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UNIVERSITY OF DELHI

B. Tech. (Information Technology & Mathematical Innovations)

(Effective from Academic Year 2019-20)

Revised Syllabus as approved by

Academic Council

Date: No:

Executive Council

Date: No:

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B. Tech. (IT & Mathematical Innovations)

Preamble

INTRODUCTION

This unique course, the first one to be offered at Cluster Innovation Centre, is designed to inculcate an innovation mindset as part of the curriculum and pedagogy. Building strong analytical skills through Mathematics and application skills of Information Technology (IT), this course encourages students to recognize the connectedness of various disciplines. Using IT as a vehicle for connecting mathematics with other disciplines, students are encouraged to develop innovative products and processes as part of curriculum. The course aims to produce adequately skilled graduates with a creative mindset who can provide new solutions to industry in particular and to society in general. It is hoped that some of these innovators will be entrepreneurs, who will be job providers rather than job seekers. The course is specifically designed to boost undergraduate research.

The course offers three discipline centric elective streams – Management, Electronics & Embedded System and Systems Biology – important fields of education with significant interface with Mathematics and IT. The mode of learning shall be a healthy and productive blend of the formal and the inquiry based, with special focus on "hands on" and "project based" mode of learning. Learning shall happen to a large extent through teacher mentoring and peer learning that encourages creativity and relies on innovations. This is in tandem with the requirement of CBCS tenets.

Upon graduation, these students would have acquired innovation based creativity and would have matured in their thinking. They will have enhanced their communication and leadership abilities, and will have understood the deep and abiding connections between knowledge and its uses - between understanding the needs of society and the relevance of knowledge and the importance of societal obligations. Experiments, hands-on projects, innovative projects, model implementations linked to the curriculum will be carried out in the "Engineering Kitchen: Innovation Lab". Assessment, at each stage, is designed in a manner to incentivize innovation by encouraging students to carry out new creative application of the theoretical knowledge acquired, either through a project, or through a laboratory activity/prototype in the engineering kitchen.

CHOICE BASED CREDIT SYSTEM (CBCS)

The credit based semester system provides flexibility in designing curriculum and assigning credits based on the course content and hours of teaching. The Choice Based Credit System provides a 'cafeteria' type approach in which the students can take courses of their choice, learn at their own pace, undergo additional courses to acquire more than the required credits and adopt an interdisciplinary approach to learning.

PROGRAMME LEARNING OUTCOMES (PLO)

PLO1: To inculcate an innovation mindset as part of the curriculum and pedagogy. Building strong analytical skills through Mathematics and application skills of Information Technology (IT).

PLO2: To create an interdisciplinary learning approach.

PLO3: To promote learning based on "hands-on" and "project-based" mode of learning.

PLO4: To aim to produce adequately skilled graduates with a creative mindset who can provide new solutions to industry in particular and to society in general.

PLO5: To encourage students under mentoring of teachers, for innovation and entrepreneurship. In addition to this, the course is specifically designed to boost undergraduate research.

GRADUATE ATTRIBUTES

Disciplinary knowledge: Capable of demonstrating comprehensive knowledge of fundamentals, understanding and applications of Information Technology and Mathematics.

Communication Skills: Capability to communicate complex engineering concepts with peers, faculty, industry and society at large. Such ability includes reading, writing, speaking and the ability to comprehend. Write effective reports and respond effectively to instructions.

Critical thinking and Problem Solving: An ability to use acquired knowledge and skills to identify, formulate, analyze and solve complex engineering problem. Extrapolate from what one has learned in theory and apply their competencies to solve different kinds of non-familiar problems.

Investigation: Demonstrate competence to investigate complex problems by methods that include appropriate experiments, analysis and interpretation of data and synthesis of information in order to reach valid conclusions.

Design thinking: Capability to design solutions, system components or processes that meet the specified needs to solve the local, national and global challenges. Ability to analyse, interpret and draw conclusions from quantitative/qualitative data collected during practical sessions; and critically evaluate ideas, evidence and experiences.

Use of ICT and other engineering tools: Capability to select, apply, create, adapt and extend modern tools including modeling and prediction to a range of simple and complex situations with a complete understanding of their usage and associated limitations.

Entrepreneurial skill: Ability to drive innovation to lead breakthrough changes. Apart from strong technology skills, develop traits of creativity and decision making to develop a new business idea, start-up or an innovative process.

Interdisciplinary Approach: Ability to incorporate knowledge and skills from multiple areas of learning in order to obtain a comprehensive and a detailed solution of a problem/ situation.

Cooperation/Team work: Ability to work effectively with various project teams, build strong per-to-peer associations to achieve educational and professional goals.

Self-directed learning: Ability to work independently, identify appropriate resources required for a project, and manage a project through to completion.

Professional Ethics: Ability to embrace ethical principles and commit to professional ethics, accountability and responsibilities

Lifelong learning: An ability to identify and to address their own educational needs in a changing world in ways sufficient to maintain their competence and to allow them to contribute to the advancement of knowledge and nation.

QUALIFICATION DESCRIPTORS

- Enable the students to realize their true potential in terms of innovation for real world applications that is largely driven by the engine of mathematics and IT.
- Ability to work and learn in an environment of creativity, through real world situations that opens up links to ideas and disciplines from various areas and realms.
- Acquirement of expertise in innovative ways of technology based problem solving, a 'hands on' approach to real world thinking with an ability to think creatively and work in groups with a flair for communication and leadership
- Solve innovative projects in collaboration with industry and other segments of society
- Recognition of the fact that disciplines are connected and need each other.
- Recognition of the importance and centrality of mathematics and the advantages of using IT as a vehicle for connecting mathematics with other disciplines
- In addition to having built up deep knowledge in mathematics and IT, acquirement of expertise at a deep level in one of the following: Economics and Management, Robotics and Embedded Systems, System Biology.
- Imbibe innovation based creativity and mature thinking
- Enhancement of communication and leadership abilities an understanding of the deep and abiding connections between knowledge and its uses
- Understand the needs of society and the relevance of knowledge and the importance of societal obligations

TYPE OF COURSES

The courses (or the subjects) to be taught in this program are categorized into three types:

i. **Core Course (CC):** This is a course that is to be compulsorily studied by a student as a core requirement to complete the requirement of B.Tech (IT and Mathematical Innovations).

ii. **Elective Course:** An elective course is a course that can be chosen from a pool of courses. It is intended to support the discipline of study by providing an expanded scope, enabling exposure to another discipline/domain and nurturing a student's proficiency and skill. An elective may be of following types:

a) **Discipline Centric Elective (DCE)**: It is an elective course that adds proficiency to the students in the discipline or leads to an interdisciplinary approach to learning.

b) **Open Elective (OE):** It is an elective course offered by different academic disciplines at CIC that broadens the perspective of a student undergoing the B.Tech course.

iii. **Foundation Course (FC):** A Foundation course leads to knowledge enhancement and provides value-based training.

A student shall accumulate 50% of the credits from Core Courses, 25% credits from Foundation Courses and the rest from elective courses.

NO OF SEATS:	40	
DURATION:	8 Semesters (4 years)	
ELIGIBILITY:	A minimum aggregate marks at 10+2 level as follows	
	General Category	: 60 % in four subjects (including mathematics)
	OBC category	: 54% in four subjects (including mathematics)
	PH category	: 55% in four subjects (including Mathematics)
	SC/ST category : Passing marks with Mathematics as one subject	
ADMISSION:	Through a written MCQ based entrance test.	
COURSE FEE:	As notified by the university time to time	

B. Tech. (IT & Mathematical Innovations)

COURSE STRUCTURE

Key: L: Lecture, T: Tutorial, P: Project/Practical/Internship,
IA: Internal Assessment, EA: External Assessment (End semester exams)

Semester I

Paper No.	Interactive Learning Modules (Paper Title)	Credits				Marks				
		L	T	P	Total	Theory		Practical		Total
						IA	EA	IA	EA	
I.1 (FC)	Seeing the world through ***Calculus***. First steps through symbolic mathematics	3	0	2	4	30	40	15	15	100
I.2 (FC)	Modeling continuous changes through ***ordinary differential equations***	3	0	2	4	30	40	15	15	100
I.3 (FC)	Automating real world through Programs: ***Programming Fundamentals***	3	0	2	4	30	40	15	15	100
I.4 (FC)	Understanding ***Computing Systems Architecture***	3	0	2	4	30	40	15	15	100
I.5 (FC)	Physics at work I: ***Deconstructing Machines***	3	0	2	4	30	40	15	15	100
I.6 (FC)	***Business, Entrepreneurship and Innovation Management***	2	0	0	2	20	30	0	0	50
I.7 (FC)	***Environment Science & Ecosystem Management***	3	1	0	4	50	50	0	0	100
Grand Total					**26**					650

Key: L: Lecture, T: Tutorial, P: Project/Practical/Internship,
IA: Internal Assessment, EA: External Assessment (End semester exams)

Semester II

Paper No.	Interactive Learning Modules (Paper Title)	Credits				Marks				
		L	T	P	Total	Theory		Practical		Total
						IA	EA	IA	EA	
II.1 (FC)	Linearity in Nature: Engineering through ***Linear Algebra***. First steps through numerical algorithms	3	0	2	4	30	40	15	15	100
II.2 (FC)	Understanding real life situations through ***Discrete Mathematics***	3	1	0	4	50	50	0	0	100
II.3 (FC)	Optimizing memory use through ***Data Structure and Design***	3	0	2	4	30	40	15	15	100
II.4 (FC)	Reflecting thought processes via ***Object Oriented Programming***	3	0	2	4	30	40	15	15	100
II.5 (FC)	Physics at work II: ***Deconstructing devices***	3	0	2	4	30	40	15	15	100
II.6	**Open Elective - 1**									
II.7	**Knowing specialization streams (Foundation Course Electives (FC))**									
II.7.1	***Business processes and strategic IT alignment***	3	1	0	4	50	50	0	0	100
II.7.2	***Electronics at work & circuit simulations***	3	1	0	4	50	50	0	0	100
II.7.3	***Exploring Biology - Systems Approach***	3	0	2	4	30	40	15	15	100
	Grand Total				**26**					650

Note:

1. The student may opt for only one paper in II.6 from the set of open electives for even semester (Table 2).

2. The student may opt for one or more papers in II.7. Only one paper will be included in the transcript as credit paper and the others as non-credit paper.

Key: L: Lecture, T: Tutorial, P: Project/Practical/Internship,
IA: Internal Assessment, EA: External Assessment (End semester exams)

Semester III

Paper No.	Interactive Learning Modules (Paper Title)	Credits				Marks				
		L	T	P	Total	Theory		Practical		Total
						IA	EA	IA	EA	
III.1 (CC)	Modeling change in the world around us: ***Partial Differential Equations***	3	1	0	4	50	50	0	0	100
III.2 (CC)	***Design and Analysis of Algorithms***	3	1	0	4	50	50	0	0	100
III.3 (CC)	Handling Information through ***Data Modeling and Design***	3	0	2	4	30	40	15	15	100
III.4	**Open Elective – 2 (OE)**									
III.5	**Discipline Centric Elective – 1 (DCE)**									
III.5.1	Understanding ***Economic Behavior***: The ***micro*** level	3	1	0	4	50	50	0	0	100
III.5.2	***Electronics circuit elements and instruments***	3	1	0	4	50	50	0	0	100
III.5.3	***Integrative Biology***	3	1	0	4	50	50	0	0	100
III.6	**Discipline Centric Elective – 2 (DCE)**									
III.6.1	***Principles of Management***	3	1	0	4	50	50	0	0	100
III.6.2	***Electronics circuit elements and instruments – Innovation Lab***	0	0	8	4	0	0	50	50	100
III.6.3	***Cell: Biochemical and Molecular perspective***	3	1	0	4	50	50	0	0	100
III.7 (CC)	Summer Internship: projects drawn from the world around us	0	0	8	4	0	0	40	60	100
	Grand Total				**26**					650

Note:

1. The student may opt for only one paper in III.4 from the set of open electives for odd semester (Table 1).
2. The students will opt for only one elective in III.5 & III.6.
3. The student will execute the internship III.7 during the preceding summer break.

Key: L: Lecture, T: Tutorial, P: Project/Practical/Internship,
IA: Internal Assessment, EA: External Assessment (End semester exams)

Semester IV

Paper No.	Interactive Learning Modules (Paper Title)	Credits				Marks				
		L	T	P	Total	Theory		Practical		Total
						IA	EA	IA	EA	
IV.1 (CC)	Does Nature play dice?: The amazing world of ***probability and statistics***	3	0	2	4	30	40	15	15	100
IV.2 (CC)	Instructing computing devices: ***Operating System***	3	1	0	4	50	50	0	0	100
IV.3 (CC)	Information exchange in computing devices: ***Data Communication & Networking***	3	1	0	4	50	50	0	0	100
IV.4	**Open Elective – 3 (OE)**									
IV.5	**Discipline Centric Elective – 3 (DCE)**									
IV.5.1	Understanding ***Economic Behaviour***: The ***macro*** level	3	1	0	4	50	50	0	0	100
IV.5.2	***Digital electronics and logic design***	3	1	0	4	50	50	0	0	100
IV.5.3	***In silico Biology***	2	0	4	4	15	35	25	25	100
IV.6	**Discipline Centric Elective – 4 (DCE)**									
IV.6.1	Bringing Companies and clients together: **Sales & Marketing management**	3	1	0	4	50	50	0	0	100
IV.6.2	***Digital electronics and logic design*** – Innovation Lab	0	0	8	4	0	0	50	50	100
IV.6.3	***Flow of information in living systems***	3	0	2	4	30	40	15	15	100
IV.7 (CC)	Semester long innovation project	0	0	8	4	0	0	40	60	100
	Grand Total				**26**					650

Note:

1. The student may opt for only one paper in IV.4 from the set of open electives for even semester (Table 2).
2. The student will attend only one elective in IV.5 & IV.6.
3. The student will finalize the semester long project title, area, and mentor(s) for IV.7 during Semester III. The project work will commence from the beginning of the preceding winter break.

Key: L: Lecture, T: Tutorial, P: Project/Practical/Internship, IA: Internal Assessment, EA: External Assessment (End semester exams)

Semester V

Paper No.	Interactive Learning Modules (Paper Title)	Credits				Marks				
		L	T	P	Total	Theory		Practical		Total
						IA	EA	IA	EA	
V.1 (CC)	Complexity and Symmetry in Mathematics: ***Complex Analysis and Algebra***	3	1	0	4	50	50	0	0	100
V.2 (CC)	***Computer Graphics and Visualization***	3	0	2	4	30	40	15	15	100
V.3 (CC)	Computer and Brain: Knowledge Discovery and ***Artificial Intelligence***	3	1	0	4	50	50	0	0	100
V.4	**Open Elective – 4 (OE)**									
V.5	**Discipline Centric Elective – 5 (DCE)**									
V.5.1	Maximizing performance: ***Human Resource management and Organizational Behavior***	3	1	0	4	50	50	0	0	100
V.5.2	***Embedded systems studio - I***	3	0	2	4	30	40	15	15	100
V.5.3	***Applied Genomics and Proteomics***	3	1	0	4	50	50	0	0	100
V.6	**Discipline Centric Elective – 6 (DCE)**									
V.6.1	Efficient manufacturing process: ***Production and Operations Management***	3	0	2	4	30	40	15	15	100
V.6.2	***Signals & Systems Engineering***	3	0	2	4	30	40	15	15	100
V.6.3	Biological Instrumentation Kitchen: ***Genomics and Proteomics***	0	0	8	4	0	0	40	60	100
V.7 (CC)	Industrial mini project	0	0	8	4	0	0	40	60	100
	Grand Total				**26**					650

Note:

1. The student may opt for only one paper in V.4 from the set of open electives for odd semester (Table 1).
2. The students will opt for only one elective in V.5 & V.6.
3. The student will execute the industrial mini project V.7 during the preceding summer break.

Key: L: Lecture, T: Tutorial, P: Project/Practical/Internship,
IA: Internal Assessment, EA: External Assessment (End semester exams)

Semester VI

Paper No.	Interactive Learning Modules (Paper Title)	Credits				Marks				
		L	T	P	Total	Theory		Practical		Total
						IA	EA	IA	EA	
VI.1 (CC)	Linear Construction of Actions: Engineering through ***Linear Programming and Game Theory***	3	0	2	4	30	40	15	15	100
VI.2 (CC)	Decoding Computation Structure and ***Logic***	3	1	0	4	50	50	0	0	100
VI.3 (CC)	***Internet and Web Technology***	3	0	2	4	30	40	15	15	100
VI.4	**Open Elective – 5 (OE)**									
VI.5	**Discipline Centric Elective – 7 (DCE)**									
VI.5.1	Handling money: ***Finance management***	3	1	0	4	50	50	0	0	100
VI.5.2	***Embedded systems studio – II***	3	1	0	4	50	50	0	0	100
VI.5.3	***Biological Networks***: from Micro to Macro niche	3	0	2	4	30	40	15	15	100
VI.6	**Discipline Centric Elective – 8 (DCE)**									
VI.6.1	***e - Business***: Organization and Strategy	3	0	2	4	30	40	15	15	100
VI.6.2	***Control systems***	3	0	2	4	30	40	15	15	100
VI.6.3	***Genes to Genomes***	3	0	2	4	30	40	15	15	100
VI.7 (CC)	Project in Industry, Society and Villages	0	0	8	4	0	0	40	60	100
	Grand Total				**26**					650

Note:

1. The student may opt for only one paper in VI.4 from the set of open electives for even semester (Table 2).
2. The student will attend only one elective in VI.5 & VI.6.
3. The student will finalize the semester long project title, area, and mentor(s) for VI.7 during Semester V. The project work will commence from the beginning of the preceding winter break.

Key: L: Lecture, T: Tutorial, P: Project/Practical/Internship,
IA: Internal Assessment, EA: External Assessment (End semester exams)

Semester VII

Paper No.	Interactive Learning Modules (Paper Title)	Credits				Marks				
		L	T	P	Total	Theory		Practical		Total
						IA	EA	IA	EA	
VII.1 (CC)	Algorithms for Computational Mathematics: ***Numerical Methods***	3	0	2	4	30	40	15	15	100
VII.2 (CC)	***Software Engineering and Project Management***	3	0	2	4	30	40	15	15	100
VII.3	**Discipline Centric Elective – 9 (DCE)**									
VII.3.1	***Computer Language Design & Engineering***	3	1	0	4	50	50	0	0	100
VII.3.2	Making Society Smart through ***Computational Social Systems***	3	1	0	4	50	50	0	0	100
VII.3.3	Introduction to ***Natural Language Processing***	3	1	0	4	50	50	0	0	100
VII.4	**Open Elective – 6 (OE)**									
VII.5	**Discipline Centric Elective – 10 (DCE)**									
VII.5.1	***Environment Management***	3	1	0	4	50	50	0	0	100
VII.5.2	Engineering at Molecular Scale: ***Devices and Nanotechnology***	3	1	0	4	50	50	0	0	100
VII.5.3	***Biodefense and Bioengineering***	3	1	0	4	50	50	0	0	100
VII.6	**Discipline Centric Elective – 11 (DCE)**									
VII.6.1	***Business automation strategies***. ERP. Case studies and project in industry	3	0	2	4	30	40	15	15	100
VII.6.2	***Circuit Analysis and Synthesis***	3	0	2	4	30	40	15	15	100
VII.6.3	***Systems Biology***	2	0	4	4	15	35	25	25	100
VII.7 (CC)	Industrial mini project, Simulation of real time cases	0	0	8	4	0	0	40	60	100
	Grand Total				**26**					650

Note:

1. The student may opt for only one paper in VII.4 from the set of open electives for odd semester (Table 1).
2. The students will opt for only one elective in VII.3, VII.5 & VII.6.
3. The student will execute the industrial mini project VII.7 during the preceding summer break.

