, 1996.

CSL5210/CSP2210	Data Structures/Lab	(4-0-2) , 5credits

Course Learning Outcomes (CLO):

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

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

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

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

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

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

Recommended Books:

1. Seymour Lipschutz, Data Structures, Schaums' Outlines Indian Adapted Edition 2006, Tata McGraw-Hill.
2. Tanenbaum, Augenstein, & Langsam, Data Structures using C and C++, Prentice Hall of India, Second edition.
3. Richard Gilberg, Behrouz Forouzan, Data Structures, Second edition.
4. Samet, Hanan,The design and analysis of spatial data structures. Vol. 85. Reading, MA: Addison-Wesley, 1990.

CSL4318	Advanced Programming Concepts	(4-1-0), 5 Credits

Course Learning Outcomes (CLO):

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

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

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

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

CLO5: Incorporation of programming in real time applications

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 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 Userdefined functions Recursion Storage classes Arrays: Introduction, Need & Importance Types of Arrays: One Dimensional Arrays ,Two Dimensional Arrays, Initialization of arrays, inputing values, assigning Values Multi-Dimensional Arrays Declaration of an Array Initialization of an Array Passing 1d to Function, passing two dimensional array to function.Sparse Matrix Strings Reading and writing strings String functions (Predefined) isalpah(),isdigit(),isspace() strcat(),strncat(),strcpy(),strncpy(),strlen(),strncpy Implementing user defined functions for Strcpy,strlen,strcmp,strlwr,strupr,strcat Arrays of strings. Pointers Introduction to pointer Pointer expression and pointer arthimetic Assignment, Value finding (dereferencing),Taking a pointer address, Adding an integer to a pointer, Incrementing a pointer Pointers and strings Passing pointer to a function, Representing arrays as pointer,Arrays of pointers,Null pointers,Generic pointerDynamic Allocation of ArraysAllocating block of memoryReleasing the used blockTo Alter the size of allocated memoryAllocating memory to single dimensional arrayAllocating memory to two dimensional arrayStructure –IDeclaring StructureAccessing members of StructureCopying StructureAccessing Structure elementsNested StructureArray of structure,passing structure elements to a function individually. Passing entire structure to a functionUnionAccessing member of UnionInside structurePointer to structurePassing pointer of structure to functionFile HandlingFile pointer,openfile,close fileRead data from filefgetc(),fgets(),fscanf(),fprintf()writing data from a filefputc(),fputs(),fprintf(),fwrite()Difference between Text Mode, Binary Mode,Detecting End-of-fileAccepting command line argumentsFunctions for selecting record randomlyfseek(),ftell(),rewind()Difference between Text Mode, Binary Mode,Detecting End-of-fileAccepting command line argumentsFunctions for selecting record randomlyfseek(),ftell(),rewind()PreProcessor Directive And Revision.

Recommended Books:

1. Finkel, Raphael A., and Raphael A. Finkel. Advanced programming language design. Reading: Addison-Wesley, 1996.

2. Pattis, R. E., Roberts, J., & Stehlik, M. (1995). Karel the robot a gentle introduction to the art of programming. John Wiley & Sons, Inc..
3. Stevens, W. R., & Rago, S. A. (2013). Advanced Programming in the UNIX Environment: Advanc Progra UNIX Envir_p3. Addison-Wesley.
4. Roy, Uttam Kumar. Advanced Java Programming. Oxford University Press, 2015.

CSL4320	Advanced Object Oriented Programming	(4-1-0), 5 Credits

Course Learning Outcomes (CLO):

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

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

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

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

CLO5: Incorporation of programming in real time applications

C++ Fundamentals: iostream Namespace Use of c in and c out Comments Declaring Variables Scope Arithmetic operators and operator Precedence Increment ,Decrement operators Control Structure(Selection And looping) Relational operator Logical operators if.else Switch While For Do.while Break Continue Arrays Declaring arrays Initialisation Accessing an arrays Multi-Dimensioned arrays User defined functions(i)Reference variable Call by value Call by reference Functions(ii)Static variable, global variable Function overloading Default arguments Classes And Objects Defining data members ,member functions Defining member functions outside class Making it inline Classes And Objects IINesting of member functions Private member function Static data members Static member functions Arrays of objects Const member functions Friend functions and Friend classes Constructor And Destructor Parameterized constructor Default constructor Constructor with default arguments Declaring pointers Use of new and delete Copy constructor Destructor Operator Overloading Overloading unary operator Overloading binary operator Type conversion String Object Creating String Objects Manipulating String Objects Relationsal operators String Characterstic Inheritance (I)Base Class And Derived Class Public, private and protected data members Constructor And Destructor In derived class Public ,private And protected Inheritance Inheritance(ii) Polymorphisim Invoking Base class Objects with Derived class Aiming derived class pointers at Base class Objects Derived class member function call via base class Pointers Virtual Functions Abstract class And Pure Virtual Functions Dynamic Binding Templates Function templates Class templates Non Type Paramaters and default type for class type Exception Handling When to use Exception Handling Rethrowing an Exception Stack Unwinding Processing new failure Class auto_ptr and Dynamic Memory Allocation Exception Handling Basics of exception handling Throwing Mechanism Catching Mechanism Rethrowing an exception File Handling Creating A Sequential File Reading data From Sequential File Random Aceess file Introduction To STL Components of STL Containers Algorthim Interators Application of Container Classes Shared Pointersm Auto_ptr Memory Leak in C++Function pointers Pointers vs references .

Recommended Books:

1. Odell, James J. Advanced object-oriented analysis and design using UML. Vol. 12. Cambridge University Press, 1998.
2. Rumbaugh, J., Blaha, M., Premerlani, W., Eddy, F., & Lorensen, W. E. (1991). Object-oriented modeling and design (Vol. 199, No. 1). Englewood Cliffs, NJ: Prentice-hall.
3. Lutz, M. (2013). Learning python: Powerful object-oriented programming. " O'Reilly Media, Inc.".
4. Coad, Peter, and Edward Yourdon. Object-oriented analysis. Yourdon press, 1991.

CSP2332	Advanced Networking Concepts	(4-1-0), 5 credits

Course Learning Outcomes (CLO):

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

CLO2: Acquire theoretical knowledge about the different network technologies

CLO3: Understand the functioning of different layers in OSI model and TCP/IP .

CLO4: Identify various system security and protection issues.

CLO5: Skilled to Administer the system for managing its resources.

Introduction: Data Communications, LANs , WANs and Internetworks, Topologies, Protocols and Standards, Protocol data units and Data Encapsulation, Concepts of layer protocols and layer interfaces, TCP/IP reference model, comparison of OSI &TCP/IP reference models, Addressing : Physical Addressing, Logical Addressing, Port Addressing and User Specific Address, Networking Devices. Physical Layer: Communicating Signals, Transmission media (Guided and Unguided), Switching (Circuit Switched Network, Datagram and Virtual Circuit networks), Cable TV and DSL. Data Link Layer: Design Issues, Error detection and correction techniques (checksum, hamming code, parity bit, cyclic redundancy check), Framing, Bit oriented and Byte oriented approach, Flow Control and Error Control, Protocols (Noiseless Channel and Noisy Channel), Simplest, Stop and Wait, sliding window protocols, Piggybacking, HDLC, PPP. Medium Access Sub layer: The channel allocation, Media Access Protocols (Random Access, Controlled Access and Channelization) IEEE standards 802 for LAN & MAN,Network Layer: Design issues, Routing Processes (Static Routing and Dynamic Routing), Routing Protocols (RIP, OSPF, EIGRP), Congestion control Algorithms, IP addresses IPv4 Protocol, IPv4 Header, Subnetting, Variable Length Subnet Mask. Transport Layer: Transport Services, Service Point Addressing, Elements of Transport protocols,UDP: Features, UPD header, Checksum Calculation,TCP : Features of TCP, Concept of sequencing, TCP connection : 3 way Handshaking ,Congestion Control in TCP, protocol,Application Layer: Remote Login, DNS, HTTP, WWW, FTP, SMTP, E-mail, world wide web, multimedia.