Key: L: Lecture, T: Tutorial, P: Project/Practical/Internship,
IA: Internal Assessment, EA: External Assessment (End semester exams)

Semester VIII

Paper No.	Interactive Learning Modules (Paper Title)	Credits				Marks				
		L	T	P	Total	Theory		Practical		Total
						IA	EA	IA	EA	
VIII.1 (CC)	Industrial Internship/Major Project	0	0	52	26	0	0	200	450	650
	Grand Total	0	0	52	**26**	0	0	300	350	650

Note:

1. Students will decide the field of work and the organization for execution of the Industrial Internship/Major Project VIII.1 during Semester VII.
2. The Industrial Internship/ Major Project VIII.1 will be of minimum 20 weeks duration.

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OPEN ELECTIVES

Table 1: Open Electives (Odd Semester)

Interactive Learning Modules (Paper Title)	Credits				Marks				
	L	T	P	Total	Theory		Practical		Total
					IA	EA	IA	EA	
Language and Communication: ***Computational Linguistics***	2	0	0	2	25	25	0	0	50
History, culture & civilization	2	0	0	2	25	25	0	0	50
Visual arts & aesthetics	2	0	0	2	25	25	0	0	50
An introduction to GIS and GPS*	4	0	0	2	20	30	0	0	50
Computer Applications in Humanities & Social Science Research*	4	0	0	2	20	30	0	0	50
Appreciating Literary Works*	4	0	0	2	20	30	0	0	50
Introduction to Documentary – Technologies & Techniques*	4	0	0	2	20	30	0	0	50
Education Entrepreneurship for Social Change**	2	0	0	2	12	38	0	0	50
Education for Sustainable Future**	2	0	0	2	12	38	0	0	50

Table 2: Open Electives (Even Semester)

Interactive Learning Modules (Paper Title)	Credits				Marks				
	L	T	P	Total	Theory		Practical		Total
					IA	EA	IA	EA	
Art of ***Communication & Creative Writing***	2	0	0	2	25	25	0	0	50
Science, Philosophy, Truth: Impact of technology	2	0	0	2	25	25	0	0	50
Art & Design	2	0	0	2	25	25	0	0	50
Legal Literacy*	4	0	0	2	20	30	0	0	50
Documentary Film making*	4	0	0	2	20	30	0	0	50
Film Appreciation*	4	0	0	2	20	30	0	0	50
Translation*	4	0	0	2	20	30	0	0	50
Innovation in Education**	2	0	0	2	12	38	0	0	50
Mathematical Visualizations**	2	0	0	2	12	38	0	0	50

- * Elective courses floated for BA Hons (Humanities and Social Sciences). The syllabus and evaluation of these courses will be as prescribed in the course structure and evaluation process of BA Hons (Humanities and Social Science)
- ** Elective courses floated for M.Sc (Mathematics Education). The syllabus and evaluation of these courses will be as prescribed in the course structure and evaluation process of M.Sc (Mathematics Education)

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EVALUATION SCHEME

There will be continuous assessment based on class tests, presentations, seminars, assignments, projects etc. There will be an **Evaluation and Review Committee (ERC)** for each Semester. The Programme Coordinator will be the Chairman of the ERC and all CONVENERS (teachers teaching major portions of a paper) concerned for the semester will be its members.

FUNCTIONS OF THE ERC

a. To finalize examination schedule, its notification, preparation of invigilation chart and conduct of end semester examinations.
b. To ensure timely preparation of question papers and Evaluation of answer books for the end semester examination. ERC may assign full or a part of the work to any other faculty member of CIC.
c. To periodically assess the continuous evaluation of the papers and project/internship.
d. To determine and notify the eligibility of appearing in the end semester examination based on the attendance percentage prior to the commencement of the end semester examination.
e. To ensure timely notification of internal assessment marks. To consider such individual representations of students about internal evaluation which have not been possible to reconcile between the student and the concerned teacher and take the remedial action if needed. The case will be scrutinized by the ERC and the decision of the ERC shall be final.
f. To prepare the consolidated results semester wise and send them to the University Examination Branch for declaration of results.

EVALUATION

a. Letter Grades and Grade Points: A 10-point grading system shall be used with the letter grades as given in Table 3.

Table 3: Grades and Grade Points

Letter Grade	Grade Point
O (Outstanding)	10
A^+ (Excellent)	9
A (Very Good)	8
B^+ (Good)	7
B (Above average)	6
C (Average)	5
P (Pass)	4
F (Fail)	0
Ab (Absent)	0

b. Computation of SGPA and CGPA: The following procedure shall be used to compute the Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA):

   i. The SGPA is the ratio of sum of the product of the number of credits and the grade points scored in all the courses of a semester, to the sum of the number of credits of all the courses taken by a student, i.e.

$$SGPA\ (S_i) = \frac{\sum C_j \times G_j}{\sum C_j}$$

   where S_i is the i^{th} Semester, C_j is the number of credits of the j^{th} course in that semester and G_j is the grade point scored by the student in the j^{th} course.

   ii. The CGPA is also calculated in the same manner taking into account all the courses taken by a student over all the semesters of a programme, i.e.

$$CGPA = \frac{\sum C_i \times SGPA\ (S_i)}{\sum C_i}$$

   where *SPGA* (S_i) is the SGPA of the i^{th} semester and C_i is the total number of credits in that semester.

   iii. The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.

   iv. CGPA shall be converted into percentage of marks if required, by multiplying CGPA with 10.

c. For a 4 credits paper of FC, CC and DCE with practical (3-0-2 or 2-0-4), the end semester assessment (EA) for practical will have a project. For a 4 credits paper of FC, CC and DCE with tutorial (3-1-0), the internal assessment (IA) of theory will have a project of 25% weightage. A practical paper of FC, CC and DCE with 4 credits, will have a project of minimum 30% weightage (Table 4). These projects must relate the application of theory to real world problem. However, the projects must be such that a student spends a maximum of 10-12 hours on them. The continuous evaluation (CE) of the theory will be in the form of class test/ quiz/ assignments/ field work/ presentations/research paper review/ class participation/ etc.

Table 4: Weightage distribution for different credit papers

Credits				Marks					
				Theory			Practical		Total
L	T	P	Total	IA		EA	IA	EA (Project)	
				CE	Project				
2	0	0	2	25	0	25	0	0	50
3	1	0	4	25	25	50	0	0	100
3	0	2	4	30	0	40	15	15	100
0	0	8	4	0	0	0	40	60	100
0	0	4	2	0	0	0	25	25	50
2	0	4	4	25	0	25	25	25	100

d. For the project work or internship carried out either during the semester or during the summer break (Semester III – Semester VIII), broad guidelines for the evaluation shall be as follows:

I. Evaluation of projects/ Internship with 4 credits.

(i) A group of maximum 4 candidates will be mentored by a teacher OR a student/ group of students may be mentored by a responsible person in industry/organisation as assigned by the Programme Coordinator. On completion of the project, the students will submit a brief written report to the ERC. The report will be examined by a board of examiners (one board for 10 students), consisting of three members appointed by the Director, CIC on the recommendation of ERC.

(ii) The evaluation will be on the work carried out by the student, written report and viva/ presentation. 40% weightage will be given to the continuous performance (by the mentor) and 60% weightage for the final assessment (by the board of examiners) after the completion of the project.

II. Evaluation of 26 Credits Industrial Internship/Major Project (Semester VIII)

(i) There will be two mid term evaluations of marks 100 and 200 respectively.

(ii) The final evaluation will be of 350 marks. A dissertation should be submitted during the final evaluation. The dissertation will be examined by a board of three members appointed by the Director, CIC on the recommendation of the ERC. A viva-voce examination will be conducted by the board and marks awarded taking into consideration both dissertation and viva.

(iii) The Industrial Internship/ Major Project will be of minimum duration of 20 weeks. A student must complete the internship/ project within six months of the start of the semester. However, ERC may grant extension, not exceeding the maximum duration of the semester but not more than six months at a time.

B. Tech. (IT & Mathematical Innovations)

PROMOTION CRITERIA

i. A student who obtains a grade F or Ab in any paper shall have to repeat the paper.

ii. For non-credit courses, 'Satisfactory' or 'Unsatisfactory' shall be indicated instead of the letter grade and this will not be counted for the computation of SGPA/CGPA.

iii. A student who has to reappear in any paper of Semester I/ III/ V/ VII may do so only in the subsequent semester examination for Semester I/ III/ V/ VII respectively. Similarly if a student has to reappear in any paper of Semester II/ IV/ VI may do so only in the subsequent semester examination for Semester II/ IV/ VI respectively.

iv. A student who reappears in any paper shall carry forward the marks of the internal assessment originally awarded to him/her.

v. If a student has an ER in an open elective, and the same open elective is not being offered in the subsequent year, he/ she will have to change the elective. In that case, the student will have to give the internal assessment for the new elective.

vi. Total credit earned by students in eight semesters is 204. A student passing a paper will earn the total credit assigned to that paper.

vii. A student shall be eligible for promotion from 1st year to the 2nd year if he/she accrues at least 50% of the total credits in Semester I and Semester II combined. Similarly a student shall be eligible for promotion from 2nd year to the 3rd year if he/she accrues at least 50% of the total credits in Semester III and Semester IV combined (irrespective of the result at the end of the first year). A student shall be eligible for promotion from 3rd year to the 4th year if he/she accrues at least 50% of the total credits in Semester V and Semester VI combined (irrespective of the result at the end of the second year). A student shall be eligible to have passed the 4th year provided he/she earns a minimum of 204 credits during Semester I to Semester VIII.

viii. No student will be held back in Semester I/ III/ V/ VII.

ix. A student who does not satisfy criterion (vii) is required to repeat a year.

SPAN PERIOD

The total span period to complete the course will not be more than eight years from the year of admission.

ATTENDANCE

Averaged percentage of attendance to appear in the end semester examination shall be as per University Rules for Undergraduate Degree Examinations at the time.

B. Tech. (IT & Mathematical Innovations)

COURSE CONTENT

SEMSTER – I

I.1 Seeing the world through calculus. First steps through symbolic mathematics [Theory + Practical] [Semester I] [3 – 0 – 2]

Course Objective: Calculus is the most powerful tool in mathematics with widespread applications. The goal of this course is for students to gain proficiency in calculus computation. The course builds up on the topics, namely limits and continuity, differentiation and integration. These topics will use to solve application problem in a variety of fields such as physics, biology, business and economics.

Keywords: Calculus; Limits and continuity, differentiation and integration; Sequences and Series

Unit I: Limits and continuity - Limits at infinity - Indeterminate forms - Special limits involving exponential and logarithmic functions – Asymptotes - Graphs of function and its derivatives - Optimization problems - Fluency in differentiation - Concavity and inflexion points - Sequences, infinite series including Taylor approximations, Power series **(12 lectures)**
Unit II: Integration - Parametric equations of curves, arc length and surface area - Vector valued functions, differentiation and integration of vector valued functions **(9 lectures)**
Unit III: Functions of several variables - Level curves and surfaces - Limits and continuity of functions of two and three real variables - Partial differentiation (two variables), partial derivative as a slope, partial derivative as a rate, Maxima and Minima **(12 lectures)**
Unit IV: Multiple Integrals, line, surface and volume integrals - Applications of Green's, Stokes and Gauss's Theorem. **(9 lectures)**

Engineering Kitchen Activity (Symbolic Mathematics Software) [Laboratory]

- Introduction of basic functions
- Plotting of graphs of functions and their derivatives
- Manipulating the parameters in a graph
- Fitting of a curve
- Parametric plot of curves (Eg. Trochoid, Cycloid, Epicycloid)
- Obtaining surfaces of revolution of curves
- Plotting functions of two variables and their level curves
- Graphical illustration of limits for functions of two variables
- Innovation Project

Course Learning Outcomes:

- A good understanding of basic concepts of limits, derivatives, continuity, asymptotes, sequence and series, integrals, vector valued functions, partial differentiation, multiple integrals, etc.
- Able to find points of discontinuity for functions and classify them and understand the consequences of the intermediate value theorem for continuous functions.
- Able to solve applied problems using basic concepts of calculus.
- Able to explain why calculus is valuable in daily life.
- Create a project using the fundamental knowledge and principle of differential and integral calculus that helps to provide a hands-on experience of the same.
- Able to plot and manipulate the curves appropriately to make various real life models like studying the projectile motion in firecrackers and the flow of water in fountain.

- Create animations of given problems using MATHEMATICA software.

Teaching Plan (**Theory**)

Week 1:	Limits and continuity; Limits at infinity; Indeterminate forms; Special limits involving exponential and logarithmic functions
Week 2:	Asymptotes; Concavity and inflexion points; Graphs of function and its derivatives
Week 3:	Sequences, Infinite series including Taylor approximations
Week 4:	Power series
Week 5:	Integration; Parametric equations of curves, arc length
Week 6:	Volume and Surface area
Week 7:	Vector valued functions, differentiation and integration of vector valued functions
Week 8:	Functions of several variables; Level curves and surfaces; Limits and continuity of functions of two and three real variables
Week 9:	Partial differentiation (two variables)
Week 10:	Partial derivative as a slope; Partial derivative as a rate
Week 11:	Maxima and Minima
Week 12 and 13:	Multiple Integrals, line, surface and volume integrals
Week 14:	Applications of Green's, Stokes and Gauss's Theorem

References

1. *Calculus*, T. M. Apostol, Volumes 1 and 2, Wiley Eastern, 1980.
2. *Calculus - Single and Multivariable*, Hughes-Hallett et al., John-Wiley and Sons, 2003.
3. *Calculus*, James Stewart, Thomson, 2003.
4. *Calculus and Analytic Geometry*, G. B. Thomas and R. L. Finney, Addison-Wesley, 1998.

I.2 Modeling continuous change through ordinary differential equations [Theory + Practical] [Semester I] [3 – 0 – 2]

Course Objective: Differential equations have the remarkable ability to translate the real world problems in mathematical language. This course enables to study many engineering systems, population dynamics in ecology and biology, mechanics of particles in physics, planetary models etc. involving differential equations. The main objective of the paper is to first analyze and understand the real world problem through mathematical lens and then develop the corresponding mathematical model with differential equations in most realistic sense. Once, governing equations are obtained, students should be able to solve them analytically and analyze the solution in physical situations. Students will use MATHEMATICA software for purpose of simulation.

Keywords: First and higher order differential equations; Power Series; Laplace Transforms

Unit I: Review of first order differential equations - Variable separable, homogeneous, linear, exact differential equation - Integrating factors - Existence and uniqueness of solution **(12 lectures)**
Unit II: General solutions of second order differential equation - Homogeneous and non-homogeneous differential equations with constant coefficients - Method of variation of parameters - Method of undetermined coefficients, higher order differential equations with constant coefficients **(12 lectures)**
Unit III: Planar autonomous linear systems with graphical representation - Determination of stability and classification of equilibrium of a planar nonlinear system by linearization **(6 lectures)**
Unit IV: Power series solution about a regular point of an analytic ordinary differential equation - Power series solution of Legendre and Bessel's equation - Orthogonality of Legendre and Bessels function - Laplace transform and its application to differential equations **(12 lectures)**

Engineering Kitchen Activity (through mathematical software) [Laboratory]

- Plotting of slope fields and solution curves of first order and higher order differential equations
- Graphical analysis of solution of Population model, Pollution Model, Acceleration – Velocity Models
- Projectile motion, Mechanical Vibrations – Motion of Simple Pendulum, Free undamped and damped motion, Forced undamped and damped motion
- Plotting of phase plane diagrams for predator – prey model, competing species, epidemic model and their analysis
- Innovation project

Course Learning Outcomes:

- Able to explain the fundamental concepts of ordinary differential equations (ODEs)
- Able to use MATHEMATICA software to solve problems and applications of ordinary differential equations (ODEs) and complex analysis.
- Formulate real life problems as ODEs.
- Able to use concepts of ordinary differential equations to solve physical models such as mass spring, pendulum, alternating current circuits, etc.
- Able to use knowledge of ODEs, the general and particular structure of solutions and different methods for solutions.

Teaching Plan (**Theory**)

Week 1:	First order differential equations
Week 2:	Variable separable, homogeneous, linear, exact differential equation
Week 3:	Integrating factors
Week 4:	Existence and uniqueness of solution
Week 5:	General solutions of second order differential equation
Week 6:	Homogeneous and non-homogeneous differential equations with constant coefficients
Week 7:	Method of variation of parameters
Week 8:	Method of undetermined coefficients, higher order differential equations with constant coefficients
Week 9:	Planar autonomous linear systems with graphical representation
Week 10:	Determination of stability and classification of equilibrium of a planar nonlinear system by linearization
Week 11:	Power series solution about a regular point of an analytic ordinary differential equation
Week 12:	Power series solution of Legendre and Bessel's equation
Week 13:	Orthogonality of Legendre and Bessels function
Week 14:	Laplace transform methods applied to differential equations

References

1. *Elementary differential equations*, W. E. Boyce and R. DiPrima, John Wiley, 2005.
2. *Differential equations and boundary value problems: Computing and modeling*, C.H. Edwards and D.E. Penny, Pearson education (Singapore), Pte. Ltd., 2005.
3. *Advanced engineering mathematics*, E. Kreyszig, John Wiley, 1999.

I.3 Automating real world through Programs: Programming Fundamentals [Theory + Practical] [Semester I] [3 – 0 – 2]

Course Objectives: This course aims at providing the fundamental knowledge of programming. This course train students to design code, write programs to instruct the computer systems. In addition, the course objective is to give an understanding of real-world data, tasks and their representation in terms of programs.

Keywords: Algorithm; Programming; Coding

Unit I: Algorithm and its characteristics-Programming philosophy-Problem solving process-Programming language concepts-Program life cycle **(9 lectures)**
Unit II: Data definition structures such as types-constants-variables-Expressions such as arithmetic-logical-Precedence and associative rules-Control Structures-Functions-Variable scope **(12 lectures)**
Unit III: Preprocessing - Arrays, Structures – Strings - Pointers - Memory allocation **(12 lectures)**
Unit IV: Files handling – Coding guidelines - testing & debugging-System testing & Integration **(9 lectures)**

Engineering Kitchen Activity [Laboratory]

- User input and output programs having mathematical operations
- Pattern printing programs
- Programs for operators implementation
- Programs to implement function
- Programs to implement collection such as Array and String
- Programs to implement structure
- Innovation Project

Course Learning Outcomes: Following are the Course Learning Outcomes which students will have at the end of the course.

- Will have understanding of Programming Concepts
- Will have understanding of real world applications development through programs
- Will have understanding of independent data and collection of data and their organization
- Will have understanding of memory allocation on runtime
- Will understanding the program life cycle
- Will have understanding of testing, coding guidelines, debugging and integration.

Teaching Plan (**Theory**)

Week 1:	Algorithm and its characteristics, Programming philosophy
Week 2:	Problem solving process, programming language concepts
Week 3:	Program life cycle
Week 4:	Data definition structures such as types-constants-variables
Week 5:	Operators implementation, expressions such as arithmetic, logical
Week 6:	Control structures, Precedence and associative rules
Week 7:	Functions, Variable scope
Week 8:	Pointers
Week 9:	Memory allocation, Preprocessing
Week 10:	Arrays, Strings
Week 11:	Structures
Week 12:	Files handling
Week 13 and 14:	Coding guidelines, Unit testing & debugging, System testing & Integration

References:

1. *C++: The Complete Reference, Fourth Edition*, Herbertz Schildt, McGraw Hill, 2015.
2. *The C++ Programming Language, 4th Edition*, Bjarne Stroustrup, Addison-Wesley, 2013.
3. *Computer Science: A Structured Approach Using C++ 2nd Edition*, Behrouz A. Forouzan, Richard F. Gilberg, 2004
4. *The C Programming Language (Ansi C Version)*, Brian W. Kernighan, Dennis M. Ritchie, 1990.

I.4 Understanding Computing Systems Architecture [Theory + Practical] [Semester I] [3 – 0 – 2]

Course Objectives: The objective is to concentrate on the principles underlying systems organisation, issues in computer system design, and contrasting implementations of modern systems and to familiarize the students with a fundamental knowledge of computer hardware and computer systems, with an emphasis on system design and performance.

Keywords: Computer arithmetic; Combinational Circuits; Computer Architechture

Unit I: Computer arithmetic: fixed point and floating-point representation and arithmetic, numbers conversion.Digitals circuits: Boolean algebra, logic gates, logical synthesis by minimization of Boolean functions **(12 lectures)**
Unit II: Combinational circuits, sequential circuits (synchronous and asynchronous). Construction of the computer: Von Neumann Architecture **(12 lectures)**
Unit III: Organization and architecture of memory systems, input/output systems **(12 lectures)**
Unit IV: Construction of the simple processor. **(6 lectures)**

Engineering Kitchen Activity [Laboratory]

- Logic Gate Designs
- Deconstructing Digital Architecture of a computing devices and study of components (Hardware/Software)
- Hands on experiments with Arduino/ARM Interface
- Programming in Assembler: memory addressing, interrupts, operations on numbers bits and tables, conditional instructions, loops, input/output
- Innovation Project

Course Learning Outcomes: Following are the Course Learning Outcomes which students will have at the end of the course.

- Will have understanding of Computing Systems, Models & Logic, Organization & Architecture of Memory.
- Will have understanding of CPU, I/O Devices
- Will have understanding of Distributed Computing, Parallel Architecture, Mobile Systems Architecture
- Will have understanding about Deconstructing Digital Architecture of a computing devices and study of components (Hardware/Software)
- Will have hands on experience with Arduino/ARM Interface, Programming & interfacing with Sensors and Parallel Programming using OPENMP, OpenMPI & CUDA.

Teaching Plan (**Theory**)

Week 1 and 2: Computer arithmetic; fixed point and floating-point representation and arithmetic, numbers conversion
Week 3 and 4: Digitals circuits; Boolean algebra; logic gates; logical synthesis by minimization of Boolean functions
Week 5 and 6: Combinational circuits; sequential circuits (synchronous and asynchronous)
Week 7 and 8: Construction of the computer; Von Neumann Architecture
Week 9 and 10: Organization and architecture of Memory systems

Week 11 and 12: Input/output systems
Week 13 and 14: Construction of the simple processor

References:

1. *Computer System Architecture*, Morris Mano, Pearson Education, 2008
2. *Computer Systems Architecture: a Networking Approach*, Rob Williams, Pearson Education, 2006
3. *Advanced Computer Architecture: Parallelism, Scalability, Programmability*, K. Hwang, McGraw Hill, 2017.

I.5 Physics at work I: Deconstructing Machines [Theory + Practical] [Semester I] [3 – 0 – 2]

Course Objective: This interactive learning module intends to provide basic theoretical understanding of Classical Mechanics with special emphasis on learning how these theoretical concepts are applied in designing mechanical and energy efficient systems etc.

Keywords: Classical Mechanics; Central force motion; Machines; Energy

Unit I: Newtonian Mechanics (Kinematics & Dynamics) - Classical Mechanics at work - deconstructing mechanical systems - Universal Gravitation **(12 lectures)**
Unit II: Oscillations - Inertial & Non-inertial frames - Central force motion - Understanding rotational dynamics **(12 lectures)**
Unit III: Efficiency and mechanical advantage in simple and complex machines: Levers, Pulley, Wheel & Axles, Gear systems, Hydraulic systems **(12 lectures)**
Unit IV: Forms of energy and conversion between different forms of energy. **(6 lectures)**

Engineering Kitchen Activities [Laboratory]

- Concepts of measurement, error, precision, accuracy. Concept of scale. Understanding Measuring Instruments
- Understanding oscillation using simple and compound pendulums
- Mechanics system with 850 Universal Interface – understanding Newtonian Dynamics
- Measurement of Moment of inertia from rotational dynamics
- Roller coaster dynamics – computer simulation and physical verification
- Coupled pendulum motion – using webcam and image analysis
- Ballistic Pendulum
- Understanding physics of complex machines – one implementation of "Tod-Phod-Jod" concept.
- Visualization in 3D and understand how things work – Building a CAD model in 3D to trace the flow of power, energy, information and material.
- Innovation project – designing instruments, machines, prototypes, applets

Course Learning Outcomes:

- Understanding of physics principles in machines.
- Ability to conceptualize and build machines for real life use.
- Reverse engineering of mechanical devices and redesigning of such objects.
- Practical hands-on skills and understanding of simple engineering concepts derived from Mechanics.

Teaching Plan (**Theory**)

Week 1: Newtonian Mechanics (Kinematics & Dynamics)
Week 2: Newtonian Mechanics (Kinematics & Dynamics)
Week 3: Classical Mechanics at work -deconstructing mechanical systems
Week 4: Universal Gravitation
Week 5: Oscillations

Week 6:	Inertial & Non-inertial frames
Week 7:	Central force motion
Week 8:	Understanding rotational dynamics
Week 9:	Efficiency and mechanical advantage in simple and complex machines:
Week 10:	Levers, Pulley, Wheel & Axles
Week 11:	Gear systems
Week 12:	Hydraulic systems
Week 13 and 14:	Forms of energy and conversion between different forms of energy

References:

1. *Classical Mechanics*. Herbert Goldstein, Pearson Education, 2011.
2. *A Textbook of Machine Design*. R. S. Khurmi, and J. K. Gupta, S. Chand Publishing, 2005.

I.6 Business, Entrepreneurship and Innovation Management [Theory] [Semester I] [2 – 0 – 0]

Course Objective: The module is a basic introduction to the nature of innovation in the economy, and will cover a wide range of associated topics, which needs to be addressed by management and policy makers. It comprises a set of self-contained, but related topics, which are necessary to the understanding of the nature of innovation and entrepreneurial decisions.

Keywords: Business; Entrepreneurship; Innovation

Unit I: Understanding Business - Types of Business Activities - Evaluating the Business - Business organization - Starting a Business - Entrepreneurship concept - Entrepreneurial attributes & characteristics **(12 lectures)**
Unit II: Leadership - Business Plan preparation - B2B and B2C models **(9 lectures)**
Unit III: Creativity & its components - Invention vs. Innovation - Types of innovation - Innovation and Technology **(12 lectures)**
Unit IV: Innovation policy & IPR - Commercialization of Innovation. **(9 lectures)**

Course Learning Outcomes:

- Have a clear understanding of the types Business activities and organization
- Understand the underlying principles of starting a business
- Identify the Entrepreneurial attributes & characteristics
- Prepare business plans for B2B and B2C models
- Differentiate between Invention and Innovation
- Relate Innovation with technology, existing policies
- Understand the role of IPR in commercialization of innovation

Teaching Plan (**Theory**)

Week 1:	Understanding Business; Types of Business Activities; Evaluating the Business
Week 2:	Business organization
Week 3:	Starting a Business; Entrepreneurship concept
Week 4:	Entrepreneurial attributes & characteristics
Week 5:	Leadership
Week 6:	Business Plan preparation
Week 7:	B2B and B2C models
Week 8:	Creativity & its components
Week 9:	Invention vs. Innovation
Week 10:	Types of innovation
Week 11:	Innovation and Technology
Week 12:	Innovation policy & IPR

Week 13 and 14: Commercialization of Innovation

References:

1. *Entrepreneurship*. R. D. Hisrich, M. P. Peters, and D. A. Shepherd, D. A., New York: McGraw-Hill / Irwin (New York), 2005
2. *Innovation and entrepreneurship: Practice and principles*. P. F. Drucker, Elsevier, USA, 2006.

I.7 Environmental Studies and Ecosystem Management [Theory] [Semester I] [3 – 1 – 0]

Course Objective: The main objective of this paper is to understand the relation of environment and human beings. Therefore, imparting basic knowledge about the environment and its allied problems. Also intend to develop an attitude of concern for the environment protection and biodiversity conservation.

Keywords: Public Health; Biodiversity; Pollution; Environment management

Unit I: Relationship between environment and public health - Sustainable development: policy and practices **(9 lectures)**
Unit II: Biodiversity: Hotspots, Threats, Conservation - Ecosystem: Structure, Function, Energy flow, cycles **(12 lectures)**
Unit III: Environmental pollution & public health - Mitigation strategies - Policy **(9 lectures)**
Unit IV: Collection and processing of environmental data - IT in ecosystem & environment management – Social and Cultural parameters - Environmental Risk & Impact Assessment. **(12 lectures)**

Course Learning Outcomes: This paper gives students a general understanding of the interdisciplinary nature of environmental phenomenon and environmental issues. Upon completion of the course the students would be able to-

- Understand the environmental issues, such as natural resource degradation, environmental pollution, biodiversity conservation etc.
- Apply knowledge of mathematics, science, engineering and state-of-the-art technology in the environmental science.
- Design and conduct project studies related to environmental issues
- Analyse environmental data and interpret environmental issues through the data.
- Ability to explain environmental sustainability in a societal, environmental, and economic context.
- Explore the environmental open source database and interpret remotely sensed database.
- Prepare basic cartographic maps

Teaching Plan (**Theory**)

Week 1: Basic concepts on Environment, ecosystem & natural resources
Week 2: Elaborating different kind of environmental impacts and adverse impact on human health
Week 3: Global policies and national policies on Sustainable development. . Earth summits and outcome of earth summits.
Week 4: Biodiversity at different level, Biomes, Ecosystem functioning and Ecosystem services
Week 5: Different threats on biodiversity, Mass extinction, Millennium ecosystem assessment and Biodiversity hotspot area. Different kind of biodiversity conservation policies at global and national level.
Week 6: Ecosystem at Physical, chemical and structure. Ecosystem function, Energy cycle and energy flow. Food chain and food web. Different kind of Energy pyramids.
Week 7: Biogeochemical cycles: Carbon, Nitrogen, Sulphur, Phosphorus, Oxygen and

	Water cycles
Week 8:	Air pollution: Primary pollutants & Secondary pollutants. Adverse impacts of Air pollution to plants, ecosystem and human. Water Pollution: Surface and marine pollution, Point source and non-point source pollution, contaminant, sources and control of water pollution.
Week 9:	Soil Pollution: Source of Soil pollution, health effects and ecosystem effects.
Week 10:	Environmental pollution & public health - Mitigation strategies - Policy
Week 11:	Environmental data analysis using Geoinformatics.
Week 12:	Environment, Social and Cultural parameters. Traditional Ecological knowledge, Environmental activism, Migration, Urbanization, Poverty, Religious rituals & Modern life style.
Week 13 and 14:	Environmental Hazard, Environmental Vulnerability and Environmental Risk Assessment. Environmental Impact assessment (EIA) of various projects in India.

References:

1. *Fundamental Concepts in Environmental Studies, D.D. Mishra, (S Chand & Co Ltd.), 2014.*
2. *Environmental Management for Sustainable Development,* Chris Barrow, *(Routledge Environmental Management Series), 2nd Ed.*, 2006.
3. *Essentials of Environmental Management,* Paul Hyde and Paul Reeve, (IOSH Services Ltd. UK.), 2004.
4. *Environmental Impact Assessment Methodologies,* Y. Anjaneyulu, Valli Manicka, (CRC Press), 2011.
5. *Fundamentals of Ecological Modelling*, S.E. Jorgensen and G. Bendorrichio (Elsevier), 3rd Ed., 2001.
6. *Introduction to Environmental Economics*, Nick Hanley, Jason F. Shogren and Ben White, (Oxford University Press), 2001.

SEMESTER II

II.1 Linearity in Nature: Engineering through Linear Algebra. First steps through numerical algorithms [Theory + Practical] [Semester II] [3 – 0 – 2]

Course Objective: Almost, every area of modern science contains models where equations may be approximated by linear equations and linear algebra plays a vital role for finding their solution and interpreting them. This paper aims to enable the student to learn linear models for various physical problems such as traffic flow, electric-circuit flow etc. and to facilitate their solution using concepts of linear dependence, independence, rank, basis, eigenvalues, eigenvectors etc. This paper intends to provide geometrical interpretation of vectors, basis and vector operations in 2 & 3 dimensions and lays the groundwork for a more abstract, pure-mathematical treatment of vector spaces. Also, the importance and application of eigenvalues, eigenvectors in computer graphics, face recognition and many other fields is taught. Students will also learn how to use MATLAB for some simple matrix operations, for finding eigenvalues & eigenvectors, rank etc.

Keywords: Matrices; Eigenvalues and Eigenvectors; Vector space; Orthogonalisation

Unit I: Algebra of matrices – Review of Determinants - Hermitian, Skew-Hermitian and Unitary matrices - Vectors and vector operations in 2 and 3 dimensions - Solution and application of linear matrix system AX = B

(9 lectures)

Unit II: Eigenvalues and eigenvectors, minimal polynomial, Cayley-Hamilton therorem and diagonalisation **(9 lectures)**

Unit III: Abstract vector spaces, subspaces - Finite dimensional vector spaces - Linear independence and dependence of vectors, bases, dimension of vector spaces - Finite dimensional inner product spaces

(12 lectures)

Unit IV: Orthogonal sets and projections, Gram Schmidt process, orthogonal diagonalisation

(12 lectures)

Engineering Kitchen Activity (matrix based numerical mathematics software) [Laboratory]

- Basic arithmetic operations, hierarchy of arithmetic operations
- Declaration and assignment of variables
- Introduction to elementary mathematical functions
- Dealing with matrices and arrays
- Basic programming with loops (for, while, switch), if else statements
- Programs for solving system of linear equations, Orthogonalization
- Creating 2D, 3D plots
- Innovation project

Course Learning Outcomes: After completing this course, student should be able to;

- Understand graphical representation of vector and their operations in 2 and 3 dimensions
- Solve linear matrix system AX=B
- Understand the concept of Eigen values and Eigen vectors and their applications in computer graphics, face recognition algorithms & many other fields
- Conceptualize vector spaces, subspaces and their basis functions
- Understand inner product spaces, orthogonal sets, projection and orthogonal diagonalisation
- Learn basic arithmetic operations of matrices in MATLAB
- Implement basic loops (for, while, if else etc) of programming in MATLAB
- Write their own programs for solving system of linear equations

Teaching Plan (**Theory**)

Week 1:	Algebra of matrices; Determinants; Hermitian, Skew-Hermitian and Unitary matrices
Week 2:	Vectors and vector operations in 2 and 3 dimensions
Week 3:	Solution and application of linear matrix system $AX = B$
Week 4:	Eigenvalues and eigenvectors
Week 5:	Minimal polynomial; Cayley-Hamilton therorem
Week 6:	Diagonalisation of Matrices
Week 7:	Abstract vector spaces and subspaces; Finite dimensional vector spaces
Week 8:	Linear independence and dependence of vectors
Week 9:	Bases and dimension of vector spaces
Week 10:	Finite dimensional inner product spaces
Week 11:	Orthogonal sets and projections
Week 12:	Gram Schmidt process
Week 13:	Orthogonality of Legendre and Bessels function
Week 14:	Orthogonal diagonalisation

References

1. *Linear Algebra and its Applications*, D. C. Lay, Addison Wesley, 2005.
2. *A Modern Introduction*, David Poole, *Linear Algebra,* Brooks Cole, 2011.

II.2 Understanding real life situation through Discrete Mathematics [Theory] [Semester II] [3 – 1 – 0]

Course Objective: The objective of this paper is to familiarize the student with basic concepts of combinatorics and to conceptualize the terminologies of graph theory, isomorphism, paths, cycles, circuits, graph coloring in various physical situations. Throughout this paper, students will be encouraged to develop their own algorithms and to analyze their computational complexities. Further, students may develop codes in any of the programming language for implementation of various algorithms.

Keywords: Combinatorics; Graph theory; Trees

Unit I: ***Combinatorics***: Sets, counting of sets - Permutation - Combination - Inclusion - exclusion - Generating functions - Recurrence relations - ***Graph Theory***: Introduction - Basic terminologies - Graph representation - Euler relation **(12 lectures)**
Unit II: Isomorphism - Connectivity - Cut vertices and edges - Covering - Euler and Hamilton paths and circuits - Shortest Path Algorithms: Dijkstra's algorithm **(12 lectures)**
Unit III: Travelling salesman problem - Scheduling problems - Matching - Independent sets - Coloring - *Planar graph*: idea of region - Euler formula - Kuratowski theorem and application **(9 lectures)**
Unit IV: *Tree*: basic terminology, traversal, Prefix code - Idea of data compression: Huffman code - Spanning tree - Minimum spanning tree: Prim's and Kruskal method. **(9 lectures)**

Course Learning Outcomes: After completing this course, student should be able to;

- Understand combinatorics principles: sets, permutations, combinations, recurrence relations etc.
- Conceptualize basic terminologies of graph theory, isomorphism, connectivity etc
- Understand concepts of paths, cycles, circuits and their applications in various fields
- Learn different shortest path algorithms, their computational complexities, implementation & programming
- Understand travelling salesman problem and its importance
- Understand the concept of graph coloring with real applications, planar graphs and algorithms
- Conceptualize trees, spanning trees and algorithms

Teaching Plan (**Theory**)

Week 1 and 2:	Sets, counting of sets; Permutation; Combination; Inclusion and exclusion principles; Generating functions; Recurrence relations
Week 3:	Introduction to Graph theory; Basic terminologies
Week 4:	Graph representation; Euler relation
Week 5 and 6:	Isomorphism; Connectivity; Cut vertices and edges; Covering
Week 7:	Euler and Hamilton paths and circuits
Week 8:	Shortest Path Algorithms: Dijkstra's algorithm
Week 9:	Travelling salesman problem
Week 10:	Scheduling problems - Matching - Independent sets - Coloring
Week 11:	Idea of region in a planar graph; Euler formula; Kuratowski theorem and application
Week 12:	Basic terminologies of a Tree; Traversal; Prefix code
Week 13:	Idea of data compression: Huffman code
Week 14:	Spanning tree - Minimum spanning tree; Prim's and Kruskal method.