Recommended Books:

1. 'Data Communications and Networking' by Forouzen, Third edition,
2. 'William Stallings ,Data Communication' William Stallings
3. Networking Fundamentals by Cisco
4. Routing Protocols and Concepts by Cisco.

Year 4, Semester – 7
Department Elective III

CSL3308	Artificial Intelligence and Expert System	(3-0-0), 3 credits

Course Learning Outcomes (CLO):

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

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

CLO3: Skilled to solve techniques associated with artificial intelligence

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

CLO5: Skilled to solve intelligence expert system.

Introduction: Artificial Intelligence and its applications, Artificial Intelligence Techniques, criteria of success. Intelligent Agents: Intelligent Agents, Nature and structure of Agents, Learning Agents. Problems, Problem Spaces & Search: Defining problem as a space, State space search, production system, control strategies, heuristic search, problem characteristics, production system, characteristics, issues in the design of search programs. Heuristic Search Techniques: Generate and test, Hill climbing, best first search, A* search, Constraint satisfaction problem, Means-end analysis. Knowledge representation: Representations & Mappings, Approaches to knowledge representation, procedural vs declarative knowledge, Forward vs. Backward reasoning, Matching, conflict resolution.
Predicate Logic: Logic representation, Propositional logic - statements, variables, symbols, connective, truth value, contingencies, tautologies, contradictions, antecedent, consequent, argument; Predicate logic - expressions, quantifiers, formula; Representing "IsA" and "Instance" relationships, computable functions and predicates; Resolution. Symbolic reasoning under uncertainty: Introduction to Non-monotonic reasoning, Logic for Non-monotonic reasoning, Depth first search, Breadth first search. Statistical Reasoning: Probability and Baye's theorem, Bayesian networks, Fuzzy logic. Natural Language processing: Introduction, Syntactic processing, Semantic and pragmatic analysis.Expert system Introduction, Knowledge acquisition, Knowledge base, working memory, Inference engine, Expert system shells, Explanation, Application of expert systems.

Recommended Books:

1. Kevin Night and Elaine Rich, Nair B., "Artificial Intelligence (SIE)", Mc Graw Hill-2008.
2. Ela Kumar, Artificial Intelligence I. K. International Pvt Ltd.
3. Stuart Russel and Peter Norvig "AI – A Modern Approach", 2nd Edition, Pearson Education 2007.
4. Peter Jackson, "Introduction to Expert Systems", 3rd Edition, Pearson Education, 2007.

ECL4407	Optical Communication	(3-0-0), 3 credits

Course Learning Outcomes (CLO):

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

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

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

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

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

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

Recommended Books:

1. John M Senior ,Optical Fiber Communications ; Pearson Education, Third Edition.
2. Djafar K. Mynbaev & Lowell L, Fiber-Optics Communications Technology . Scheiner Prentice Hall, 2006.
3. R.P. Khare, Fiber Optics and Optoelctronics , Oxford publication, First edition.
4. Gerd keiser, Optical Fiber Communications, 5E.

ECL4319	Information Theory and Coding	(3-0-0), 3 credits

Course Learning Outcomes (CLO):

CLO1: Design the channel performance using Information theory:

CLO2: Comprehend various error control code properties

CLO3: Apply linear block codes for error detection and correction

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

CLO5: Apply different codes for performance analysis for error and correction.

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

Recommended Books:

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

Department Elective IV

ECL4406/ECP1406	Mechatronics/ Mechatronics lab	(0-0-6), 3 credits

Course Learning Outcomes (CLO):

CLO1: Understand key elements of Mechatronics system, representation into block diagram

CLO2: Understand concept of transfer function, reduction and analysis

CLO3: Understand principles of sensors, its characteristics, interfacing with DAQ microcontroller

CLO4: Skilled to understand the system modeling and analysis in time domain and frequency domain

Introduction to Mechatronics System: 9 Key elements – Mechatronics Design process –Design Parameters – Traditional and Mechatronics designs – Advanced approaches in Mechatronics - Industrial design and ergonomics, safety. System Modelling: Introduction-model categories-fields of application-model development-model verification-model validation-model simulation-design of mixed systems-electro mechanics design-model transformation- domain-independent description forms-simulator coupling. Real Time Interfacing: Introduction-selection of interfacing standards Elements of Data Acquisition & control Systems- Over view of I/O process, General purpose I/O card and its installation, Data conversion process, Application Software- Lab view Environment and its applications, Vim-Sim Environment & its applications -Man machine interface. Case Studies On Mechatronic System: Introduction, Fuzzy based Washing machine, pH control system, Autofocus Camera exposure control, Motion control using D.C. Motors & Solenoids, Engine management systems, Controlling temperature of a hot/cold reservoir using PID, Control of pick and place robot, Part identification and tracking using RFID, Online surface measurement using image processing.Micro Mechatronic System: Introduction, System principle, Component design, System design, Scaling laws, Micro actuation, Micro robot, Micro pump, Applications of micro mechatronic components.

Recommended Books:

1. Devdas shetty, Richard A. Kolk, Mechatronics System Design, 2nd Edition,Cengage Learning
2. George pelz, Mechatronic Systems: Modeling and simulation with HDL's, John Wiley and sons Ltd, 2003
3. Bishop, Robert H, Mechatronics Hand book, CRC Press, 2002
4. Bradley, D. Dawson, N.C. Burd and A.J. Loader, Mechatronics: Electronics in Products and Processes, CRC Press 1991, First Indian print 2010.

EC262	Machine Learning	(3-0-0), 3 credits

Course Learning Outcomes (CLO):

CLO1: Understand and implement classical machine learning models and algorithms using python programming concepts.

CLO2: Develop Skills of using of recent machine learning software to identify the problems

CLO3: Choose the relevant models and algorithms to turn available data into valuable and useful Information

CLO4: To make the new applications to solve the societal issues.

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 Neighbours (KNN), Introduction and building a Decision Tree. Representing disjunctive concepts as trees and rules, Random Forest Discriminative Learning models: Support Vector Machine (SVM) and its Kernels, Unsupervised Learning: Introduction to clustering, Unsupervised Learning: Introduction to clustering, k-Means clustering algorithm and Hierarchical Clustering, Supervised learning after clustering, Introduction to regression

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

Recommended Books:

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

ECL4411	Wireless Sensor Networks	(3-0-0), 3 credits

Course Learning Outcomes (CLO):

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

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

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

CLO4: Efficient operation in modern applications including healthcare

CLO5: Application in modern technology

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

Recommended Books:

1. KazemSohraby Daniel Minoli ,Wireless Sensor networks: Technology, Protocols & Applications' ,TaiebZnati, Wiley India Pvt Ltd.
2. Holger Karl & Andreas Willig, Protocols & Architectures for Wireless Sensor Networks', John Wiley,2005.
3. Sunil Gupta and Dr. Harish,Wireless Sensor Networks' , katson publisher .'
4. Liam I. Farrugia,' Wireless Sensor Networks, Nova.