References:

1. *Discrete and Combinatorial Mathematics,* Ralph Grimaldi, International Edition, 2003.
2. *Discrete Mathematical Structures,* Bernard Kolman, Robert Busby, Sharon Ross, International Edition, 2008.
3. *Discrete Mathematics and Its Applications,* K. H. Rosen, McGraw-Hill, 2008.

II.3 Optimizing Memory use through Data Structure and Design [Theory + Practical] [Semester II] [3 – 0 – 2]

Course Objectives: This course objective is to give an understanding of the real world data representation, organisation and structuring to the student while writing the programs and software. The course makes them familiar with the several types of data structures and their strengths and weaknesses, particularly in a real-world situation.

Keywords: Data structure; Algorithms; Graph theory

Unit I: Introduction to Data structure, Basic concepts of Correctness, Efficiency and Application, Dynamic optimization Concept, Search Algorithms **(12 lectures)**
Unit II: Sorting Algorithms, Introduction to Linear Data Structures: Linked List, Stack and Queues **(12 lectures)**
Unit III: Introduction to Hierarchical Data structure: Tree, Introduction to Heap, Priority Queues and Hashing **(12 lectures)**
Unit IV: Introduction to Graphs **(6 lectures)**

Engineering Kitchen Activity [Laboratory]:

- Implementation of Linked list in C/C++
- Implementation of Trees in C/C++
- Implementation of variant of Trees in C/C++
- Implementation of Heaps in C/C++
- Implementation of Hashing in C/C++
- Implementation of Priority Queues in C/C++
- Implementation of Graph and Network based approaches in C/C++
- Innovation Project

Course Learning Outcomes

- Introduction to Data structure and their significance.
- Practical and theoretical understanding of Dynamic optimization
- Basics of Memory Hierarchy and implementation
- Understanding and implementation of Hashing, Networks and Graphs
- Understanding basics and practical aspects of Searching algorithms in the real world through implementation.
- Introduction and implementation of Heaps and Priority Queues and their comparison with other data structure

Teaching Plan (**Theory**)

Week 1 and 2:	Introduction to Data structure, Basic concepts of Correctness, Efficiency and Application
Week 3 and 4:	Dynamic optimization Concept, Search Algorithms
Week 5 and 6:	Sorting Algorithms
Week 7 and 8:	Introduction to Linear Data Structures: Linked List, Stack and Queues.
Week 9 and 10:	Introduction to Hierarchical Data structure: Tree
Week 11 and 12:	Introduction to Heap, Priority Queues and Hashing
Week 13 and 14:	Introduction to Graphs

References:

1. *Algorithms and Data Structures*, N. Wirth, Prentice-Hall of India, 2009
2. *Data Structures and Algorithms in C++,* A. Drozdek, Course Technology, 2013

II.4 Reflecting thought processes through Object Oriented Programming [Theory + Practical] [Semester II] [3 – 0 – 2]

Course Objectives: The objective is to implement real-world entities like inheritance, hiding, polymorphism etc. in programming. To learn how to bind together the data and the functions that operate on them so that no other part of the code can access this data except that function.

Keywords: Data variables; Classes and objects; Dynamic objects; Multithread programming

Unit I: Introduction to byte code, security and portability, Data Types, variables, operators, arrays, type conversion and casting, type promotion, Control statements, standard input-output, Designing Classes, constructors, methods. access specifiers - public, private, protected **(12 lectures)**

Unit II: Classes and objects - Introduction, Class revisited, constant objects and constructor, static data members with constructors and destructors, constructor overloading, nested classes, objects as arguments, returning objects, constant parameters and member functions, static data and member functions. **(12 lectures)**

Unit III: Inheritance, packages and interfaces, Math, String, polymorphism - function overloading, function overriding, abstract classes, Dynamic objects - Introduction, array of objects, Exception Handling - exception types, nested try-catch, throw, throws and finally statements **(12 lectures)**

Unit IV: Multi Thread Programming - thread creation, synchronization and priorities **(6 lectures)**

Engineering Kitchen Activities [Laboratory]

- Programs implying the use of Arrays, Linked Lists, Strings, Loops
- Programs on Object & Classes from Realistic Environment and Systems
- Programs demonstrating Constructors, Destructors, Methods & other concepts
- Programs Showcasing Inheritance, Polymorphism, Encapsulation & other OOPS features
- Programs on Exception Handling, Packages and Threading

- Reverse Engineering a Java Source/ project/Mobile Application and understanding the concepts
- Mapping the programs with Real life Systems and showcasing the implementation
- Innovation project

Course Learning Outcomes: Upon Completion of this course the students will be able to:

- Recognise features of object-oriented design such as encapsulation, polymorphism, inheritance, and composition of systems based on object identity.
- Use NetBeans, Eclipse, BlueJ as an Integrated Development Environment. Test a program and, if necessary, find mistakes in the program and correct them.
- Take a problem and develop the structures to represent objects and the algorithms to perform operations.
- Name and apply some common object-oriented design patterns and give examples of their use.
- Apply standards and principles to write truly readable code.
- Design a class that serves as a program module or package.
- Design applications with an event-driven graphical user interface using java applets.
- Design different android applications such as web apps for the real world problems.

Teaching Plan (**Theory**)

Week 1 and 2:	Introduction to byte code; security and portability; Data Types; variables; operators; arrays; type conversion and casting; type promotion
Week 3 and 4:	Control statements; standard input-output; Designing Classes; constructors; methods; access specifiers public, private, protected
Week 5 and 6:	Classes and objects Introduction; constant objects and constructor; static data members with constructors and destructors; constructor overloading; nested classes; objects as arguments; returning objects; constant parameters and member functions; static data and member functions
Week 7 and 8:	Dynamic objects Introduction; array of objects.
Week 9 and 10:	Inheritance; packages and interfaces
Week 11 and 12:	Exception Handling
Week 13 and 14:	Multi-Thread Programming

References:

1. *Java: The Complete Reference*, 10th Edition. Herbert Schildt. McGraw-Hill, 2017.
2. *C++: The Complete Reference*, 4th Edition. Herbert Schildt. McGraw-Hill, 2012.
3. *Object Oriented Programming with C++*, 6th Edition. E Balagurusamy. Tata McGraw-Hill, 2001.
4. *C++ For Artists: The Art, Philosophy, and Science Of Object-Oriented Programming*. Rick Miller, Pulp Free Press, 2008
5. *Java For Artists: The Art, Philosophy, and Science Of Object-Oriented Programming*. Rick Miller , Pulp Free Press, 2008

II.5 Physics at work II: Deconstructing Devices [Theory + Practical] [Semester II] [3 – 0 – 2]

Course Objective: This module intends to provide an understanding of the basics of electrostatics and electrodynamics. It emphasizes on learning of concepts of electric circuits, electromagnets and induction mechanism. Further it gives a day-to-day knowledge of transformers, motors and generators. Also, it provides learning of solar energy usage and its technology. The lab activities provide a hand on experiments on electricity and solar energy. It provides understanding of working of utility devices. It intends to promote projects on robotics and solar energy.

Keywords: Electrostatics; Electrodynamics; Electromagnetism; Solar energy

Unit I: Basics of Electrostatics and Electrodynamics - Electric Circuit elements and function - Current, voltage, capacitance, resistance - Power and efficiency in electrical appliances **(12 lectures)**
Unit II: Joule heating - Electrical safety devices - Basics of Electromagnetism - Electromagnets and induction - Transformers. DC motors and generators **(12 lectures)**
Unit III: AC motors - Using electromagnetic spectrum - Information transfer and broadcasting **(6 lectures)**
Unit IV: Use of Radiation energy and appliances - Photovoltaic cells and conversion of solar energy to electricity - Advantages, limitations and challenges of different solar cell technologies - Different forms of renewable energy and technology. **(12 lectures)**

Engineering Kitchen Activities [Laboratory]

- Electric circuit, power requirement, cost of electricity, energy efficiency of sample appliances
- Potential divider, measurement of resistances of different scales
- Build a buzzer
- Conversion of solar power to electricity using photovoltaic cells: design, working principle, performance, application
- Build an autonomous robot
- Build a remote controlled robot
- Understanding physics of devices – one implementation of "Tod-Phod-Jod" concept.
- Innovation project – designing instruments, devices, model & prototyping

Course Learning Outcomes:

- Understanding of physics principles in devices.
- Ability to conceptualize and build electrical devices for real life use.
- Reverse engineering of electrical devices and redesigning of such objects.
- Practical hands-on skills and understanding of simple engineering concepts derived from Electricity & Magnetism.

Teaching Plan (**Theory**)

Week 1	Basics of Electrostatics
Week 2	Basics of Electrodynamics
Week 3	Electric Circuit elements and function - Current, voltage, capacitance, resistance
Week 4	Power and efficiency in electrical appliances
Week 5	Joule heating - Electrical safety devices
Week 6	Basics of Electromagnetism
Week 7	Electromagnets and induction
Week 8	Transformers. DC motors and generators
Week 9	AC motors
Week 10	Using electromagnetic spectrum – Information transfer and broadcasting
Week 11	Use of Radiation energy and appliances
Week 12	Photovoltaic cells and conversion of solar energy to electricity
Week 13	Photovoltaic Advantages, limitations and challenges of different solar cell technologies
Week 14	Different forms of renewable energy and technology.

References:

1. *Introduction to Electrodynamics*. David. J. Griffiths, PHI Learning, 2012
2. *Textbook of Electrical Technology* – Volume I & II. B. L. Thareja, and A. K. Thareja, S. Chand Publishing, 2006

II.6 Art of communication and Creative Writing [Theory] [Semester II] [2 – 0 – 0]

Course Objective: This paper intends to improve the communication skills and writing skills. One of the aims of the course is to develop in students the creative, practical, critical and collaborative skills. Overall, objective is to improve the speaking skill, writing skill and reading skill.

Keywords: Scientific report writing; Blog writing; Travel writing; Film criticism

Unit I: Introduction to Communication-Components of Communication & Scientific report writing. **(8 lectures)**

Unit II: Art of Creative writing & Letter writing. **(8 lectures)**

Unit III: Blog writing, Art of interviewing, Fiction & non-fiction writing. **(8 lectures)**

Unit IV: Travel writing, film criticism writing and significance of publications. **(4 lectures)**

Course Learning Outcomes: This paper gives students a general understanding of technical project writing, scientific literature survey, oral presentations and business letter writing. Upon completion of the course the students would be able to-

- Possess substantially improved skills in written and verbal communication.
- Frame technical project writing concepts.
- Understand the importance of secondary database through scientific literature review.
- Research problems and questions and thereby framing the research methodology, subsequently analysing and interpreting the results of the project.
- Present and participate in group discussion during the oral presentation.
- Write business letters.

Teaching Plan (**Theory**)

Week 1:	Introduction to Communication. Objective of Communication and Communication and its process.
Week 2:	Components of Communication, Barriers to communication, Patterns of communication and Types of Communication.
Week 3:	Scientific and technical writing of Projects: Scientific review of literature, Importance of secondary literature
Week 4:	Framing research objectives, importance of Figures and tables..
Week 5:	Business letter writing.
Week 6:	Business letter writing.
Week 7:	Art of creative writing.
Week 8:	Essential of creative writing, strategy and style.
Week 9:	Blog writing.
Week 10:	The Art of Interviewing.
Week 11:	Fiction writing, non-fiction writing.
Week 12:	Travel writing and film criticism writing
Week 13 and 14:	Pitching to publication

References:

1. *Study Writing: A Course in Written English for Academic Purpose.* Liz Hamp-Lyons, and Ben Heasley, Cambridge University Press, 2006

II.7.1 Business Process and strategic IT alignment [Theory] [Semester II] [3 – 1 – 0]

Course Objective: This is a basic course to provide an introduction to the sub-stream of management and economics that a student may choose from the third semester onwards. It will cover a range of topics from Human Resource management, Operation management, e-commerce and ERP.

Keywords: Business processes; Business analysis; IT enabled business; Digital marketing

Unit I: Introduction to different business Processes: Human Resources, Production, Operations, Marketing and Finance - Business process linkage with IT **(9 lectures)**
Unit II: IT enabled Businesses - IT governance & architecture - IT enabled change management **(9 lectures)**
Unit III: Business Analysis strategies & planning - Cost Benefit analysis - Enterprise Resource Planning **(15 lectures)**
Unit IV: Digital Marketing and Media - Internet, Multimedia, and Mobile apps in business. **(9 lectures)**

Course Learning Outcomes:

- Understanding various functions of a business organisation
- Able to relate the role of IT in business
- Aware of IT governance and architechture
- Appreciate the need for change management
- Gather a brief idea of Business Analysis strategies & planning , Cost Benefit analysis and ERP
- Understand the way digital marketing operates

Teaching Plan (**Theory**)

Week 1 and 2:	Introduction to different business Processes: Human Resources, Production, Operations, Marketing and Finance
Week 3:	Business process linkage with IT
Week 4:	IT enabled Businesses
Week 5:	IT governance & architecture
Week 6:	IT enabled change management
Week 7 and 8:	Business Analysis strategies & planning
Week 9:	Cost Benefit analysis
Week 10 and 11:	Enterprise Resource Planning
Week 12:	Digital Marketing and Media
Week 13:	Digital Marketing and Internet; Multimedia
Week 14:	Mobile apps in business

References:

1. *IT Enabled Business Change - Successful Management.* S. Manwani, The British Computer Society, 2009
2. *Exploiting IT for Business Benefits*, B. Hughes, The British Computer Society, 2009
3. *Projects: Planning, Analysis, Selection, Financing, Implementation, and Review*, P. Chandra, Mc Graw Hill Education, 2009.
4. *E-Business and E-Commerce Management : Strategy, Implementation and Practice*, D. Chaffey, Pearson Press, 2013.

II.7.2 Electronics at Work & Circuit simulation [Theory] [Semester II] [3 – 1 – 0]

Course Objective: This is a basic introductory module to provide an insight of the field of electronics to the students to assist them in choosing their main stream of study. Students learn about three aspects of electronics namely analog world, digital world and signals & systems. The emphasis is on basic electronics components and devices and their application in real world.

Keywords: Analog World; Digital World; Semiconductor Devices; Signal and System

Unit I: ***Analog World:*** resistor, capacitor, inductor, power source, transducer, sensor, detector, switch – Potentiometer - Integrated Circuit – Transformer **(12 lectures)**

Unit II: ***Digital World:*** logic families, logic gates, boolean algebra - Combinational circuits: adders, encoders, decoders, multiplexer and de-multiplexer - Sequential circuits: like flip flops, counters, shift registers, memories **(12 lectures)**

Unit III: ***Semiconductor Devices:*** PN Junctions characteristics, Zener and Avalanche breakdown, diode applications, transistor & applications. FET, MOSFET, FET, Operational Amplifier (Op Amp): inverting and non-inverting amplifier, integrator, differentiator, summing amplifier, active filters **(12 lectures)**

Unit IV: ***Signal and System:*** Types, Generation, Audio and Video Signals and their applications, Operation on Signals, Classification of Signals and Systems, Discrete Convolution & Correlation

(9 lectures)

Course Learning Outcomes:

- It 's an introductory paper to help students get familiar with concepts of Electronics and to assist them in choosing stream options in next semester.
- Familiarizing students with following analog electronic components and their identification: resistor, capacitor, inductor, power source, transducer, sensor, detector, switch, Potentiometer - Integrated Circuit – Transformer;
- Familiarizing students with following digital electronic components, circuits, devices and their identification: logic families, logic gates, Boolean algebra - Combinational circuits: adders, encoders, decoders, multiplexer and de- multiplexer - Sequential circuits: like flip flops, counters, shift registers, memories
- Familiarizing students with following semiconductor devices, circuits and their identification: PN Junctions characteristics, Zener and Avalanche breakdown, diode applications, transistor & applications. FET, MOSFET, FET, Operational Amplifier (Op Amp): inverting and non-inverting amplifier, integrator, differentiator, summing amplifier, active filters
- Familiarizing students with following Signal and Systems: Types, Generation, Audio and Video Signals and their applications, Operation on Signals, Classification of Signals and Systems, Discrete Convolution & Correlation

Teaching Plan (**Theory**)

Week 1:	Analog World : Resistor, Capacitor, Inductor,
Week 2:	Power source and Transducer.
Week 3:	Sensor, Detector, Switch – Potentiometer
Week 4:	Integrated Circuit – Transformer.
Week 5:	Digital World: Logic families, Logic gates, Boolean Algebra.
Week 6:	Combinational circuits: Adders, Encoders, Decoders, Multiplexer and De-multiplexer.
Week 7:	Sequential Circuits: Flip Flops.
Week 8:	Counters, Shift registers and Memories.
Week 9:	Semiconductor Devices: PN Junctions characteristics, Zener and Avalanche breakdown, Diode applications.
Week 10:	Transistor & its applications.
Week 11:	FET and MOSFET.
Week 12:	Operational Amplifier (Op Amp): Inverting and Non-inverting amplifier, Integrator, Differentiator, Summing amplifier, Active filters.
Week 13:	Signal and System: Types, Generation, Audio and Video Signals and their applications.
Week 14:	Operation on Signals, Classification of Signals and Systems, Discrete Convolution & Correlation.

Reference:

1. *Electronic Principles*. Albert Paul Malvino, McGraw-Hill, 1998
2. *Electronic Devices & Circuit Theory*. Robert L. Boylestad, and Louis Nashelsky, Pearson Education, 2009
3. *Digital Logic and Computer Design*. M. Morris Mano, Pearson Education, 2008
4. *Signals and Systems*. Alan V. Oppenheim, Alan S.willsky, and Nawab S.Hamid, Prentice Hall, 1997

5. *Art of Electronics*. Paul Horowitz, and Winfield Hill, Cambridge University Press, 2008

II.7.3 Exploring Biology: Systems approach [Theory] [Semester II] [3 – 1 – 0]

Course Objective: This module is designed to introduce students the living system in terms of their hierarchal organization and their distinction them from the nonliving. The specific objective of the module is to introduce biology even to students with no biology background and enable them to understand living systems.