Department Elective V

ECL4403	Microwave and Satellite Communication	(3-0-0), 3 Credits

Course Learning Outcomes (CLO):

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

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

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

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

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

Microwave: Introduction to microwave, Two Cavity klystrons, Reflex klystrons, magnetrons and TWT.Microwave Component and devices: Analysis of MW components using s-parameters , junctions, directional coupler , bends and corner, MW posts, S.S.Tuner, attenuaters, phase shifter, ferrite devices (isolator , circulator , gyrator), cavity resonator ,matched termination. classification of solid state microwave devices, microwave transistors, diode(tunnel, varactor,PIN),transferred electron devices(Gunn Diode) ,Avalanche transit time effect. Radar Communication : 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 . Satellite communication: Origin of Satellite Communication, Technical characteristics of a satellite communications, Advantages of Satellite Communication, Active & Passive satellite. Communication Satellite Link Design: Introduction, general link design equation, system noise temperature, C/N & G/T ratio, atmospheric &econospheric effects on link design, complete link design, interference effects on complete link design, earth station parameters.Earth station parameter.

Recommended Books:

1. Microwave and Radar Engineering , M.Kulkarni , Umesh publication , 3rd edition
2. Satellite Communication, Timothy Pratt, Charles W. Bostian , Jeremy E.Allnutt , 2nd edition
3. Satellite Communication, Dr.DC Agarwal , Khanna publishers, 5th edition
4. 'R.S.Rao ,Microwave Engineering', , PHI publishers'

ECP1403	Microwave and Satellite Communication Lab	(0-0-2), 1 Credits

Course Learning Outcomes (CLO):

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

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

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

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

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

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

Recommended Books:

1. M.Kulkarni ,Microwave and Radar Engineering , Umesh publication , 3rd edition.
2. Timothy Pratt, Charles W. Bostian ,Satellite Communication, , , 2nd edition.
3. Dr.DC Agarwal ,Satellite Communication', Khanna publishers, 5th edition.
4. R.S.Rao ,Microwave Engineering', PHI publishers.

ECL4404/ECP1404 Digital Image Processing/Lab	**(3-0-2), 4 credits**

Course Learning Outcomes (CLO):

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

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

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

CLO4: Applications of image processing in recognition

CLO5: Applications in real-time problem solving

Fundamental steps in Digital Image Processing, Components of digital image processing system, elements of visual perception, Structure of the human eye, Image formation in the eye, Simple image formation model, Image Sampling and Quantization, Basic relationship between pixels, Linear and Non-Linear operations, Gray level transformations, Piecewise linear transformation, Histogram processing, enhancement using Arithmetic/ logic operations, Basics of spatial filtering, Smoothing and sharpening spatial filters, Use of first order and second order derivative in enhancement, Fourier Transform and the Frequency Domain, Basis of Filtering in Frequency Domain, Filters – Low-pass, High-pass; Correspondence Between Filtering in Spatial and Frequency Domain; Smoothing Frequency Domain Filters – Gaussian Lowpass Filters; Sharpening Frequency Domain, Filters – Gaussian High pass Filters; Homomorphic Filtering,Basic Morphological Operations, Dilation, erosion, Opening & Closing, morphological Algorithms – Boundary Extraction, Region Filling, Extraction of Connected Components, Convex Hull, Thinning, Thickening, Introduction to Image Segmentation, Detection of discontinuties, Pixel-Based Approach, Multi-level Thresholding, Local Thresholding, Region-based Approach, Edge and Line Detection: Edge Detection, Edge Operators, Thresholding, Basic global thresholding, Adaptive thresholding, Region based segmentation, region growing, splitting and merging,A Model of Restoration Process, Noise Models, Restoration in the presence of Noise only-Spatial,Filtering – Mean Filters: Arithmetic Mean filter, Geometric Mean Filter, Order Statistic Filters – Median Filter, Max and Min filters; Periodic Noise Reduction by Frequency Domain Filtering – Bandpass Filters; Inverse Filter, Minimum Mean-square Error Restoration.

Recommended Books:

1. Niblack, Wayne. An introduction to digital image processing. Strandberg Publishing Company, 1985.
2. Bhabatosh, Chanda. Digital image processing and analysis. PHI Learning Pvt. Ltd., 1977.
3. Baxes, Gregory A. Digital image processing: principles and applications. John Wiley & Sons, Inc., 1994.
4. Gonzalez, Rafael C., Richard E. Woods, and Barry R. Masters. "Digital image processing." (2009): 029901-029901.

ECL4412/ECP1412 Advance Wireless Communication/Lab (3-0-2), 4credits

Course Learning Outcomes (CLO):

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

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

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

CLO4: Efficient operation in modern applications including healthcare

CLO5: Application in modern technology

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

Recommended Books:

1. Cooklev, Todor. Wireless communication standards: A study of IEEE 802.11, 802.15, 802.16. IEEE Standards Association, 2004.
2. Golomb, Solomon W., and Guang Gong. Signal design for good correlation: for wireless communication, cryptography, and radar. Cambridge University Press, 2005.
3. Sripimanwat, Keattisak. Turbo code applications. Springer, 2005.
4. Barry, John R., Edward A. Lee, and David G. Messerschmitt. Digital communication. Springer Science & Business Media, 2012.

ECL4401	Embedded System Design	(3-1-0), 4 credits

Course Learning Outcomes (CLO):

CLO1: The students would be able to understand fundamental concepts and technologies related to embedded system and IoT based devices.

CLO2: The students would be able to understand the fundamentals of RTOS and application development techniques

CLO3: The students would be able to understand the various communication and networking protocols used for developing IoT enabled devices for employment.

CLO4: Skilled to understand the application development techniques.

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

Recommended Books:

1. Raj kamal ,Embedded System Design- architecture, programming and design , Second edition, Tata Mc-Graw hill.
2. David E Simon ,An Embedded Software Primer , first edition, Pearson.
3. James K.Peckol ,Embedded System Design,wiley.
4. Daniel Lacamera,Embedded System Architecture,packt.

ECP2401	Embedded System Design Lab	(0-0-2), 1credits

Course Learning Outcomes (CLO):

CLO1: Skill to design the various application-oriented embedded system and IoT devices.

CLO2: Implement different communication and networking protocols used for developing IoT enabled devices as entrepreneur.

CLO3: Skill of hands-on training.

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

Recommended Books:

1. Raj kamal ,Embedded System Design- architecture, programming and design , Second edition, Tata Mc-Graw hill.
2. David E Simon ,An Embedded Software Primer , first edition, Pearson .'
3. James K.Peckol ,Embedded System Design,wiley.'
4. Daniel Lacamera,Embedded System Architecture,packt.'

ER101	CEED Acceleration Program(CAP) Cohort-II-Module I	(0-0-6), 3 credits

Course Learning Outcomes (CLO):

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

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

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

CLO4: Implement personal skills in their employment.

CLO5: Design strategies to be a entrepreneur.

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

Recommended Books:

1. Barilan, Y. Michael. "From hope in palliative care to hope as a virtue and a life skill." Philosophy, Psychiatry, & Psychology 19.3 (2012): 165-181.
2. Super, Sabina, Kirsten Verkooijen, and Maria Koelen. "The role of community sports coaches in creating optimal social conditions for life skill development and transferability–a salutogenic perspective." Sport, education and society 23.2 (2018): 173-185.
3. Meyer, Kimberly A. Students' perceptions of life skill development in project-based learning schools. Minnesota State University, Mankato, 2015.
4. Education, Kallakurichi. "Importance of Life Skill.

ER102	CEED Acceleration Program(CAP) Cohort-II- Module II	(0-0-6), 3 credits

Course Learning Outcomes (CLO):

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

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

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

CLO4: Implement personal skills in their employment.

CLO5: Design strategies to be a entrepreneur.

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

Recommended Books:

1. Raven, James. The Business of Books: Booksellers and the English Book Trade 1450-1850. Yale University Press, 2007.
2. Schiffrin, André. The business of books: How international conglomerates took over publishing and changed the way we read. Verso, 2001.
3. Martin, Bill, and Xuemei Tian. Books, bytes and business: the promise of digital publishing. Routledge, 2016.
4. Ottman, Jacqueline, and N. B. Books. "Green marketing: opportunity for innovation." The Journal of Sustainable Product Design 60.7 (1998): 136-667.

Appendix-A

Course Code	Title of the Course	Course Learning Outcomes(CLOs)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
AML5101	Engineering Mathematics – I	CLO1: Define vector space, subspace, basis, dimension and spanning set of a vector space.	L											
		CLO2: Compute eigen values, eigenvectors, inverse and rank of matrices.		M										
		CLO3: Explain geometry of a complex plane and state properties of analytic functions.		L										
		CLO4: Skilled to calculate the Taylor and Laurent series of a function of complex variable about a given point.			M									M
ECL5101	Basics of Electronics Engineering	CLO1: Students would know the basics of electronics elements, their functionality and applications. They would be able to perceive the concept of logic gates and integrated circuits in electronics.	L											
		CLO2: Skilled to interpret the characteristics of various types of diodes and transistors to describe the operation of related circuits for evolving engineering solutions.											L	
		CLO3: Students would be able to apply fundamental principles of		M			L							

			electronics together with analytic tools to evaluate and describe physical situations appropriate to address a scientific problem.											
		CLO4:	Students would possess a skill to explore physical systems by setting up experiments, collecting and analysing data, identifying sources of uncertainty, and interpreting their results in terms of the fundamental principles and concepts of electronics.				M							
		CLO5:	Skilled to apply fundamental principles of electronics together with analytic tools					M						M
ECP1101	Basics of Electronics Engineering Lab	CLO1:	After completing the course, students would know the basics of electronics elements, their functionality and applications and would be able to design basic electronics projects.	M										
		CLO2:	They would be able to analyze and characterize the electronic circuits and have basic understanding for their implementation.	L	L									
		CLO3:	They would possess a skill to perceive the concept of logic gates like XOR and X-NOR and integrated circuits in electronics.				L							
		CLO4	Skill of explaining the basics of electronics fundamentals				L						L	

MEL4102	Engineering Graphics	CLO1:	Improve the technical writing, basic sketching and drawing.	L				L							
		CLO2:	Skill to use engineering scale effectively					M							
		CLO3:	Use dimensioning effectively.						M						
		CLO4:	Use development of surfaces.				M								
MEP1102	Engineering Graphics Lab	CLO1:	Improve the technical writing, basic sketching and drawing.	L									M		
		CLO2:	Skill to use engineering scale effectively					M							
PYL5101	Engineering Physics	CLO1:	Apply the knowledge of physics through fundamental concepts together with analytical tools in everyday life.	M					L						
		CLO2:	Skill to analyze a physical problem, and suggest appropriate possible solution based on the physics concepts.		M	L									
		CLO3:	Explore physical systems by setting up experiments, collecting and analyzing data, identifying sources of uncertainty, and interpreting their results in terms of the fundamental principles and concepts of physics				M								
		CLO4:	Evaluate and analyze scientific measurement and error		L										

		analysis.												
		CLO5: Apply the fundamental concepts of physics to related engineering problems.	M											
PYP1101	Engineering Physics Lab	CLO1: Students would be able to correlate practical knowledge of physics with the theoretical concepts.	L											
		CLO2: Students would achieve perfectness in experimental skills related to physics fundamentals.	M											
		CLO3: The study of practical applications will bring more confidence.									M			
		CLO4: Skill to design, perform, document and analyze advanced experiments in physics.				M								
HUL2101	Disaster Management	CLO1: Increase the knowledge and understanding of the disaster phenomenon, its different contextual aspects, impacts and public health consequences.	L											
		CLO2: 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.								M	M			

		CLO3:	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.						H						
GEL4101	Environmental Sciences	CLO1:	Understand the transnational character of environmental problems and ways of addressing them, including interactions across local to global scales.		L				M						
		CLO2:	Apply systems concepts and methodologies to analyze and understand interactions between social and environmental processes.					M							
		CLO3:	Reflect critically about their roles and identities as citizens, consumers and environmental actors in a complex, interconnected world.		M				H						
		CLO4:	Skill to demonstrate proficiency in quantitative methods, qualitative analysis, critical thinking, and written and oral communication needed to conduct high-level work as interdisciplinary scholars and/or practitioners..	M									M	L	
AML5102	Engineering Mathematics- II	CLO1:	Skill to analyze and correlate many real-life problems mathematically and thus find the appropriate solution for them using Fourier series and Transforms (Fourier and	M											L

			Laplace transform).											
		CLO2:	Using ordinary differential equations student will be able to solve various practical problems in Science and Engineering.	M				M		M			M		M
		CLO3:	Possess an ability to recognize and find families of solutions for most real physical	M											
		CLO4:	Processes such as heat transfer, elasticity, quantum mechanics, water flow and others, which are governed by partial differential equations subject to boundary conditions.	H		M					M				H
CS101	Introduction to C Programming	CLO1:	Choose the appropriate C programming constructs to solve the problems.	H					H					H	
		CLO2:	Demonstrate the advantages and disadvantages of specific techniques to be used.		M										
		CLO3:	Skilled to differentiate between efficient and inefficient way of programming.							L					M
		CLO4:	Determine and demonstrate bugs in a program and recognize needed basic operations.		M									M	
		CLO5:	Formulate new solutions for programming problems or				L				H			L	M

			improve existing code to program effectively											
EEL4103	Basics of Electrical Engineering	CLO1:	Students would know the basics of DC circuits, Series and parallel connections, Kirchhoff's current and voltage laws, mesh and nodal analysis. They would be able to compute various electrical engineering concepts based on real time applications.	L			M								
		CLO2:	Students would possess an ability to analyze and characterize the RL, RC & RLC circuits and have basic understanding of their implementation and also able to compute parameters related to these circuits like impedance and power. They would also learn phenomenon like resonance		L										
		CLO3:	Students would be skilled to apply and clarify fundamental principles of magnetic effects, magnetism and their functionality for electrical equipment's.			H								H	
		CLO4:	Students would possess the skill to conduct experiments, understand the principle, construction and working of Transformers, DC motors and Induction motors.				H							M	H
EEP1103	Basics of Electrical	CLO1:	After completing the course, students would know the basic components of electrical	H					M			H			

	Engineering Lab		elements, equipment's and their functionality with applications. With the knowledge of the basic components, students would be able to make basic electrical projects											
		CLO2:	They would possess an ability to analyze and characterize the electrical equipment's and instrument's basics for their implementation.		H									
		CLO3:	They would be skilled to measure power and power factor of ac circuits and understand three-phase star and delta connections with and without applying loads to calculate 3-phase power.		L			M						H
		CLO4:	Possess skill to perceive the concept of Fuse/MCB characteristics for different fault currents. Students will be familiarized with appearance and functioning of the MCB and fuse used in their homes.	L						M			H	
CHL4101	Engineering Chemistry	CLO1:	Develop innovative methods to produce soft water for industrial use and potable water at cheaper cost.	M										
		CLO2:	Substitute metals with conducting polymers and also produce cheaper biodegradable polymers to reduce environmental pollution.		M									M
		CLO3:	Design economically and new			L								