Keywords: Origin of life; Metabolism; Diversification of living system; Evolution

Unit I: Biological sciences: from descriptive to reductionist and to systems biology - Introduction to living state and life processes - Origin of life - Cell as a structural unit of life **(12 lectures)**
Unit II: Metabolism in living state - Living systems as energy machines - Life cycles, Cell cycle & turnover **(9 lectures)**
Unit III: Origin and diversification of living systems - Hierarchy of organization of living systems (molecular, cellular, and population levels) - Evolution of living systems: probabilistic versus deterministic **(9 lectures)**
Unit IV: Evidences of evolution, Evolutionary theories, Introduction to molecular evolution. **(12 lectures)**

Engineering Kitchen Activity [Laboratory]

- Understanding parts of flower and Placentation in fruit
- Viewing cells, pollens, microbes and biological sections in microscope
- Isolation of cytoplasmic organelle by centrifugation
- Preparation of metaphase chromosome
- Enzyme assay
- Demonstration of osmosis and plasmolysis
- Bacterial growth curve analysis
- Inflorescence models

Course Learning Outcomes: This paper has been designed to initiate students with current ideas and perspective in the field of bioscience. Special care is taken such that a student coming from any course can apprehend the modern biology.
Upon completion of the course, the student will be able

- To understand the diversity and complexity of living systems
- To comprehend different fields within Bio-Sciences
- To understand experimental processes undertaken in Biology
- To know the history of Biology Research
- To ideate on evolution and life

Teaching Plan (**Theory**)

Week 1:	Biological sciences: from descriptive to reductionist and to systems biology
Week 2:	Introduction to living state and life processes
Week 3:	Origin of life
Week 4:	Cell as a structural unit of life
Week 5:	Metabolism in living state
Week 6:	Living systems as energy machines
Week 7:	Life cycles, Cell cycle & turnover -
Week 8:	Origin and diversification of living systems
Week 9:	Hierarchy of organization of living systems (molecular, cellular, and population levels)
Week 10:	Evolution of living systems: probabilistic versus deterministic

Week 11: Evidences of evolution
Week 12: Evolutionary theories
Week 13 & 14 Introduction to molecular evolution.

References:

1. *Biology*, Raven et al., Tata McGraw-Hill, 2013.
2. *Biology: Global Approach*. Reece et al., Pearson Educations, Global edition, 2014.

SEMSTER – III

III.1 Modeling change in the world around us: Partial Differential Equations [Theory] [Semester III] [3 – 1 – 0]

Course Objective: This course helps to develop Partial differential equation models, in the context of modeling heat and mass transport and, in particular, wave phenomena, such as sound and water waves. This course develops students' skills in the formulation; find a solution, understanding and interpretation of PDE models. As well as developing analytic solutions, this course establishes general structures and characterizations of PDEs. The course will also expose the students to various applications of the partial differential equations.

Keywords: PDE; Method of characteristics; Second order PDE; Fourier series and transform

Unit I: Familiarities with different type of first order linear and non-linear PDEs - Examples of PDEs arising in transport equation, conservation laws, spread of epidemic cholera - Cauchy problem for first order PDE **(12 lectures)**
Unit II: Method of characteristics; Monge's cone; Classical methods for simple PDE models **(6 lectures)**
Unit III: Second order PDE arising in wave equations, conduction of heat, gravitational potential, telegraph equation, dispersion of contaminants - classification of second order PDE and their solution **(12 lectures)**
Unit IV: Fourier Series and Fourier transforms - Boundary value problem: Dirichlet and Neumann - Lagrange – Green's identity - existence and uniqueness by energy considerations. **(12 lectures)**

Course Learning Outcomes:

- Understand how partial differential equations (PDEs) represent real-world problems.
- Able to use computational tools to solve problems and applications of PDEs.
- Understand the importance of Laplace's equation, heat equation, wave equation, conduction of heat, gravitational potential, telegraph equation, dispersion of contaminants, Fourier series, Fourier transforms, etc. in the theory of PDEs.
- Able to use knowledge of PDEs, the general and particular structure of solutions and different methods for solutions.
- Able to apply the knowledge of PDEs to specific research problems in different fields.

Teaching Plan (**Theory**)

Week 1	Introduction to different type of first order linear and non-linear PDEs
Week 2-3	Examples of PDEs arising in transport equation; Conservation laws; Spread of epidemic cholera
Week 4	Cauchy problem for first order PDE
Week 5	Method of characteristics; Monge's cone
Week 6	Classical methods for simple PDE models
Week 7	Second order PDE arising in wave equations
Week 8	Second order PDE for conduction of heat & gravitational potential
Week 9	Telegraph equation; Second order PDE for dispersion of contaminants
Week 10	Classification of second order PDE and their solution
Week 11	Fourier Series and Fourier transforms
Week 12	Boundary value problem; Dirichlet and Neumann boundary conditions
Week 13	Lagrange – Green's identity
Week 14	Existence and uniqueness by energy considerations.

References

1. *Partial Differential Equations*, E. DiBenedetto, Birkhauser, Boston, 1995.
2. *Partial Differential Equations*, Fritz John, Narosa Publ. Co., New Delhi, 1979.

3. *Linear Partial Differential Equation for Scientists and Engineers*, Tyn Myint-U and Lokenath Debnath, Springer, Indian reprint, 2006.
4. *Partial Differential Equations: An Introduction with Mathematica and MAPLE*, Ioannis P Stavroulakis and Stepan A Tersian, World Scientific, 2004.

III.2 Design and Analysis of Algorithm [Theory] [Semester III] [3 – 1 – 0]

Course Objectives: The objective is to teach techniques for effective problem-solving in computing. The use of different paradigms of problem-solving will be used to illustrate clever and efficient ways to solve a given problem. In each case, emphasis will be placed on rigorously proving the correctness of the algorithm. In addition, the analysis of the algorithm will be used to show the efficiency of the algorithm over the naive techniques.

Keywords: Algorithmic analysis; Sorting methods analysis; Geometric algorithms; Dynamic Programming

Unit I: Algorithmic analysis and modeling - Algorithmic proofs - Computational complexity - Asymptotic notation and analysis **(12 lectures)**
Unit II: Sorting methods analysis – Randomization – NP Completeness – Advanced data structure **(12 lectures)**
Unit III: Geometric algorithms – Graph algorithms – Linear Programming – Design paradigm such as Divide & conquer **(9 lectures)**
Unit IV: Dynamic Programming – Greedy Approaches – Search heuristics – Approximation algorithms – Compression and streaming algorithms – Distributed and parallel algorithms. **(12 lectures)**

Course Learning Outcomes

- Basics of algorithmic analysis and their practical understanding of the real world examples.
- Learning mathematical design of algorithms and their algorithmic correctness through proofs.
- Understating computational complexity with asymptotic notations and their analysis.
- Introduction of different types of paradigm and domain of algorithms such as NP-completeness.
- Hands on experiments on dynamic programming and greedy approaches.
- Hands on experiments on advanced data structures such as AVL tree and Red black etc.
- Hands on experiments of Search heuristics and Approximation algorithms.
- Hands on experiments of Distributed and parallel algorithms.

Teaching Plan (**Theory**)

Week 1 and 2:	Concepts of algorithmic analysis and modeling, Algorithmic proofs
Week 3 and 4:	Computational complexity - Asymptotic notation and analysis
Week 5 and 6:	Sorting and Searching methods analysis , Randomization and NP Completeness
Week 7 and 8:	Advanced data structure such as AVL, Red Black Tree etc
Week 9 and 10:	Introduction to Programming Paradigm and types
Week 11 and 12:	Graph algorithms and their analysis
Week 13 and 14:	Introduction to Distributed and parallel algorithms.

References:

1. *Introduction to Algorithms*. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein. MIT Press, 2009.
2. *Problem Solving with Algorithms and Data Structures Using Python*. Bradley W. Miller, and David L. Ranum. Franklin, Beedle & Associates, 2011.
3. *Data Structures and Algorithms in C++,* A. Drozdek, Course Technology, 2013

4. *The Art of Computer Programming, Vol. 1,2,3,4*. Donald E. Knuth, Pearson Education, 2013.

III.3 Handling information through Data Modeling & Design [Theory + Practical] [Semester III] [3 – 0 – 2]

Course Objectives: The objective is to present an introduction to database management systems, with an emphasis on how to organize, maintain and retrieve - efficiently, and effectively - information from a DBMS. In addition, Course also introduces the present day modern databases with implementation on real-world projects.

Keywords: Database management system; Data modeling techniques; Query language; Data mining techniques

Unit I: Traditional Files & Databases – Database Management Systems **(9 lectures)**
Unit II: Relational Model - ER Modeling – Constraints, Query language & features – Normalization – Indexing **(12 lectures)**
Unit III: Transaction Processing & Concurrency Control – PL/SQL Basics
Graph Databases - Data Modeling Techniques & UML **(9 lectures)**
Unit IV: Analysis of Data using Mining Techniques – MongDB - NoSQL – Object Oriented Databases - Study of Real World Applications **(12 lectures)**

Engineering Kitchen Activity [Laboratory]

- ER Diagram of Existing systems and new systems
- SQL Commands, Structures & execution of Commands on Test Database
- Creation of Databases and identifying the Constraints
- Execution of DDL, DML, TCL Queries on created database
- XML Databases
- Executing Aggregate Functions and Extraction of Data elements
- Programs on Database Objects including Procedures, Functions, Exception
- Modeling of Systems and Requirements using UML
- Design of Application(s) using Mining Techniques
- Reverse Engineering & Study of a Database System Architecture
- Innovation Project

Course Learning Outcomes: Upon Completion of this course the students will be able to:

- Install, configure, and interact with a relational database management system.
- Describe, define and apply the major components of the relational database model to database design.
- Learn and apply the Structured Query Language (SQL) for database definition and manipulation.
- Utilize a database modelling technique for a single entity class, a one-to-one (1:1) relationship between entity classes, a one-to-many (1:M) relationship between entity classes, a many-to-many (M:M) relationship between entity classes, and recursive relationships.
- Define, develop and process single entity, 1:1, 1:M, and M:M database tables.
- Learn and implement the principles and concepts of information integrity, security and confidentiality.
- Apply ethical computing concepts and practices to database design and implementation.

Teaching Plan (**Theory**)

Week 1 and 2: Introduction to Traditional Files & Databases
Week 3 and 4: Database Management Systems
Week 5 and 6: Relational Model; ER Modeling; Constraints; Query language & features
Week 7 and 8: Data Modeling Techniques; PLSQL
Week 9 and 10: Normalization; Indexing
Week 11 and 12: Transaction Processing & Concurrency Control
Week 13 and 14: MongoDB; NoSQL; Object Oriented Databases; Study of Real World Applications

References:

1. *Fundamental of Database Systems*, R. Elmasri and S. B. Navathe, Pearson Education Asia, 7th edition, 2016.
2. *Database System Concepts*, Abraham, H. and Sudershan, S., 5 Ed., McGraw-Hill, 2013
3. *Introduction to Data Mining*, Pang, N. T., Pearson Education, 2013
4. *Database System : The Complete Book*, Jeffrey Ullman, Jennifer Widom, and Héctor García-Molina, Pearson Education, 2008
5. *Data Modeling: A Beginners Guide*, Andy Oppel, McGrew Hill, 2010

III.4 Language and Communication: Computational Linguistics [Theory] [Semester III] [2 – 0 – 0]

Course Objectives: The course aims at giving a basic understanding of computational languages, language analysis, their development, components of the languages, their syntax and semantic analysis.

Keywords: Morphological Analysis; Parsing; Lexical semantics; Speech synthesis

Unit I: Introduction to Natural Language Processing (NLP) - Language structure and Analyzer - Morphological Analysis **(8 lectures)**
Unit II: Local Word Grouping - Parsing - Computational grammar and requirements - Machine Translation **(8 lectures)**
Unit III: Lexical semantics and algorithms – Spoken Language System – Tagging **(8 lectures)**
Unit IV: Speech synthesis – Speech recognition **(4 lectures)**

Course Learning Outcomes: Upon Completion of this course the students will be able to:

- Analyse language using computer.
- Design a simple computer program for language analysis.
- Be able to distinguish between human capacity and ability from machine /computer capacity and ability.
- Apply techniques that are being widely used in search engines, digital libraries, speech recognition systems, and NLP data mining toolkits.
- Apply syntactic and semantic analysis to natural language.
- Engage in speech synthesis and in machine translation.

Teaching Plan (**Theory**)

Week 1 and 2: Introduction to Natural Language Processing (NLP)
Week 3 and 4: Language structure and Analyzer; Morphological Analysis
Week 5 and 6: Local Word Grouping; Parsing; Computational grammar and requirements
Week 7 and 8: Machine Translation
Week 9 and 10: Lexical semantics and algorithms; Spoken Language System
Week 11 and 12: Tagging and Real world applications
Week 13 and 14: Basics of Speech synthesis; Speech recognition

References:
1. *Natural Language Processing*, A. Bharati, V. Chaitanya, R. Sangal, Prentice Hall India, 1995
2. *Natural Language Processing with Python: analyzing text with the Natural Language Toolkit*, Steven Bird, Ewan Klein, and Edward Loper, O'Reilly, 2009.
3. *Speech and language processing: an introduction to natural language processing, computational linguistics, and speech recognition* (2nd edition), Daniel Jurafsky and James H. Martin, Pearson International, 2009

III.5.1 Understanding Economic Behavior: The micro level [Theory] [Semester III] [3 – 1 – 0]

Course Objectives: The purpose of this course is to familiarize the student with the generally accepted concepts of demand and supply. In addition to this, the purpose of this course is to analyses how individual decision-makers, both consumers and producers, behave in a variety of economic environments.

Keywords: Demand and supply; Market Interactions; Government policies

Unit I: Exploring the subject matter of Economics - The Economic Problem: Scarcity and Choice; the question of What to Produce, How to Produce and How to Distribute Output, Markets and Competition **(9 lectures)**

Unit II: Determinants of individual demand & supply, Demand-Supply schedule and curves, Market versus individual demand & supply, Shifts in the demand & supply curve **(9 lectures)**

Unit III: Market Interactions, How Price allocate resources, Elasticity and its application, Controls on Prices, Taxes and the Costs of Taxation, Households and Consumer Behavior, Budget Constraints, Firms and Producer Behavior, Perfect Market Structure, Imperfect Market Structures; Monopoly and antitrust policy **(12 lectures)**

Unit IV: Government policies towards competition, Imperfect information in the product market--The information problem, The market for lemons and adverse selection and Input Markets. **(12 lectures)**

Course Learning Outcomes:
- Understanding of the basic structure of the economic ecosystem.
- Conception, of how individuals and firms allocate resources and how market prices are determined.
- It introduces a framework for learning about consumer behaviour and analysing consumer decisions.
- Students will be able to understand shifts in supply and demand and their implications for price and quantity sold.
- Student will also learn how to analyse how consumers respond to a shift in the price of the goods they consume.
- Understanding of how to analyse firms' decisions mathematically using a production function and calculate their optimal level of production, costs, and profits.
- Learn to model the decisions made by firm in a monopoly and an oligopoly, and the implications of these alternate structures for consumer welfare.

Teaching Plan (**Theory**)

Week 1:	Define Economics**,** Explain The Ideas That Define The Economic Way Of Thinking
Week 2:	Concepts of Scarcity, Production Efficiency, And Tradeoff Using the Production Possibilities Frontier. Opportunity Cost Absolute Advantage And Comparative Advantage
Week 3:	The Different Forms Of Markets, Basic Terminology That Is Useful In Analyzing Markets.
Week 4:	Quantity Demanded/Supplied And Demand/Supply, And Explain What Determines Demand/Supply.
Week 5:	Price Elasticity Of Demand/Supply, And Explain The Factors That Influence

	These, Cross Elasticity Of Demand And The Income Elasticity Of Demand, And Explain The Factors That Influence Them
Week 6:	Main Ideas About Fairness And Evaluate The Fairness Of The Alternative Methods Of Allocating Scarce Resources
Week 7:	Taxes And The Costs Of Taxation
Week 8:	Household Behavior & Consumer Choices
Week 9:	The Behavior Of Profit Maximizing Firms, Production Process, Choices Of Technology, Perfect Market Structures
Week 10:	Imperfect Market Structure & Its Core Concepts: Monopoly & Antitrust Policy
Week 11:	Government Policies Towards Competition
Week 12:	Imperfect Information In The Product Market—Decision Making Under Uncertainty : The Tools
Week 13 and 14:	Asymmetric Information, Incentives

References

1. *Principles of Economics*, K. E. Case, R. C. Fair and S. C. Oster, Pearson Education, 10th Edition, 2011.
2. *Principles of Economics,* N. G. Mankiw, South-Western, 6th Edition, 2011.
3. *Intermediate Microeconomics,* Hal R. Varian, W.W. Norton & Company and Company/Affiliated East-West Press (India), 8th edition, 2010.
4. *Microeconomics,* R. S. Pindyck and D. L. Rubinfeld*,* Pearson Education, 8th Edition, 2012.

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III.5.2 Electronics circuit elements and instruments [Theory] [Semester III] [3 – 1 – 0]

Course Objective: This module involves interactive learning of A.C. fundamentals. It helps to understand the basic network analysis of electronic circuits. It also provides the interface to understand the working of various electronic devices and its characteristics. Working of electronic instruments will also be understood.

Keywords: AC Fundamentals; Transistor; LDR and LED; Electrical circuits

Unit I: AC Fundamentals - Concept of voltage and current sources - KVL and KCL - Node voltage analysis and method of mesh currents - Network theorems **(9 lectures)**
Unit : PN Junction: variants and applications - Bipolar Junction Transistor (BJT) biasing and amplifier design - Field Effect Transistor (FET) variants – FET biasing and amplifier design **(12 lectures)**
Unit III: Structure and working of SCR. Structure and operation of LDR, Photo voltaic cell, Photo diode, Photo transistors and LED **(9 lectures)**
Unit IV: Operational Amplifiers basics and practical circuits - Feedback and oscillator circuits - Voltmeters-Multimeters-Function generator- Cathode ray oscilloscope - Cathode Ray Tube **(12 lectures)**

Course Learning Outcomes: Upon completion of this course the students will achieve understanding of the following:

- Concepts of AC fundamentals
- Good knowledge of Network Analysis
- Basics of Diodes and Transistor based devices
- Knowledge of instrument like CRO, Function Generator, Multimeter, etc.