			methods of synthesis nano materials.												
		CLO4:	Apply their knowledge for protection of different metals from corrosion.												M
		CLO5:	Have the skill of converting solar energy into most needy electrical energy efficiently and economically to reduce the environmental pollution.	L				L						L	
CHP1101	Engineering Chemistry Lab	CLO1:	Develop innovative methods to produce soft water for industrial use and potable water at cheaper cost.	M	H										
		CLO2:	Substitute metals with conducting polymers and also produce cheaper biodegradable polymers to reduce environmental pollution.		L										L
		CLO3:	Design economically and new methods of synthesis nano materials.		L			L						L	
		CLO4:	Skill to apply their knowledge for protection of different metals from corrosion.	L							L				M
MEW2101	Manufacturing Practice	CLO1:	The students will be skilled to understand the working of engines and simple machines	M			M			M				H	
		CLO2:	The students will gain knowledge about different processes involved in manufacturing process that		L				M			M			H

			enhances employability.											
ECL4207	Digital Electronics and Logic Design	CLO1:	Understand the basics of difference between analog and digital circuits and their applications.	L	M									
		CLO2:	Skill to implement simple logical operations required for the designing of digital circuits and understand common forms of number representation.		M			M						
		CLO3:	Reduction of Boolean expressions for the designing of minimized logical circuits.		M			L						
		CLO4:	Skill to design and implementation of combinational circuits.			H		L				M		
		CLO5:	Skill to design and implementation of sequential circuits and their application.			H		L				M		
ECP1207	Digital Electronics & Logic Design Lab	CLO1:	To understand the digital logic and create various systems by using these logics.	L										
		CLO2:	Develop a skill to understand the design and simulation of digital logic circuits.		M	H								
		CLO3:	To get a basic understanding of layout of electronic circuits.		L	L								
		CLO4:	Skill to use the Multisim tool for design and simulation.			H	M	H						
		CLO5:	Skill to design and implementation of sequential			H	M	H						

		circuits and their application.												
CS102	Object Oriented Programming using C++	CLO1: Skilled to understand the problem statement using principles of mathematics and engineering sciences.	M											
		CLO2: Identify the OOPs programming constructs to solve the problems by differentiating between efficient and inefficient way of programming.		M	L									
		CLO3: Determine the bugs in a program and recognize the need of alternate approaches.			M	M								
		CLO4: Acquire ability for independent and life-long learning in the broadest context of technological change.												H
		CLO5: Provide solutions to societal, health, safety, legal, and cultural issues through contextual knowledge of professional engineering practice for employability.						M	H	H				
HUL3301	Human Rights & Values	CLO1: After completing the course students will be able to Identify constitutional or national values, social, professional, religious and aesthetic values.										M	M	H
		CLO2: Students will be able to link value education towards professional and employment ethics.									M	M	M	H

		CLO3: Students will be able to understand about national issues and international cooperation.										M	M	H
		CLO4: Students will be able to follow personal development and creation of a positive personality.										L	M	H
GEW2401	Engineering Economics Analysis	CLO1: Understand the theoretical and conceptual basis of economics (e.g., time value of money, interest, inflation rates, etc.) upon which engineering projects analysis is built.	L											
		CLO2: Posses a set of practical tools to make systematic and informative decisions when evaluating an engineering project with various uncertainties					H							
		CLO3: Have critical thinking skills, problem solving abilities, and familiarity with the project evaluations procedures essential to various engineering fields.			M						H	L	M	
		CLO4: Be able to demonstrate the capacity for critical thought, team work, resourceful study, and effective communication			M						H			
CSP3213	Introduction to LINUX	CLO1: **Understand the Installation and working with Linux Operating System.**		M	M									
		CLO2: Acquire theoretical knowledge about the Elementary			M									

			difference between Linux, UNIX, DOS & Windows OS.											
		CLO3:	Understand the Simple and Administrative Commands.			M								
		CLO4:	Programming skills with shell script..		H	M	H	M						
CSL3203	Computer Networks	CLO1:	Understand the small networks by following the top-down approach from application to physical layer.		H									
		CLO2:	Acquire theoretical knowledge about the different network technologies		L		L	M						
		CLO3:	Skilled to understand the functioning of different layers in OSI model and TCP/IP .		M									
		CLO4:	Identify various system security and protection issues.			M	L	M						
		CLO5:	Administer the system for managing its resources.			M		M				M		
CSP2203	Computer Networks Lab	CLO1:	Understand different topologies and small networks by following the down-top approach from physical layer to application layer.	L				L						
		CLO2:	Formulate functioning of different protocols (e.g. IP, TCP, UDP, WWW, http, email, DNS) of layered networking model.			L								

		CLO3: Analyze basics concepts of routing, switching, and advanced technologies.				H								
		CLO4: Students will be able to design simple networks using the application-driven paradigm helps in their employment		M			M		L					
		CLO5: Skilled to simulate and design network.					H							
CSL4207	Operating System	CLO1: Identify different types of Operating System and their components.	L											
		CLO2: Design and implementation of new system calls for any open source operating system.			M		H							
		CLO3: Implementation of existing resource management algorithms in Linux operating system.			L	L	M							
		CLO4: Skilled to Identify various system security and protection issues.			M		M							
		CLO5: Administer the system using various Operating systems (Windows and Ubuntu) for managing its resources.				L					M			
ECL4214	Analog Electronics	CLO1: Develop the ability to understand the design and working of BJT amplifiers	L	M			M							
		CLO2: Skill to design BJT based circuits and observe the amplitude and frequency	M		H						M			

			responses of common amplifiers.											
		CLO3:	Skill to design and develop the audio and power amplifiers using re and hybrid equivalent models.	M		H							H	M	H
		CLO4:	Develop the skill to build, and troubleshoot analog circuits.	M	M		M								
ECP1214	Analog Electronics Lab	CLO1:	To be able to read and interpret electronic datasheets and diagrams.	L											
		CLO2:	To be able to measure the electronics & electrical parameters of an amplifier like voltage gain, input & output impedance.		M	M	L						M	M	
		CLO3:	Skill to design, construct and troubleshoot transistor based amplifier complex electronic circuits			H		H	L	L		H			
ECL4208	Control Systems	CLO1:	The students would be able to understand operation of basic control systems employed in industries.	L	M										
		CLO2:	The students would be able to propose automation solutions to real world problems	L		H									
		CLO3:	The students would attain skill to carry out time domain and frequency domain analysis of a designed control system.			M	H								

		CLO4:	Skilled to solve automation solutions to real world problems			M	H	M					M	H	
ECP2203	Measurement & Virtual Instrumentation Lab	CLO1:	The students will be skilled to design any instrumentation-based project in employment	L	L	M	M	L							
		CLO2:	The students will be skilled to simulate any type of signals and check performance of any circuit based on these simulated signals.			M	M	M							
		CLO3:	Skill of using Elvis instrument and perform experiment on it		L									L	
		CLO4:	Skilled to work on interfacing hardware with software.			M	M	M						M	H
		CLO5:	Skilled for the creation of new projects.			H			L	M	L			M	H
ECL4205	Network Analysis & Synthesis	CLO1:	Students will develop sufficient knowledge on circuit analysis techniques.	L											
		CLO2:	Students will be skilled to perform time domain as well as frequency domain analysis of any electrical circuit.	L	M	M	L							M	
		CLO3:	Students will be skilled to synthesize various electrical networks like two port networks and filters circuits.	M	M	M								M	
		CLO4:	Skilled to execute all domain analysis of any electrical circuit.	M											

ECL4212	Analog & Digital Communication	CLO1:	The students would have a good understanding of both time and frequency domain representations of information and modulated signals used in analog, pulse and digital communication systems	L										
		CLO2:	They would be able to evolve functional blocks of Tx and Rx for AM/FM broadcast radio, baseband PCM transmission and digital wireless communication applications.	L										
		CLO3:	The students would be skilled to evaluate binary and M-ary shift keying digital modulation and demodulation techniques for digital cellular applications	L	M			M			M			
		CLO4:	They would possess an ability to apply knowledge of various digital modulation schemes to improve performance of advanced digital cellular communication systems.	L	M	M							M	M	H
		CLO5:	Skill of various schemes to improve performance of communication systems.	M			H								
ECP1206	Analog & Digital Communication Lab	CLO1:	The students would have a good understanding of both time and frequency domain representations of information and modulated signals used in analog, pulse and digital communication systems	M	L									
		CLO2:	They would be able to evolve functional blocks of Tx and Rx	M	M	L	L							L	

			for AM/FM broadcast radio, baseband PCM transmission and digital wireless communication applications.											
		CLO3:	The students would be skilled to evaluate binary and M-ary shift keying digital modulation and demodulation techniques for digital cellular applications	M	L			M						M	
		CLO4:	They would possess an ability to apply knowledge of various digital modulation schemes to improve performance of advanced digital cellular communication systems.									L	M		
		CLO5:	Skill of various schemes to improve performance of communication systems.	M	L										
CS109	Core Java	CLO1:	Implement the concept of object-oriented techniques and methodologies using Java		L										
		CLO2:	Use Exception Handling concepts for a Robust Application in Java.			H									
		CLO3:	Demonstrate an understanding of Java Input and Output		M	L	H								
		CLO4:	Develop applications using multithreading concept of Java.			L		H							
		CLO5:	Skilled to Use and Implement several Data structures using Collection Framework.		M	L									

HUL2401	Cyber Security	CLO1: Acquire Information and risk models including confidentiality, integrity and availability						M	L			L		L
		CLO2: Acquire skill to identify the Threats and attacks and exploit vulnerabilities						H	L	M	L	L	M	M
		CLO3: Gain suffiicent knowledge on Cyber security architecture and operations and acquire ability to handle the threats during employment						M	M	M			H	M
ECL4204	Signal and Systems	CLO1: Categorize various types of signals and systems as continuous/ discrete.	H	M			L							
		CLO2: Apply various transforms in analysis of systems with different input signals.	M											M
		CLO3: Skill to interpret the behaviour of Linear time invariant systems (Continuous & Discrete) in terms of system stability and response.	H	M	H								H	
		CLO4: Skilled for evaluation of several transforms in analysis of systems with different input signals	L	M		L								H
ECL4314	Linear Integrated Circuits	CLO1: Skilled to design Op-amp based circuit to give specified gain.		H										
		CLO2: To compute component values to design different Op-amp based applications such as arithmetic building blocks,	H			H						H		

		filters, waveform generators.												
		CLO3: Develop practical skills for building and testing circuits using analog ICs during employment.		H										
		CLO4: Able to compute component values to design different Op-amp based applications in their employment	H		H	H								M
		CLO5: Skilled in practical skills for building and testing circuits using analog ICs in their employment.	M	H		H							M	H
ECP1314	Linear Integrated Circuits Lab	CLO1: Skilled able to select an appropriate IC for a industrial and domestic applications by interpreting electronic datasheet.				L	H							
		CLO2: Skilled to design an op amp based circuit such as filters, oscillators, generators, converters and can solve problems related to it during employment.	L				H							
		CLO3: Skilled to troubleshoot and replace the defective parts of op amp based electronic circuits during employment.					H			M			H	
		CLO4: Develop appropriate communication skills, particularly technical reports through the laboratory for student as entrepreneur.					H					H		H

		CLO5:	Skill of hands-on training of designing linear integrated circuits			H		H							
ECL4315	Microprocessor and Microcontroller	CLO1:	After completing the course students will be skilled to differentiate between the real time applications of microprocessor and a microcontroller.	L											
		CLO2:	The student will be able to design a memory and I/O interface aspects for an 8085-based computer systems.		M			H				L			
		CLO3:	Students will develop the knowledge regarding architecture and peripheral configuration of STM32L476.			H		H							
		CLO4:	Students will be able to write embedded C code to develop applications using I/O ports, timers and other peripherals of a microcontroller which increases employability.	L										H	
		CLO5:	Skilled to develop applications using I/O ports, timers and other peripherals of a microcontroller in their employment		M	H		H							H
ECL4303	Microelectronic Circuits	CLO1:	After completion of the course, students will be able to construct and apply physical model to determine the electrical characteristic and operation principle of microelectronic devices.	H		H									

		CLO2:	Skill of designing digital as well as analog circuits using CMOS technology		L									
		CLO3:	Students will apply the concept of IC fabrication to create layouts of digital circuits at entrepreneur level.				H							
		CLO4:	Able to design both circuits using CMOS technology used in industry.	L		L								
		CLO5:	Execute the concept of IC fabrication to create layouts of digital circuits during their employment		H								M	H
ECP2303	Microelectronic Circuits Lab	CLO1:	Students will acquire hands on experience of industry oriented circuit designing tools					H						
		CLO2:	Students will be skilled to design different digital and analog circuits and verify the same through simulation on cadence design tool.		M			H						
		CLO3:	Capable of designing layouts of the designed circuit in accordance with layout design rules during employment			L		H					M	
		CLO4:	Skill of using simulator.		M			H						
		CLO5:	Skill of interfacing hardware with software.					H						H
ECP1315	Microprocessor & Microcontroller	CLO1:	After the completion of this lab course students will be skilled to handle the technical issues			H		H						

	Lab		during the programming and also able to evaluate possible causes of discrepancy in practical experimental observations.											
		CLO2:	The students will be able to write a program in assembly language to perform the specific task like arithmetic and logical operations, ON/OFF procedure for an LED pattern etc.	H									H	
		CLO3:	Student will be able to understand how to Interface the external devices to the controller		L									
		CLO4:	Skilled according to the user requirements to create novel products and solutions for the real time problems as entrepreneur					H						
		CLO5:	Skilled to create innovation through microprocessor circuit designing				M	M						H
ECL4316	Wireless and Mobile Communications	CLO1:	The students would be able to apply the knowledge of mobile communication engineering to solve coverage and call failure problems in cell phones.					H						
		CLO2:	They would be skilled to implement the cellular concept and antenna system design consideration aspects in optimizing the cellular architecture as per user needs		H		H							H

		during their employment.												
		CLO3: The students would possess in-depth knowledge to select and use optimum multiple access technique for interference-free communication.		H										
		CLO4: The students would possess an ability and technical skills necessary to understand digital cellular standards and architecture designs.	M		L									
		CLO5: The students would have acquired adequate knowledge about major aspects of 3G/4G digital cellular networks.			H								H	
ECL4409	Audio and Speech Processing	CLO1: Isolated words and commands recognition.		H										
		CLO2: Skilled to recognize Continues speech.				L								
		CLO3: Dialogue systems applications		L										
		CLO4: Time and frequency domain text-to-speech synthesis.					M							
CLL3301	Life Skills –I	CLO1: Recognize diverse communication styles (body language, tone of voice) and effectively increase comprehension and build rapport with others.	H											
		CLO2: Draw comparison and demonstrate communication in a clear and direct manner. To be able to understand words					L							

			and language used in formal and casual communication in entrepreneurship.											
		CLO3:	Use creative thinking skills to analyze and evaluate issues and arguments, to solve problems, or to make decisions during their employment and entrepreneurship.					M						
		CLO4:	Understanding a leader's responsibilities to assess the requirements of a task, identifying the strengths within the team, utilizing the diverse skills of the group to achieve the set objective as an entrepreneur and employee.											H
ECL4414	Analog Layout design	CLO1:	Enhance the skills of integrated circuit design for designing layouts of complex circuits			L								
		CLO2:	Students will be able to design layouts using CMOS technology and learn industry related design tools such as Cadence Virtuoso to work as IC design engineer.		M			H						
		CLO3:	Skill of applying different matching techniques in layouts of analog circuits and apply those techniques to design high quality and noise tolerant layout				M							
		CLO4:	Evaluate combinational and sequential logic designs using various metrics:		L		L							