Teaching Plan (**Theory**)

Week 1	AC Fundamentals; Concept of voltage and current sources
Week 2	KVL and KCL
Week 3	Node voltage analysis and method of mesh currents; Network theorems
Week 4	PN Junction: variants and applications
Week 5	Bipolar Junction Transistor (BJT) biasing

Week 6	Amplifier design
Week 7	Field Effect Transistor (FET) variants; FET biasing and amplifier design
Week 8	Structure and working of SCR
Week 9	Structure and operation of LDR, Photo voltaic cell
Week 10	Photo diode, Photo transistors and LED
Week 11	Operational Amplifiers basics and practical circuits
Week 12	Feedback and oscillator circuits
Week 13	Voltmeters; Multimeters
Week 14	Function generator; Cathode ray oscilloscope; Cathode Ray Tube.

References

1. *Circuits and Networks* - A.Sudhakar & Shyammohan S. Palli ,TMH, 2010
2. *Principles of Electronics*- V.K. Mehta and Rohit Mehta, S Chand &Co,2009
3. *Electronic Devices and Circuit Theory*-R.L.Boylestad and L.Nashelsky, Pearson Education, 2009.

III.5.3 Integrative Biology [Theory] [Semester III] [3 – 1 – 0]

Course Objective: This module would make students understand the nature of genetic material and transfer of information in living systems. It will introduce the design of living systems, types of interaction among biological components and experimental model organisms in study biology.

Keywords: RNA; Biological processes; Regulated activities; Information flow in living systems

Unit I: Demystifying living state - Central process in transmission of information - Choice of the genetic material - RNA world **(9 lectures)**
Unit II: Designing living systems - Nature of biological processes - Approaches to study Biology: Observational and Experimental, Physiology and Behaviour **(12 lectures)**
Unit III: The regulated activities - Communication (external & internal) as the basis of regulation - Circuits and regulations in living systems - Interaction of biological components **(12 lectures)**
Unit IV: Information flow in living systems: Proximate and Ultimate causes - Model organisms in study of Biology - Chaos and Order **(9 lectures)**

Course Learning Outcomes: In this paper subjects of different streams are incorporated in a holistic manner to give a broad overview of biological sciences.
Upon completion of the course, the student will be able

- To comprehend current research in different streams of Biological Sciences
- To get in depth knowledge of how living system functions (regulation, communication)
- To know about different model system and their utilization in biology
- To apprehend study design in biology
- To get an idea of career prospects in bioscience
- To design small innovative research projects in biosciences.

Teaching Plan (**Theory**)

Week 1:	Demystifying living state
Week 2:	Central process in transmission of information
Week 3:	Choice of the genetic material - RNA world
Week 4:	Designing living systems
Week 5:	Nature of biological processes
Week 6:	Approaches to study Biology: Observational and Experimental
Week 7:	Physiology and Behaviour
Week 8:	The regulated activities
Week 9:	Communication (external & internal) as the basis of regulation

Week 10:	Circuits and regulations in living systems
Week 11:	Interaction of biological components
Week 12:	Information flow in living systems: Proximate and Ultimate causes
Week 13 and 14:	Model organisms in study of Biology - Chaos and Order.

References:

1. *An Introduction to Systems Biology: Design Principles of Biological Circuits,* Uri Alon, Chapman & Hall, 2nd edition, 2013.
2. *Physical Biology of the Cell*, Phillips et al., Garland Science, 2nd edition, 2012.
3. *Molecular Cell Biology*, Lodish et al., W. H. Freeman & Company, 7th edition, 2012.
4. *Biochemistry*, Berg, Tymoczko and Stryer, W H Freeman & Company, 7th edition, 2011.

III.6.1 Principles of Management [Theory] [Semester III] [3 – 1 – 0]

Course Objectives: The module aims to equip students with a basic knowledge of management that can be used as a foundation for personal development. The course also aims to be an introduction to future courses in management.

Keywords: Function of management; Ethics; Leadership; Communication

Unit I: Evolution of Management Thoughts, contribution of selected management thinkers - concepts of managements, function of management. **(9 lectures)**
Unit II: Contemporary management practices- organization culture, structure and change, MOB, Balance Scorecard, managerial role- Stakeholders, Ethics, & Corporate Social Responsibility, Planning & Decision Making, Strategizing. **(12 lectures)**
Unit III: Approaches to Management – leadership approaches, motivation approaches **(15 lectures)**
Unit IV: Decision Making & Communication in an Organization **(6 lectures)**

Course Learning Outcomes:

- Discuss and communicate the management evolution and how it will affect future managers.
- Understanding the concept of growth strategies and its use for sustaining in business.
- Learn to analyse alternatives in a decision-making process.
- Understanding the concept of Organizational Citizenship Behaviour (OCB) for measuring performance in which any job or task takes place.
- Understanding how, the social process by which people interact and behave in a group.
- Learn and identify the roles which are fulfilled while working as a manager.
- Understanding, define, appreciate and apply of views of theories of motivation.
- Learn the relationship between leaders and followers.
- Students will learn to includes adapting to the change, controlling the change and effecting new change.
- Understanding the current theories, practices, tools and techniques in knowledge management (KM) to deal with the challenges with the organization and management of knowledge.

Teaching Plan (**Theory**)

Week 1:	Concepts Of Managements, Function Of Management, Managerial Roles
Week 2:	Origin And Evolution Of Management Thought (Part-1):- Scientific Management , Bureaucratic And Administrative Management
Week 3:	Origin And Evolution Of Management Thought (Part-2):- Human Resource Management , Operation, Information, System And Contingency Management
Week 4:	Contemporary Management Practices In Global Environment
Week 5:	The External & Internal Environmental

Week 6:	Stakeholders, Ethics, & Corporate Social Responsibility
Week 7:	Planning & Decision Making
Week 8:	Strategizing :- Business Level Strategy, Competitive Tactics, Corporate Level Strategy
Week 9:	Goals And Objectives:- The Nature Of Goals And Objectives, From Management By Objectives To The Balanced Scorecard, Characteristics Of Effective Goals And Objectives, Using Goals And Objectives In Employee Performance Evaluation
Week 10:	Organizational Structure And Change:- Organizational Structure, Contemporary Forms Of Organizational Structures, Organizational Change, Planning And Executing Change Effectively
Week 11:	Organizational Culture:- Understanding Organizational Culture, Measuring Organizational Culture,
Week 12:	Leading People And Organizations:- Trait Approaches To Leadership, Behavioral Approaches To Leadership, Contingency Approaches To Leadership, Contemporary Approaches To Leadership
Week 13 :	Decision Making & Communication In An Organization
Week 14:	Motivation :- Need-Based Theories Of Motivation, Process-Based Theories, Introduction To Other Streams Of Management

References

1. *Management Concepts and Strategies,* J.S.Chandan, Vikas Publishing House, 2010.
2. *Management Concepts and Practices*, Tim Hannagan, Macmillan India Ltd., 5th Edition, 2009.
3. *Essentials of Management,* Koontz, Tata McGraw-Hill, 7th Edition, 2006.

III.6.2 Electronics circuit elements and instruments – Innovation Lab [Practical] [Semester III] [0 – 0 – 8]

Course Objective: This module intends to provide basic practical knowledge of diodes, rectifiers and amplifier circuits. It has experiments to gain knowledge of JFET, MOSFET, LED, Solar cells and Regulators.

Engineering Kitchen Activity [Laboratory]

- Characteristics of PN junction and Zener diode
- Half wave rectifier.
- Full wave rectifier with 2 diodes.
- Full wave rectifier with 4 diodes (Bridge rectifier).
- Input, Output and Transfer characteristics of CE and CC Amplifier.
- Characteristics of LDR, Photo-diode and Photo transistor.
- Transfer characteristics of JFET.
- Transfer characteristics of MOSFET (with depletion and enhancement mode)
- Characteristics of LED with three different wavelengths.
- Series voltage Regulator.
- Shunt voltage Regulator.
- Characteristics of Thermistor

Course Learning Outcomes: Upon completion of this course the students will achieve understanding and practical knowledge of the following:

- Characteristics of Diodes and Transistors and its application
- Full and half wave Rectifiers, filters and power supply
- Functioning of Amplifier
- Fundamentals of photo diode, photo transistor and solar cell and its applications

Teaching Plan (**Practical**)

Week 1	Characteristics of PN junction
Week 2	Characteristics of Zener diode
Week 3	Half wave rectifier
Week 4	Full wave rectifier with 2 diodes; Full wave rectifier with 4 diodes (Bridge rectifier)
Week 5	Input, Output and Transfer characteristics of CE and CC Amplifier
Week 6	Characteristics of LDR, Photo-diode and Photo transistor
Week 7	Transfer characteristics of JFET
Week 8	Transfer characteristics of MOSFET (with depletion and enhancement mode)
Week 9	Transfer characteristics of MOSFET (with depletion and enhancement mode)
Week 10	Characteristics of LED with three different wavelengths
Week 11	Characteristics of LED with three different wavelengths
Week 12	Series voltage Regulator
Week 13	Shunt voltage Regulator
Week 14	Characteristics of Thermistor

III.6.3 Cell: Biochemical and Molecular perspective [Theory] [Semester III] [3 – 1 – 0]

Course Objective: This module would have an objective to unravel the organization of a cell, energy transduction in living organisms by correlating photosynthesis and respiration; cell division, cell signaling, and enzyme kinetics. Hypotheses related to origin of eukaryotes will also be critically analyzed.

Keywords: Bioenergetics and Metabolism; Cell; Cytoskeleton; Eukaryotes; Enzymes

Unit I: Bioenergetics and Metabolism - Energy transduction in the living organisms (photosynthesis and respiration) **(12 lectures)**
Unit II: Cell organelles, Cell membrane and extracellular matrix **(12 lectures)**
Unit III: Cytoskeleton and membrane trafficking - Cell division and checkpoints - Cell signalling **(9 lectures)**
Unit IV: Origin of eukaryotes: hypothesis - Enzyme and enzyme kinetics **(9 lectures)**

Course Learning Outcomes:

- This course acquaints students with basic principles related to cell, as the smallest unit of an organism, where students are exposed to the understanding of all components of a cell, its organelles, cell membranes, all types of possible molecular interactions which take place during various cellular processes.
- An understanding on the most relevant and basic topics like photosynthesis, respiration and the energetics involved during these processes would facilitate the generation of curiosity among students about the most complicated biological machineries as a whole.
- Students would be able to understand the concepts of origin of prokaryotes and eukaryotes and probably would be able to at least grab the knowledge of many unanswered queries related to biological processes, which later may act as a fuel in developing their research temperament.

Teaching Plan (**Theory**)

Week 1:	Bioenergetics : transformation of free energy in living systems
Week 2:	Metabolism and metabolic pathways: concept of network
Week 3:	Energy transduction in the living organisms
Week 4:	Photosynthesis: overview, types, process and introduction to artificial photosynthesis
Week 5:	Respiration: aerobic an anaerobic, energy calculations and processes

Week 6:	Cell organelles: membrane bound, no membrane bound and other
Week 7:	Cell membrane and extracellular matrix
Week 8:	Cytoskeleton and membrane trafficking
Week 9:	Cell division in bacteria and eukaryotes
Week 10:	Cell cycle and cell division checkpoints
Week 11:	Cell signaling and signal transduction
Week 12:	Origin of eukaryotes: hypothesis
Week 13 and 14:	Introduction to Enzyme and enzyme kinetics, enzyme inhibition.

References

1. *The cell: A Molecular Approach*, Geoffrey M Cooper, Sinauer Associates 6th edition, 2013.
2. *Molecular Biology of the Cell* , Alberts et al., Garland Science, 5th edition, 2007.
3. *Molecular Cell Biology*, Lodish et al., W. H. Freeman & Company, 7th edition, 2012.
4. *Biochemistry*, Berg, Tymoczko and Stryer, W H Freeman & Company, 7th edition, 2011.

SEMSTER – IV

IV.1 Does Nature play dice?: The amazing world of probability and statistics [Theory + Practical] [Semester IV] [3 – 0 – 2]

Course Objective: Probability theory is the branch of mathematics that deals with modelling uncertainty. It is an important course as it has direct application in areas such as genetics, finance and telecommunications. It also forms the fundamental basis for many other areas in the mathematical sciences, such as modern optimization methods and risk modelling. This course provides an introduction to probability theory, random variables. This unit will concentrate on the following: Sampling distributions, hypothesis testing, interval estimation, likelihood, analysis of categorical data, joint, marginal and conditional distributions, and regression. R software will be introduced through practical classes in the beginning of the course. Its use will be supported with examples in lectures and tutorials with supplementary material on the course website.

Keywords: Probability; Distribution; Random variables; Correlation; Regression; Hypothesis testing

Unit I: Probability space - Conditional probability - Bayes theorem – Independence - Descriptive measures (Mean, median, mode, standard deviation, dispersion, moments) - Random variables - Joint distributions **(9 lectures)**

Unit II: Discrete distributions (Bernoulli, Binomial, Poisson) and their properties (Expectation, variance, conditional expectation, moments) - Continuous distributions (Uniform, Normal, Exponential) with their properties (Expectation, variance, conditional expectation, moments) **(12 lectures)**

Unit III: Joint, marginal and conditional distributions - Weak and strong law of large numbers, -Central limit theorem - Curve fitting - linear regression, Correlation **(9 lectures)**

Unit IV: Sampling distributions - Hypothesis testing, interval estimation - Likelihood, analysis of categorical data - Test statistic and their significance **(12 lectures)**

Engineering Kitchen Activity [Laboratory]

Computer program R and its application to simple models

- Introduction to basic syntax of R for arithmetic operations, creating arrays and matrices
- Getting data into R and basic data analysis in R
- Statistical computations in R (evaluation of density functions and distribution functions, computation of descriptive measures for given data)
- Data visualization in R

Course Learning Outcomes:

- A good understanding of basic concepts of statistical distributions.
- A good understanding of elementary probability theory, the laws of probability and the use of Bayes and various other theorems of probability.
- Able to derive the probability density functions of transformations of random variables and use these to generate data from various distributions.
- Able to represent and statistically analyze data both graphically and numerically.
- A good understanding of exploratory data analysis by working on datasets related to human resources, image segmentation analysis, pollution levels in a city, health diagnosis, etc. along with the ability to write a short-report describing a simple statistical data set.
- Able to translate real-world problems into probability models.

Teaching Plan (**Theory**)

Week 1:	Probability space; Conditional probability; Bayes theorem; Independence
Week 2:	Descriptive measures (Mean, median, mode, standard deviation, dispersion, moments)
Week 3:	Random variables; Joint distributions
Week 4 and	Discrete distributions (Bernoulli, Binomial, Poisson) and their properties

5:	(Expectation, variance, conditional expectation, moments)
Week 6 and 7	Continuous distributions (Uniform, Normal, Exponential) with their properties (Expectation, variance, conditional expectation, moments)
Week 8:	Joint, marginal and conditional distributions
Week 9:	Weak and strong law of large numbers, Central limit theorem
Week 10	Curve fitting; linear regression, Correlation
Week 11 and 12	Sampling distributions; Hypothesis testing
Week 13:	Interval estimation; Likelihood, analysis of categorical data
Week 14:	Test statistic and their significance.

References

1. *Introduction to Probability and Statistics for Engineers and Scientists*, S.M. Ross, Academic Press, 2009.
2. *Applied Statistics and Probability for Engineers,* D.C. Montgomery and G.C. Runger,John Wiley and Sons, 2014.
3. *Design of Experiments: A No-Name Approach*, Thomas Lorenzen and Virgil Anderson, CRC Press 1993.
4. *Statistics and Experimental Design in Engineering and the Physical Sciences*, Vol. I and II, N.L. Johnson and F.C. Xeen Leone, Wiley Interscience, 1977.

IV.2 Instructing computing devices: Operating System [Theory] [Semester IV] [3 – 1 – 0]

Course Objectives: The objective is to introduce students with basic concepts of Operating System, its functions and services and to familiarize the students with various views and management policies adopted by O.S. as pertaining with processes, Deadlock, memory, File and I/O operations. To brief the students about the functionality of various OS like Unix, Linux and Windows XP as pertaining to resource management and to provide the knowledge of basic concepts towards process synchronization and related issues.

Keywords: Operating systems; Process management; Process synchronization; Memory management

Unit I: Overview: Operating systems – structure, operations, components, types, services, user interfaces. System calls, system programs, system boot **(12 lectures)**

Unit II: Process management - Processes: concept, scheduling, operations on processes, inter-process communications. Threads – single - and multi-threaded processes. CPU scheduling – criteria, algorithms, multiple-processor scheduling. **(12 lectures)**

Unit III: Process synchronization – critical-section problem, semaphores, classic synchronization problems, monitors. Deadlocks – characterization, deadlock prevention, deadlock avoidance, deadlock detection, recovery from deadlock **(12 lectures)**

Unit IV: Memory management: Main memory – memory allocation schemes, paging, segmentation, Virtual memory, file management **(6 lectures)**

Course Learning Outcomes: Upon Completion of this course the students will be able to:

- Analyse the structure of OS and basic architectural components involved in OS design.
- Analyse and design the applications to run in parallel either using process or thread models of different OS.
- Analyse the various device and resource management techniques for timesharing and distributed systems.
- Understand the Mutual exclusion, Deadlock detection and agreement protocols of Distributed operating system.
- Interpret the mechanisms adopted for file sharing in distributed Applications.
- Conceptualize the components involved in designing a contemporary OS.

Teaching Plan (**Theory**)

Week 1 and 2:	Overview; Operating systems structure; operations; components; types; services; user interfaces
Week 3 and 4:	System calls; system programs; system boot
Week 5 and 6:	Process management
Week 7 and 8:	Threads; single and multi-threaded processes; CPU scheduling criteria; algorithms; multiple processor scheduling
Week 9 and 10:	Process synchronization
Week 11 and 12:	Deadlocks
Week 13 and 14:	Memory management

References:

1. *Operating System Concepts*, 10th Edition, Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, John Wiley & Sons, 2009
2. *John. Lions' Commentary on UNIX® 6th Edition with Source Code.* John Lion, San Jose, CA: Peer-to-Peer Communications, 1996
3. *Exokernel: An Operating System Architecture for Application-Level Resource Management.,* Engler, Dawson R., M. Frans Kaashoek, and James O'Toole Jr., ACM Press, 1995.

IV.3 Information exchange in computing devices: Data Communication & Networking [Theory] [Semester IV] [3 – 1 – 0]

Course Objectives: This course introduces to the students, fundamentals of data communication and computer networks, organisation of network architecture, its component and functions. The course gives them a practical understanding of clients server programming and also introduced to the basics of network security.

Keywords: Data Communication; Networking; Layered Architecture; Network Security & Cryptography

Unit I: Introduction to Data Communication; Components and Basics - Communication Channels - Topologies **(12 lectures)**
Unit II: Networking Applications - Layered Architecture & Models – Network Devices **(12 lectures)**
Unit III: Introduction to Data Link - Error Management **(6 lectures)**
Unit IV: Network Protocols – Network Security & Cryptography – Network Architectures of Enterprise Applications **(12 lectures)**

Course Learning Outcomes: Following are the Course Learning Outcomes which students will have at the end of the course:

- Will have understanding of Data communication, Communication Channels, Topologies and Networking Applications.
- Will have knowledge of Layered Architecture & Models, Network Devices, Error Management, Network Protocols and Network Security & Cryptography.
- Will have exposure to Network Architectures of Enterprise Applications and Hands on experience of Network Topologies on LAN/WAN – Wired & Wireless
- Will be able to understand the Routing Mechanism in Internet and Intranet, Setting up TCP/UDP applications on Network Devices, Socket Programming, Web/Server Based Applications.