		CLO5:	Switching speed, gate count , and energy dissipation and power.	L										
ECL4413	Digital Design using FPGA	CLO1:	The students completing this course are expected to understand the structure of various number systems and its application in digital design.		H									
		CLO2:	Students will be able to design the appropriate truth table from a description of a combinational logic function					L						
		CLO3:	Students will be skilled to analyze and design various combinational and sequential circuits like Comparators, Multiplexers, Encoders etc.	M										H
		CLO4:	Students will be skilled to design the synchronous circuits like Pulse train generator, Pseudo Random Binary Sequence generator			L								
		CLO5:	Designing of Pseudo Random Binary Sequence generator.					M						
ECL3312	IOT and Embedded Systems	CLO1:	Understand fundamental concepts and technologies related to embedded system and IoT based devices	M										H
		CLO2:	Understand the fundamentals of RTOS and application development techniques.			L								
		CLO3:	Skill to write fast-executing embedded code that utilizes the					M						

			CPU, memory and peripheral resources efficiently											
		CLO4:	Understand the various communication and networking protocols used for developing IoT enabled devices during their employment.	M										H
		CLO5:	Applications of Embedded system design.			L								
ECL3313	VLSI Design and Verification	CLO1:	Students will get a clear understanding of VLSI design flow and different types of design styles which are used for integrated circuit design.					M						
		CLO2:	Students will be able to design building blocks of digital IC using different types of modelling styles used in Verilog and perform timing analysis of the blocks.	M										H
		CLO3:	Students will acquire skills to identify the faults associated in VLSI circuits and various techniques to test the ICs during employment.			L								
		CLO4:	Skilled to design building blocks of digital IC using Verilog.					M						
HUL3303	Project Management	CLO1:	Develop, implement and evaluate various stages including planning, scheduling and Execution of projects.	M										H

		CLO2:	Understand risk management, administration, costing and budgeting challenges during projects improve skill as employee and entrepreneur.			L									
		CLO3:	Identify project goals, constraints and performance criteria in project implementation in entrepreneurship.					M							
		CLO4:	Understanding of design process.	M											H
		CLO5:	Application in solving the societal issues.			L									
HUL3302	Digital Marketing and Entrepreneurship	CLO1:	Use confidence acquired in oral and visual presentation skills to sell their ideas					M							
		CLO2:	Implement personal skills for sales and marketing and work under pressure in entrepreneurship.	M											H
		CLO3:	Develop, implement and evaluate strategies for setting up a business idea in entrepreneurship.			L									
		CLO4:	Implement personal skills in their employment.					M							
		CLO5:	Design strategies to be an entrepreneur.	M											H
ECL4317	Digital Signal Processing	CLO1:	Identify different types of discrete signals, implement these signals on different		L										

			systems using z transform, Discrete Fourier Transform and Fast Fourier Transform.											
		CLO2:	Student can apply knowledge to design and filters and implement them for signal processing applications.	M										
		CLO3:	Apply the knowledge to design and analyse a practical discrete-time signal system, such as a radar, image, speech, audio, bio-medical or wireless system during employment.	M			L							
		CLO4:	Implementation of signal processing applications in employment						L					
		CLO5:	Skilled to design and analyse a practical discrete-time signal system, in their employment.			L	L							
ECP1305	Digital Signal Processing Lab	CLO1:	To understand and analyze the different types of signals in time domain and frequency domain.	L										
		CLO2:	Skill to design and implement the characteristics of the digital filters (FIR and IIR).			H							H	M
		CLO3:	Can apply skill of programming using MATLAB to develop the computation of Transforms and convolution during employment.	M			H	H	H					
		CLO4:	Skill of hand-on training on MATLAB programming and				M	H				H	H		M

		simulation.												
		CLO5: Skill of modeling FIR and IIR filters on MATLAB.	M		H	M	H						H	M
ECL4322	Electromagnetic Waves & Antennas	CLO1: Develop sufficient knowledge on fundamental of Electromagnetic field theory and its applications such as Vector Calculus and Co-ordinates Systems.	L			L								
		CLO2: Understand Maxwell's equations and apply them to solve practical electromagnetic fields problems.				M								
		CLO3: Analyses the behavior of EM Wave through different medium such as Transmission Lines and Waveguides.			L	M								
		CLO4: Skill to solve transmission line impedance mismatching problems in communication and power transmission using stub matching and Smith chart.	M											
		CLO5: Understand the basic parameters & properties of Antennas, Antenna Types, and Antenna Arrays for Antenna Gain and Directivity Enhancement.	M											
ECL4311/ECP2313	VLSI Design / VLSI design Lab	CLO1: Students will get a clear understanding of VLSI design flow and different types of design styles which are used for integrated circuit design	L											

		CLO2: Students will be able to design building blocks of digital IC using different types of modelling styles used in Verilog and perform timing analysis of the blocks			L		M							
		CLO3: Students will acquire skills to identify the faults associated in VLSI circuits and various techniques to test the ICs during employment.		L		L								
		CLO4: Skilled to design building blocks of digital IC using Verilog			M		L							
GTI4301	Numerical Ability and Logical Reasoning	CLO1: Enhance the mental and Intellectual ability and critical thinking of the students.				M								
		CLO2: Enhance the student's ability to use numerical data as a tool to make reasonable decisions and solve problems.			M									
		CLO3: Skilled to Interpret, analyze and draw logical conclusions based on numerical data presented in graphs and tables.				M						L		
		CLO4: Draw logical conclusions										M		
		CLO5: Problem solving strategies.		M	L									
CSA3211	Data Analytics	CLO1: Apply knowledge of dispersion on grouped and ungrouped data cases.	M											H
		CLO2: Skilled to evaluate discrete and continuous probability			L									

			distributions to various business problems in entrepreneurship.											
		CLO3:	Perform Test of Hypothesis as well as calculate confidence interval for a population parameter.				M							
		CLO4:	Calculate confidence interval for a population parameter.	M										H
		CLO5:	Application and its utilization.			L								
CSL5349	Essential Programming Concepts	CLO1:	Students will gain an in-depth knowledge about overall syntax and semantics					M						
		CLO2:	Students will be skilled to use an IDE to compile, load, save, and debug a program	M										H
		CLO3:	Students will develop technical thinking and problem solving ability to find an appropriate solution for a problem.			L								
		CLO4:	Students will be able to demonstrate the ability to create test cases to determine that a solution produces expected outputs for given inputs					M						
		CLO5:	Incorporation of programming in real time applications			H								
CSL5210/CSP2210	Data Structures/Lab	CLO1:	After understanding the basic types for data structure, students will be able to implement different real world	M										

		applications.												
		CLO2: Students will be able to determine time and memory complexity of basic algorithm constructs.		M										
		CLO3: Implement algorithms for the creation, insertion, deletion, and traversal of each data structure.				M						L		
		CLO4: Skilled to solve problems based on searching and sorting algorithms.	M											
		CLO5: Formulate new solutions for programming problems or improve existing code using learned algorithms during their employment.			M									
CSL4318	Advanced Programming Concepts	CLO1: Students will gain an in-depth knowledge about overall syntax and semantics of C programs					M							
		CLO2: Students will be skilled to use an IDE to compile, load, save, and debug a C program	M											H
		CLO3: Students will develop technical thinking and problem solving ability to find an appropriate solution for a problem.			L									
		CLO4: Students will be able to demonstrate the ability to create test cases to determine that a solution produces expected outputs for given					M							

			inputs											
		CLO5:	Incorporation of programming in real time applications	M										H
CSL4320	Advanced Object Oriented Programming	CLO1:	Students will gain an in-depth knowledge about overall syntax and semantics of C++ programs			L								
		CLO2:	Students will be skilled to use an IDE to compile, load, save, and debug a C++ program					M						
		CLO3:	Students will develop technical thinking and problem solving ability to find an appropriate solution for a problem.	M										H
		CLO4:	Students will be able to demonstrate the ability to create test cases to determine that a solution produces expected outputs for given inputs			L								
		CLO5:	Incorporation of programming in real time applications					M						
CSP2332	Advanced Networking Concepts	CLO1:	Understand the small networks by following the top-down approach from application to physical layer.	M										H
		CLO2:	Acquire theoretical knowledge about the different network technologies			L								
		CLO3:	Understand the functioning of different layers in OSI model and TCP/IP .					M						