Teaching Plan (**Theory**)

Week 1 and 2:	Introduction to Data Communication; Components and Basics
Week 3 and 4:	Communication Channels; Topologies
Week 5 and 6:	Networking Applications; Layered Architecture & Models
Week 7 and 8:	Physical Layer and Network Devices
Week 9 and 10:	Introduction to Data Link layer and Error Management

Week 11 and 12: Introduction to Network Layer Protocols and Transport Layer
Week 13 and 14: Introduction to Application Layer and Basics of Network Security Basics

References:

1. *Data Communication and Networking*, Forouzan, B.A., Tata McGraw-Hill. 2013
2. *Computer Networking: A Top-Down Approach Featuring the Internet*, Kurose, J.F. and Ross, K.W., 3rd Ed., Addison Wesley, 2004
3. *Computer Networks, A S Tanenbaum*, PHI, IV Ed, 2003
4. *Computer Communication Networks*, W. Stallings, PHI, 1999

IV.4 Science, Philosophy, Truth: Impact of technology [Theory] [Semester IV] [2 – 0 – 0]
(This is only a suggestive syllabus. There is no fixed syllabus for this unit)

Course Objective: This course will engage social ethics in response to its impact on the developing technologies of global societies. We will explore the idea that traditional concepts of ethics insist that people in social relationships be treated as ends, in and of themselves, and never as means to the ends of others. Since all technologies evolve from our social relationships, no technology is value-free. Because of the value-laden nature of technological developments, new technologies are characteristically defined as both socially-determinative and socially derived.

Keywords: Philosophy; Science; Pursuit of truth; Ethics

Unit I: Philosophy of Science – Methodology of Science **(6 lectures)**
Unit II: Science as a pursuit of truth: Theory of falsification by Karl Popper and theory of paradigm shift by Thomas Kuhn **(4 lectures)**
Unit III: Evolution of science driven technology and technology driven science **(8 lectures)**
Unit IV: Exploring scales - Science & Ethics **(10 lectures)**

This course will also engage social ethics in response to its impact on the developing technologies of global societies. We will explore the idea that traditional concepts of ethics insist that people in social relationships be treated as ends, in and of themselves, and never as means to the ends of others. Since all technologies evolve from our social relationships, no technology is value-free. Because of the value-laden nature of technological developments, new technologies are characteristically defined as both socially-determinative and socially derived.

Course Learning Outcomes: This paper covers the philosophy of Science, methodology of Science, historical development of modern science, science as a pursuit of truth. Upon completion of the course the students would be able to-

- Have an understanding of major themes in the development of science.
- Identify philosophical issues about the methods of science.
- Possess a thorough knowledge of selected areas in history, philosophy and sociology of science.
- Be capable to do research in unfamiliar subject areas quickly and efficiently.
- Be capable of pursuing an in-depth project

Teaching Plan (**Theory**)

Week 1 - 2: Philosophy of Science
Week 3: Methodology of Science
Week 4: Science as a pursuit of truth: Theory of falsification by Karl Popper
Week 5: Science as a pursuit of truth: theory of paradigm shift by Thomas Kuhn
Week 6 - 7: Evolution of science driven technology
Week 8 - 9: Evolution of technology driven science
Week 10 - 11: Exploring scales.
Week 12 - 14: Science & Ethics

References

1. *The Principia: Mathematical Principles of Natural Philosophy*, Isaac Newton, University of California Press, 1999.
2. *Truth and Beauty: Aesthetics and Motivations in Science*, S. Chandrasekhar, University of Chicago Press, 2013
3. *What is life?*, Erwin Schroedinger, Cambridge University Press, 1992.
4. *Gravitation and Cosmology: Principles and Applications of the General Theory of Relativity*, Steven Weinberg, Wiley, 1972
5. *Phantoms in the Brain : Human Nature and Architecture of the Mind* , V. S. Ramachandran, Fourth Estate, 1998.
6. *The logic of Scientific Discovery*, Karl Popper, Routledge, 2005.
7. *The Structure of Scientific Revolution*, Thomas Kuhn, University of Chicago Press, 2012.

IV.5.1 Understanding Economic Behaviour: The macro level [Theory] [Semester IV] [3 – 1 – 0]

Course Objectives: The module will help to understand the roots of macroeconomics, macroeconomic concerns, the role of government in the macro-economy, the components of the macro-economy and the methodology of macroeconomics.

Keywords: GDP; CPI; Monetary and fiscal policy; Unemployment; FOREX

Unit I: GDP Measurement Techniques, Classical and Keynesian Theories- Macroeconomic Equilibrium, labor market, product market **(12 lectures)**
Unit II: Full Employment, Aggregate Expenditure Model, Role of money and the Government, Monetary and Fiscal Policy **(12 lectures)**
Unit III: The multiplier effect, Inflation, Exploring the macroeconomics of an open Economy: international Economics; Balance of Payments--The current and capital account **(9 lectures)**
Unit IV: Determining equilibrium output in an open economy; Open economy with flexible exchange rates--Markets for foreign exchange, Factors affecting exchange rates, effects of exchange rates on the economy **(9 lectures)**

Course Learning Outcomes

- Student will learn to perceive the nation's economy as a whole and compare the views of Keynes and the classical economists.
- Learn various techniques measuring and tracking macroeconomics using GDP and CPI.
- Analyse the model of full employment and use it to examine important macroeconomic issues, such as the extent to which taxes may depress economic activity and lower the level of GDP.
- Understanding of the importance of the multiplier, the aggregate consumption function and how expected future income and aggregate wealth affect consumer spending.
- The aggregate demand and aggregate supply curves form an economic model that will enable students to learn, how output and prices are determined in both the short run and the long run.
- Equip students to examine the concept of unemployment and inflation and their cost implication on society.
- Demonstrate an understanding of monetary and fiscal policy options as they relate to economic stabilization in the short run and in the long run.
- Learn to analyse the causes and correction of disequilibrium of balance of payment.
- Examine the balance of payments current account and capital account for national economy.
- Acquire the understanding the working of FOREX market and mechanism of determining exchange rate under different exchange rate regime.

Teaching Plan (**Theory**)

Week 1: Schools In Macroeconomics: Classical , Keynesian , Neo-Keynesian, Monetarist, New Classical Economist, Supply Riders, New Keynesian
Week 2: Concept Of GDP, Nominal & Real GDP, Components Of GDP, CPI, PPI

Week 3:	Unemployment Rate, The Natural Rate Of Unemployment
Week 4:	Aggregate Labor Market: The Demand Of Labor, Supply Of Labor,
Week 5:	Trends & Cycles, Aggregate Demand:-Wealth Effect, Interest Rate Effect, International Effect, Multipliers Effect
Week 6:	Aggregate Supply, Potential Output Curve,
Week 7:	Type Of Money, Measuring Money Supply And Its Definition& Monetary Policy
Week 8:	The Monetary Policy Curve: Monetary Policy & Interest Rate, The IS-MP Diagram
Week 9 & 10:	The Philip Curve, Price –Shocks And Philips Curve, Cost-Push & Demand Pull Inflation, Volcker Disinflation
Week 11:	Fiscal Policy
Week 12:	Balance Of Payment, Introduction To Exchange Rates And The International Monetary System
Week 13:	Exchange Rate In The Long Run:- The Nominal Exchange Rate, The Law Of One Price, The Real Exchange Rate
Week 14:	Exchange Rate In The Short Run:- The Nominal Exchange Rate, The Real Exchange Rate, Fixed Exchange Rate

References

1. *Macroeconomics,* R. Dornbusch, S. Fischer and R. Startz, McGraw Hill, 11th edition, 2010.
2. *Macroeconomics,* N. G. Mankiw, Worth Publishers, 8th edition, 2012.
3. *Principles of Economics*, K. E. Case, R. C. Fair and S. C. Oster, Pearson Education, 10th Edition, 2011.
4. *International Economics*, Dominick Salvatore*,* John Wiley & Sons, 2007.
5. *Macroeconomics*, Robert J. Gordon , Prentice-Hall India Limited, 2011

IV.5.2 Digital electronics and logic design [Theory] [Semester IV] [3 – 1 – 0]

Course Objective: This interactive module provides advanced digital electronic concepts understanding for real life applications. It enables the learner with concepts of microprocessor, assembly language and I/O interfacing to assist in designing of circuits for data transfer. It will also provide underlying basis of computer architecture and organization.

Keywords: Boolean algebra; Logic Gates; Microprocessor; Data Transfer

Unit I: Boolean algebra **(12 lectures)**
Unit II: Logic Gates – CMOS circuits – PLA - Digital IC families – Combinatorial circuits – Sequential circuits – MSI and PLD components – ADC – DAC – Semiconductor memories **(12 lectures)**
Unit III: Microprocessor – Assembly Language – I/O Interfacing **(9 lectures)**
Unit IV: Data Transfer Techniques – Finite State Machine - Firmware design **(9 lectures)**

Course Learning Outcomes:

- Students shall be able to design and analyze electronic circuits based on: Boolean algebra, Logic Gates, CMOS circuits, PLA, Digital IC families, Combinatorial circuits, Sequential circuits , MSI and PLD components , ADC , DAC, Semiconductor memories.
- Students shall learn importance of following in digital circuit designing: Microprocessor , Assembly Language, I/O Interfacing
- Equipping students with following: Data Transfer Techniques, Finite State Machine, Firmware design

Teaching Plan (**Theory**)

Week 1:	Introduction of Boolean expressions and method to minimize the Boolean expressions like K-map
Week 2:	Number systems (representations of binary number, octal number, hexadecimal and conversion of binary to other and other to binary)
Week 3:	Addition, subtraction, multiplication and division of binary, octal and hexadecimal number

Week 4: BCD addition and subtraction, compliment's of number , addition and subtraction using complement's like 9s complement's, 10 compliments etc.
Week 5: Logic Gates and their implementation in digital circuits
Week 6: Combination circuits (Full Adder, Full subtractor, mux, demux, encoder and decoder)
Week 7: Sequential circuits like SR-latch, SR-FF,JK-FF,D-FF,T-FF etc. and conversion of one Flip-flop to others,
Week 8: Semiconductor memories like ram rom etc., PLA
Week 9: Introduction of microprocessor, Assembly Language ,I/O Interfacing
Week 10: Convertor like analog to digital and digital to analog
Week 11: MSI and PLD components
Week 12: Digital logic family and CMOS circuits

Week 13 and 14: Data Transfer Techniques – Finite State Machine - Firmware design

References

1. *Digital Design* - M. Morris Mano*,* Prentice Hall of India, 2006
2. *Digital Logic Design Principles*, Balabanian, N. and Carlson, B.,John Wiley & Sons, 2001
3. *Digital Fundamentals*, Floyd, T.L., 8th Ed., Pearson Education, 2005

IV.5.3 *in silico* Biology [Theory + Practical] [Semester IV] [3 – 0 – 2]

Course Objective: The module is aimed at understanding the advancement of computational models and simulations in studies applied to complex biological phenomena. Students would be made aware of different types of bioinformatics analysis software and their related applications so that they can solve biological problems by getting better understanding about genomes, proteomes etc.

Keywords: Sequence analysis; Biological databases; Structure analysis; Bio-statistics

Unit I: Sequence analysis and alignment – Promoter domains and motifs – Scoring matrices **(9 lectures)**
Unit II: Biological databases and data-mining – Phylogeny and cladistics **(9 lectures)**
Unit III: Structure analysis – Molecular modelling and simulations **(9 lectures)**
Unit IV: Bio-statistics – Stochastic models – Algorithm and programming language **(15 lectures)**

Engineering Kitchen Activity [Laboratory]

- Sequence analysis (BLAST, FASTA).
- Database (NCBI, DDBJ, EMBL).
- Motif and Promoter searches (e.g. CD-Search, SMART, SignalP)
- Phylogenetic analysis (PHYLIP, MEGA)
- Protein interaction (STRING, BioGRID)
- Protein structure, Function (PROSITE programs, Chimera
- Gene expression, function (GEA, Gene card, OMIM)
- Introduction to molecular docking

Course Learning Outcomes: The students will be able to perform small bioinformatics projects after the completion of this course. They will be able to know about several important bioinformatics software. After completion of this paper the students will be well versed in

- Gene and protein alignment tools
- Finding domains and motifs in protein sequences
- Homology based modeling of proteins and docking

They will also be equipped to build

- Cladograms
- Prediction of active sites in a protein,

- Energy calculation for stabilization of DNA-protein and protein-protein complexes.

Teaching Plan (**Theory**)

Week 1:	Sequence analysis and alignment
Week 2:	Promoter domains and motifs
Week 3:	Scoring matrices
Week 4:	Biological databases
Week 5:	Data-mining
Week 6:	Phylogeny and cladistics
Week 7:	Structure analysis (protein)
Week 8:	Structure analysis (DNA)
Week 9:	Molecular modelling and simulations
Week 10:	Bio-statistics
Week 11:	Stochastic models
Week 12:	Algorithm and programming language.
Week 13 and 14:	Algorithm and programming language.

References

1. *Bioinformatics: Sequence and genome analysis*, David mount, Cold Spring Harbor Laboratory Press; 2nd edition, 2013.
2. *Introduction to Bioinformatics*, Arthur M. Lesk, OUP Oxford, 4th edition, 2014.

IV.6.1 Bringing Companies and clients together: Sales & Marketing management [Theory] [Semester IV] [3 – 1 – 0]

Course Objective: The learning objectives of this course will provide exposure to students about the world of marketing and sales. There will be a focus on the management of the marketing activities and how marketing relates to overall organizational functioning, including the management of exchange processes between business units and consumers and between firms. It will include topics such as environmental analysis, industry and competitor analysis, objective setting, marketing strategies, market mix components, and finally its implementation from the perspective of information technology

Keywords: Buyer Behavior Models; Advertising and Branding; E-Business

Unit I: Concepts – Strategies - Marketing Mix	**(12 lectures)**
Unit II: Buyer Behavior Models - Marketing Research and trends in Marketing	**(9 lectures)**
Unit III: Advertising and Branding	**(12 lectures)**
Unit IV: E-Business Marketing - IT-Enabled capabilities that influence marketing strategies	**(9 lectures)**

Course Learning Outcomes:

- Understanding the concept of marketing and marketing process.
- Understanding the Marketplace and Consumer by analysing the marketing environment
- Students will get a closer look at final consumer buying influences and processes and the buyer behaviour of business customers.
- Designing a Customer Value–Driven Strategy and Mix.
- Understanding of key customer value–driven marketing strategy decisions—dividing up markets into meaningful customer groups (segmentation), choosing which customer groups to serve (targeting), creating market offerings that best serve targeted customers (differentiation), and positioning the offerings in the minds of consumers (positioning).
- Learn, how the companies develop and manage products, services, and brands.
- Understanding of new products and managing products through their life cycle.

- Learn pricing mechanism and their pricing strategies, and look at internal and external considerations that affect pricing decisions.
- Students learn to explore the nature of marketing channels, the marketer's channel design, management decisions and distribution.
- Understanding of the characteristics of different kinds of retailers and wholesalers, the marketing decisions they make, and trends for the future.
- This course will help them to examining the concepts of direct marketing and its fastest-growing form: digital marketing (online, social media, and mobile marketing).
- Understanding the need of sustainable marketing, meeting the needs of consumers, businesses, and society—now and in the future—through socially and environmentally responsible marketing actions.

Teaching Plan (**Theory**)

Week 1:	Meaning, Importance And The Evolution Of The Marketing Concept
Week 2:	Strategic Approach To Marketing Management, Steps In Strategic Marketing Planning
Week 3:	Consumer And Organizational Buyer Behavior And Marketing Strategy
Week 4	The Marketing Mix, Market Boundaries; Target Marketing
Week 5:	Changing Marketing Landscape
Week 6:	Analyzing Marketing Environment
Week 7:	Managing Marketing Information: Marketing Research
Week 8:	Advertising & Public Relation
Week 9:	Building Strong Brand:-Creating Brand Equity
Week 10:	Building Strong Brand:-Crafting The Brand And Positioning
Week 11:	Building Strong Brand:-Competitive Dynamics
Week 12:	E- Business Environment, E- Marketing Research,
Week 13:	E- Marketing Strategies, E-Consumer Behavior,
Week 14:	Multichannel Marketing, IT-Enabled capabilities that influence Marketing Strategies.

References

1. *Marketing,* M. J. Etzel, J. W. Bruce, W. J. Stanton, & A. Pandit, New Delhi: Tata McGraw-Hill, 14th edition, 2010.
2. *Marketing management: a south Asian perspectiv*e, P. Kotler, K. Keller, L. Koshy & M. Jha, New Delhi: Pearson, 13th Edition, 2009.
3. *Marketing management: Global perspective Indian context,* V. S. Ramaswamy, & S. Namakumari, New Delhi: Macmillan, 4th Edition, 2009.
4. *Marketing management,* R. Saxena, New Delhi: Tata McGrawHill, 4th Edition, 2009.

IV.6.2 Digital electronics and logic design – Innovation Lab [Practical] [Semester IV] [0 – 0 – 8]

Course Objective: This is a hands-on learning practice based module to design electronic circuits based on commonly used logic gates and flip-flops. This module will enable the students with simulation software and electronic design automation (EDA) skill for soft designing of circuits.

Engineering Kitchen Activity [Laboratory]

- Realization of logic gates through diodes and resistors
- Verification of Boolean algebraic functions through digital IC gates
- Design of half/full adder and sub tractor circuits
- Design of shift registers using flip-flops
- Circuit design and simulation software and EDA

Course Learning Outcomes:

- Providing students hands on experience of circuit designing through activities in Engineering Kitchen Laboratory

- Actual designing of following electronic circuits: Realization of logic gates through diodes and resistors, Design of half/full adder and sub tractor circuits, Design of shift registers using flip-flops
- To learn process of verification of Boolean algebraic functions through digital IC gates
- To learn circuit design and simulation software and EDA
- Implementing students own ideas on circuit designing under guidance of mentor through Innovation Projects

Teaching Plan (**Practical**)

Week 1-3: Engineering Kitchen Activity [Laboratory]: Realization of logic gates through diodes and resistors
Week 4-6: Verification of Boolean algebraic functions through digital IC gates
Week 7-9: Design of half/full adder and sub tractor circuits
Week 10-12: Design of shift registers using flip-flops

Week 12-14: Circuit design and simulation software and EDA

IV.6.3 Flow of information in living systems [Theory + Practical] [Semester IV] [3 – 0 – 2]

Course Objective: This module has an objective to understand the hierarchical packaging of the genetic material inside the nucleus and how different nuclear functions such as replication, transcription, translation, repair and recombination are performed by the genetic material. Students would also be introduced to various biophysical and biochemical techniques during their engineering kitchen laboratory.