		CLO4: Identify various system security and protection issues.	M											H
		CLO5: Skilled to Administer the system for managing its resources.			L									
CSL3308	Artificial Intelligence and Expert System	CLO1: Students will be skilled to apply problem solving techniques associated with artificial intelligence					M							
		CLO2: Apply predicate logic and fuzzy logic to represent system in artificial intelligence.	M											H
		CLO3: Skilled to solve techniques associated with artificial intelligence			L									
		CLO4: Skilled to represent fuzzy logic to represent system in artificial intelligence					M							
		CLO5: Skilled to solve intelligence expert system.	M											H
ECL4407	Optical Communication	CLO1: Understand the fundamentals, advantages and advances in optical communication system					H							
		CLO2: Acquire a detailed understanding of types, basic properties and transmission characteristics of optical fibers		L	M									
		CLO3: Understand configuration and architecture of advanced optical communication, advanced system techniques and nonlinear optical effects		L	M	M							M	H

		and their applications												
		CLO4: ain the knowledge of working nd analysis of optical amplifiers nd important evices/components of the optical ommunications system		L	M	M								H
		CLO5: Skilled to understand the important devices/ components of the optical communications system.				H								H
ECL4319	Information Theory and Coding	CLO1: Design the channel performance using Information theory:	M											H
		CLO2: Comprehend various error control code properties			L									
		CLO3: Apply linear block codes for error detection and correction					M							
		CLO4: Skilled to apply convolution codes for performance analysis & cyclic codes for error detection and correction.	M											H
		CLO5: Apply different codes for performance analysis for error and correction.					H							
ECL4406/ECP1406	Mechatronics/ Mechatronics lab	CLO1: Understand key elements of Mechatronics system, representation into block diagram	M											H
		CLO2: Understand concept of transfer function, reduction and analysis			L									

		CLO3:	Understand principles of sensors, its characteristics, interfacing with DAQ microcontroller					M						
		CLO4:	Skilled to understand the system modeling and analysis in time domain and frequency domain	M										H
EC262	Machine Learning	CLO1:	Understand and implement classical machine learning models and algorithms using python programming concepts.	M										H
		CLO2:	Develop Skills of using of recent machine learning software to identify the problems			L								
		CLO3:	Choose the relevant models and algorithms to turn available data into valuable and useful Information					M						
		CLO4:	To make the new applications to solve the societal issues.	M										H
ECL4411	Wireless Sensor Networks	CLO1:	The students would be skilled to formulate network architecture and operating environment	M										H
		CLO2:	They would possess an ability to design solutions for wireless transmission technology and protocols			L								
		CLO3:	The students would possess in-depth knowledge about					M						

		optimization techniques for efficient operation in modern applications including healthcare helps in their employability.												
		CLO4: Efficient operation in modern applications including healthcare	M											H
		CLO5: Application in modern technology					H							
ECL4403	Microwave and Satellite Communication	CLO1: Students will gain complete knowledge about the significance, types and characteristics of various microwave solid state devices	M											H
		CLO2: Analyze mathematically the operation and working of various tubes or sources for the transmission of the microwave frequencies			L									
		CLO3: Students will gain the basic understanding about the principles and working of RADAR.					M							
		CLO4: Students will acquire basic understanding of satellite communication and various design links in satellite communication	M											H
		CLO5: Skilled to understand the important applications of the satellite communications system					H							

ECP1403	Microwave and Satellite Communication Lab	CLO1:	Students will be able to design and use a microwave test bench to analyze various types of microwave measurements.	M										H
		CLO2:	Students will be able to measure the parameters and characteristics of the various waveguide components.			L								
		CLO3:	Acquire an understanding of various characteristics of Microwave Tee's through practical demonstrations.					M						
		CLO4:	Students will be skilled to determine the radiation characteristics and gain of an antenna during their employment.	M										H
		CLO5:	Understanding of important devices/ components of the Satellite communications system					H						
ECL4404/ECP1404	Digital Image Processing/Lab	CLO1:	After the completion of the course student will be able to understand the fundamental concepts of a digital image processing system like Image formation, Image sampling and quantization	L					L		H			
		CLO2:	Students will develop the knowledge to analyze the different images in the frequency domain using various transforms	L	M			M		L	M			

		CLO3:	Students will be skilled to realize the importance of filters for the images and also they will be able to differentiate between the different types of filters.	L	M										
		CLO4:	Applications of image processing in recognition			H								H	H
		CLO5:	Applications in real-time problem solving			H								H	H
ECL4412/ECP1412	Advance Wireless Communication/ Lab	CLO1:	The students would be able to demonstrate knowledge and understanding on existing digital cellular systems and standards across the world.	M											H
		CLO2:	The students would have an ability to recognize the need of 3G/4G cellular networks and evolve its architecture.			L									
		CLO3:	The students would possess the capability for evolving technological path for higher user performance in cell phone technology during their employment.					M							
		CLO4:	Efficient operation in modern applications including healthcare	M											H
		CLO5:	Application in modern technology					H							
ECL4401	Embedded System Design	CLO1:	The students would be able to understand fundamental concepts and technologies	L			L	M							

			related to embedded system and IoT based devices.											
		CLO2:	The students would be able to understand the fundamentals of RTOS and application development techniques	L			M	M						
		CLO3:	The students would be able to understand the various communication and networking protocols used for developing IoT enabled devices for employment.									H	M	M
		CLO4:	Skilled to understand the application development techniques.				M	M				L	M	
ECP2401	Embedded System Design Lab	CLO1:	Skill to design the various application-oriented embedded system and IoT devices.			H								
		CLO2:	Implement different communication and networking protocols used for developing IoT enabled devices as entrepreneur.		H		M					M	M	M	H
		CLO3:	Skill of hands-on training.				M	H				M		H	H
ER101	CEED Acceleration Program (CAP) Cohort-II-Module I	CLO1:	Use confidence acquired in oral and visual presentation skills to sell their ideas										M		
		CLO2:	Implement personal skills for sales and marketing and work under pressure in entrepreneurship.										M		
		CLO3:	Develop, implement and evaluate strategies for setting up a business idea in entrepreneurship.											H	H

		CLO4: Implement personal skills in their employment.										M		
		CLO5: Design strategies to be a entrepreneur.										M		
ER102	CEED Acceleration Program (CAP) Cohort-II-Module II	CLO1: Use confidence acquired in oral and visual presentation skills to sell their ideas											H	H
		CLO2: Implement personal skills for sales and marketing and work under pressure in entrepreneurship.										M		
		CLO3: Develop, implement and evaluate strategies for setting up a business idea in entrepreneurship.										M		
		CLO4: Implement personal skills in their employment.											H	H
		CLO5: Design strategies to be a entrepreneur.										M		