Keywords: Genetic; DNA; Transcription; Regulation of gene expression
Unit I: Experimental evidences for the nature of genetic material – Process of information transfer (Replication, Transcription and translation machinery) **(15 lectures)**
Unit II: Energetics and accuracy of information transfer – Problems of information transfer (DNA damage and repair) **(9 lectures)**
Unit III: Regulation of informational transfer (transcription factors, operon) **(9 lectures)**
Unit IV: DNA packaging and chromatin structure, regulation of gene expression in eukaryotes **(9 lectures)**

Engineering Kitchen Activity [Laboratory]
- Agarose Gel Electrophoresis
- SDS-PAGE Electrophoresis
- Polymerase Chain Reaction (PCR)
- Primer design
- Spectrometry
- Analysis of growth curve, molar extinction coefficient, absorption maxima
- Biochemical assays
- Restriction digestion
- Introductory Gene Cloning (Transformation to Ligation).

Course Learning Outcomes:
- The importance of DNA and RNA as genetic material is very well known to everyone, during this course, the students would be able to understand all the relevant concepts about structure and function of these biomolecules
- Students would also learn in detail about the processes taking place as a part of central dogma of a cell where the most relevant topics of replication, transcription and translation are introduced to students, which further facilitate in building up a relationship between these biological processes.

- Since DNA damage and repair are a part of this course, students would be encouraged to understand and take up such projects, where they might be involved with the real-time working to find answers to many unanswered questions.
- Engineering kitchen being one of the significant part of this course would be able to inculcate practical and hands-on skills among students for working on various projects.

Teaching Plan (**Theory**)

Week 1:	Experimental evidences for the nature of genetic material
Week 2:	Process of information transfer
Week 3:	Replication
Week 4:	Transcription
Week 5:	Translation machinery
Week 6:	Energetics and accuracy of information transfer
Week 7:	Problems of information transfer (DNA damage
Week 8:	Repair
Week 9:	Regulation of informational transfer
Week 10:	Transcription factors
Week 11:	Operon
Week 12:	DNA packaging and chromatin structure
Week 13 and 14:	Regulation of gene expression in eukaryotes.

References

1. *Molecular Cell Biology*, Lodish et al., W. H. Freeman & Company, 7th edition, 2012.
2. *Biochemistry*, Berg, Tymoczko and Stryer, W H Freeman & Company, 7th edition, 2011.

SEMSTER – V

V.1 Complexity and Symmetry in Mathematics: Complex Analysis and Algebra [Theory] [Semester V] [3 – 1 – 0]

Course Objectives: This interactive learning module intends to provide capabilities and basic understanding of complex analysis and algebra. The primary objective of this course is to introduce the basic tools of complex numbers, analytic functions, Laurent expansions and complex integration to understand their connection with the real-world problems. The second part of this course deals with introduction to group theory and its applications.

Keywords: Differentiation and integration of complex variables; Groups and subgroups

Unit I: Functions of complex variable - Derivatives, differentiation formulas - Cauchy-Riemann equations - sufficient conditions for differentiability - Analytic functions of a complex variable: Power-series expansions, Laurent expansions and Liouville's theorem **(15 lectures)**
Unit II: Complex integration - Cauchy Integral Theorem - Residue Theorem and applications to evaluate real integrals **(9 lectures)**
Unit III: Sets, relations, functions - Groups, subgroups - Permutations – Cyclic notation of permutation – Even and odd permutations - Permutation groups – Alternating groups – Subgroups **(9 lectures)**
Unit IV: Lagrange's theorem and its consequences – Cyclic and Abelian groups – Centralizer and normalizer of a group, Symmetries of plane figures **(9 lectures)**

Course Learning Outcomes:

- Understand the significance of limit, continuity and differentiability for complex functions.
- Evaluate integrals along a given path and compute the Taylor and Laurent expansions of complex functions.
- An introduction to the fundamentals of group theory
- Visualization of the applications of group theory

Teaching Plan (**Theory**)

Week 1:	Functions of complex variable
Week 2:	Derivatives; Differentiation formulas
Week 3:	Cauchy-Riemann equations; Sufficient conditions for differentiability
Week 4 and 5:	Analytic functions of a complex variable: Power-series expansions, Laurent expansions and Liouville's theorem
Week 6:	Complex integration
Week 7:	Cauchy integral theorem
Week 8:	Residue theorem and applications to evaluate real integrals
Week 9:	Sets; Relations; Functions; Groups
Week 10:	Permutations; Cyclic notation of permutation; Even and odd permutations
Week 11:	Permutation groups; Alternating groups; Subgroups
Week 12:	Lagrange's theorem and its consequences
Week 13:	Cyclic and Abelian groups
Week 14:	Centralizer and normalizer of a group; Symmetries of plane figures

References

1. *Complex Variables and Applications*, J.W. Brown and R. V. Churchill, McGraw Hill (8th Edition), 2009.
2. *Contemporary Abstract Algebra*, J. A. Gallian, (8th Edition), Cengagae Learning, 2013.
3. *An Introduction to Theory of Groups*, J. J. Rotman, (4th Edition), Springer, 1995.

V.2 Computer Graphics and Visualization Architecture [Theory + Practical] [Semester V] [3 – 0 – 2]

Course Objectives: This course provides an introduction to the principles of computer graphics. In particular, the course will consider methods for modelling 3-dimensional objects and efficiently generating photorealistic renderings on colour raster graphics devices. The emphasis of the course will be placed on understanding how the various elements that underlie computer graphics (algebra, geometry, algorithms and data structures, optics, and photometry) interact in the design of graphics software systems.

Keywords: Computer graphics; drawing algorithms; Bezier Curves; Shading and Depth buffer

Unit I: Overview of Computer Graphics - Usage of Graphics and their applications, Over view of Graphics systems - Refreshing display devices, Random and raster scan display devices, Colour Models: RGB, HSV etc., Tablets, Joysticks, Track balls, Mouse and light pens, plotters, printers, digitizers. **(12 lectures)**

Unit II: Output primitives - DDA Line drawing algorithm, Bresenham's Line Drawing Algorithm, Mid-point circle algorithm, Mid-point Ellipse algorithms. Transformations - Basic 2D Transformations, Matrix representations & Homogeneous Coordinates, Matrix Representations for basic 2D and 3D transformations, Composite Transformations, reflection and shear transformations **(12 lectures)**

Unit III: Two dimensional viewing - Barky line clipping algorithm, Algorithm for polygon clipping, Sutherland-Hodgeman polygon clipping, Curves - Bezier Curves, 4 point and 5 point Bezier curves using Bernstein Polynomials **(12 lectures)**

Unit IV: Shading and Hidden Surface Removal - Shading, Guard Shading, Phong Model, Back Face Detection, Depth Buffer (Z-Buffer, A-Buffer) Method **(6 lectures)**

Engineering Kitchen Activities [Laboratory]:

- Programs related on different concepts
- 2D and 3D transformation modeling
- Concept of Animations and Motion Pictures
- Smart Interfaces
- Virtual Augmentation applications in security, medicine and manufacturing
- Indexing and retrieval of video databases
- Innovation Project

Course Learning Outcomes:

- Introduction to Display devices and their background
- Understanding and implementation of Transformation algorithms
- Basics of Ray Tracing and shading.
- Understanding the process of Camera and image formation and implementation
- Introduction to Computer and machine vision and its applications such as in Object recognition, Motion analysis.
- Practical understating of 2D and 3D transformation modelling
- Learning the basics of the Animations and Motion Pictures
- Understanding the Virtual Augmentation applications in security, medicine and manufacturing
- Basics of video databases and understating indexing and retrieval of video.

Teaching Plan (**Theory**)

Week 1 and 2:	Overview of Computer Graphics; Usage of Graphics and their applications; Overview of Graphics systems; Refreshing display devices
Week 3 and 4:	Random and raster scan display devices; Colour Models RGB, HSV etc; Tablets; Joysticks; Track balls; Mouse and light pens; plotters; printers; digitizers
Week 5 and 6:	Output primitives; DDA Line drawing algorithm; Bresenham's Line Drawing Algorithm; Mid-point circle algorithm; Midpoint Ellipse algorithms
Week 7 and 8:	Transformations Basic 2D Transformations; Matrix representations & Homogeneous Coordinates; Matrix Representations for basic 2D and 3D transformations; Composite Transformations; reflection and shear transformations
Week 9 and 10:	Two dimensional viewing; Barky line clipping algorithm; Algorithm for polygon clipping; Sutherland Hodgeman polygon clipping
Week 11 and 12:	4 point and 5 point Bezier curves using Bernstein Polynomials
Week 13 and 14:	Shading and Hidden Surface Removal; Shading; Guard Shading; Phong Model; Back Face Detection; Depth Buffer (Z-Buffer, A-Buffer) Method

References:

1. *Watt, Alan*, 3D Computer Graphics. Addison-Wesley, 1999.
2. *Shirley, Peter, Michael Ashikhmin, Steve Marschner*, Fundamentals of Computer Graphics. 3rd ed. A K Peters/CRC Press, 2009.
3. *The Illusion of Life – Disney Animations*, Frank Thomas, Ollie Johnston, Walt Disney, 1981
4. *Computer Graphics, C Version*, 2nd Edition, Hearn & Baker, Pearson Education, 1997
5. *Computer Graphics: Principles and Practice in C*, 2nd Edition, J. Foley, Addison Wesley, 1995

V.3 Computer and Brain: Knowledge Discovery and Artificial Intelligence [Theory] [Semester V] [3 – 1 – 0]

Course Objectives: The objective is to introduce the basic principles, techniques, and applications of Artificial Intelligence. Emphasis will be placed on the teaching of the fundamentals, not on providing mastery of specific software tools or programming environments. Assigned projects promote a 'hands-on' approach for understanding, as well as a challenging avenue for exploration and creativity.

Keywords: Artificial Intelligence; Computer Vision

Unit I: Introduction Artificial Intelligence (AI) Concepts – AI Techniques – Intelligent program and agents **(12 lectures)**
Unit II: Problem Solving basics – issues in design of Intelligent search algorithm– Heuristic search techniques – Game Playing **(12 lectures)**
Unit III: Knowledge Representation-Rule based Systems – Structured Knowledge Representation – Semantic Nets – Fundamental and concepts of Programming languages like Prolog or Lisp **(12 lectures)**
Unit IV: Languages and Knowledge Representation – Expert Systems – Domain Knowledge – Knowledge Acquisition – Case Studies – Computer Vision **(6 lectures)**

Course Learning Outcomes: Upon Completion of this course the student will be able to:

- List the objectives and functions of modern Artificial Intelligence.
- Categorize an AI problem based on its characteristics and its constraints.
- Understand and implement search and adversarial (game) algorithms.

- Understand mathematical models such as belief networks and apply them to a range of AI problems.
- Have a glance at machine learning algorithms and extracting knowledge models from data.
- Learn different logic formalisms and decision taking in planning problems.
- Learn how to analyse the complexity of a given problem and come with suitable optimizations.
- Demonstrate practical experience by implementing and experimenting with the learnt algorithms.
- Student will also have sufficient expertise in both the theory of machine learning and its application to data mining, so as to use these powerful techniques in a wide range of industrial contexts, for example, bioinformatics, electronic commerce, and finance.
- Learn to analyse research activities with the different applications to explore the different analytical tools.

Teaching Plan (**Theory**)

Week 1 and 2:	Introduction Artificial Intelligence (AI) Concepts; AI Techniques
Week 3 and 4:	Intelligent program and agents
Week 5 and 6:	Problem Solving basics; issues in design of Intelligent search algorithm
Week 7 and 8:	Heuristic search techniques; Game Playing
Week 9 and 10:	Knowledge Representation; Rule based Systems; Structured Knowledge Representation; Semantic Nets
Week 11 and 12:	Fundamental and concepts of Programming languages like Prolog or Lisp
Week 13 and 14:	Expert Systems; Domain Knowledge; Knowledge Acquisition; Case Studies Computer Vision

References:

1. *Artificial Intelligence - Building Intelligent Systems, 1st Edition.* P. Joshi & P. Kulkarni, PHI Learning, 2015.
2. *Artificial Intelligence, 3rd Edition. R. Elaine, K. Knight, S. Nair*, Tata McGraw-Hill, 2009.
3. *Winston, Patrick Henry*, Artificial Intelligence. 3rd ed. Addison-Wesley, 1992.
4. *Kevin P. Murphy and Robert R. Reitano*, Machine Learning: A Probabilistic Perspective, MIT Press, 2012.
5. *Artificial Intelligence and Soft Computing Behavioral and Cognitive Modeling of the Human Brain, Amit Konar,* CRC Press, 2000.

V.4 History, culture & civilization [Theory] [Semester V] [2 – 0 – 0]
(This is only a suggestive syllabus. There is no fixed syllabus for this unit)

Course Objective: This interactive module intends to provide the basic understanding of the intersection of digital technologies and humanities. The multidisciplinary nature of the paper will provide the interface to understand the relation of humanities disciplines and computer science and its allied technologies.

Keywords: Digital revolution; Digital Humanities; Impact on the society

Unit I: Introduction to History, Culture and Civilization. **(6 lectures)**
Unit II: Science and Technology, Industrial Revolution and Digital revolution- Impact on the society. **(8 lectures)**
Unit III: Social Science and Digital technology: Digital Humanities. **(8 lectures)**
Unit IV: Dealing with the impact of digital technology on socio-cultural set up**.** **(6 lectures)**

Course Learning Outcomes: History, culture and Civilization or Digital Humanities is a multidisciplinary field, undertaking project based paper at the intersection of digital technologies and humanities. Upon completion of the course the students would be able to-

- Develop preliminary models to deals with the issues connected to humanities disciplines and computer science and its allied technologies.
- Understand the impact of these techniques on cultural heritage, libraries, archives, and digital culture.
- Deal with contemporary issues on the impact of digital technology on socio-economic structure.

Teaching Plan (**Theory**)

Week 1:	Brief introduction to history: Ancient, Medieval and Modern
Week 2:	Cultural and linguistic diversity.
Week 3:	Brief description on Civilization: Indus, Mohenjo-Daro, Mesopotemia, Egyptian, and Maya.
Week 4:	Evolution of science and technology.
Week 5:	Modern science and technology.
Week 6:	Industrial revolution: Advancement of Technological invention in the western world.
Week 7:	Digital revolution: Impact on the Socio-economic.
Week 8:	Digital revolution: Impact on the Socio-economic.
Week 9:	Digital Humanities: The fusion of Social Science and Digital technology.
Week 10:	History of Digital Humanities
Week 11:	Pre – Internet and Post - Internet analysis of culture
Week 12:	Impact of digital technology on socio-cultural set-up.
Week 13 and 14:	Digital humanities and social issues.

Suggestive Reading

1. *Digital_Humanities*, Anne Burdick, Johanna Drucker, Peter Lunenfeld, Todd Presner, Jefferey Schnapp, MIT Press, 2012
2. *Snap to Grid*, Peter Lunenfeld, MIT Press, 2001

V.5.1 Maximizing performance: Human Resource management and Organizational\ Behavior [Theory] [Semester V] [3 – 1 – 0]

Course Objective: In this course students will get familiarity about the significance of human resource in a competitive environment and how the information technology helps in attracting potential human resource

Keywords: Human Resource Management; Leadership; Organizational Behavior; Human resource information system

Unit I: Evolution of the concept of HRM - HR policies, functions and roles – Leadership – Recruitment **(12 lectures)**
Unit II: Training - Performance & potential appraisal - Statutory laws **(12 lectures)**
Unit III: Individual & Group Behavior- Leadership & power **(12 lectures)**
Unit IV: Dynamics of Organizational Behavior- Human resource information system **(6 lectures)**

Course Learning Outcomes:

- Learn to the rationality of evolution of management thought
- Discuss how to strategically plan for the human resources needed to meet organizational goals and objectives.
- Define the process of job analysis and discuss its importance as a foundation for human resource management practice.
- Steps required to develop and evaluate an employee training program.
- Know the activities involved in evaluating and managing employee performance.
- Able to explain how legislation impacts human resource management practice.
- Identify and describe the context in which unions and employers meet to organize, bargain, and resolve disputes.

Teaching Plan (**Theory**)

Week 1:	Meaning, nature and scope of HRM; HRM functions & HRM classification; organization of HRM
Week 2:	HRP; Benefits and strategic for HRP; process of HRP and factors affecting HRP
Week 3:	Objectives, strategies & policy of recruitment; Sources of recruitment & factors affecting recruitment
Week 4	Job analysis & job specification; Purpose and techniques of job description; Recent trends in the recruitment process
Week 4:	Need and importance of training; Techniques of training; Benefits of training and MDP
Week 5:	Job enlargement & job enrichment; Identification of training needs in various industries
Week 6:	Need, importance and benefits of performance appraisal (pa); Techniques of performance appraisal
Week 7:	Career planning, succession planning & career development; Time management
Week 8:	Retaining and motivating; Designing the performance appraisal form for various industries
Week 9:	Individual & group behavior analysis
Week 10:	Organizational level behavior analysis
Week 11:	Leadership theories
Week 12:	Eight leadership styles
Week 13 & 14:	Human resource information system

References

1. *Organisational Behavior*, Stephen P. Robins, PHI Learning / Pearson Education, 15th Edition, 2012.
2. *Organisational Behavior*, Fred Luthans, McGraw Hill, 12th Edition, 2005.
3. *Organizational behaviour: Text and Cases,* K. Singh, New Delhi: Pearson education, 2009.
4. *Fundamentals of human resource management,* D. A. DeCenzo, & S. P. Robbins, New York: John Wiley & Sons, 9th Edition 2010.
5. *Industrial relations in India*, R. Sen, New Delhi: Macmillan India, 2nd Edition, 2009.

V.5.2 Embedded systems studio - I [Theory + Practical] [Semester V] [3 – 0 – 2]

Course Objective: This interactive learning module intends to provide capabilities and basic understanding of microcontroller and microprocessor. It will emphasise on the concepts of RSIC, CISC, I/O port, RTOS, assembly language, internet of things, robotics etc. It will also provide an insight of the technology that deals with the design, construction, and operation and its application in manufacturing and automation processes.

Keywords: Microcontroller and Microprocessor; Assembly Language; Embedded systems

Unit I: Microcontroller and Microprocessor – Introduction to RTOS, VHDL, FPGA - Embedded system development (Memory, Interfaces, Peripheral devices, Sensors) – Basic RISC – CISC – I/O Ports **(12 lectures)**

Unit II: Instructions Sets – Addressing Modes – Clock System - Timers & Counters – Interrupts – ADC- DAC – Assembly Language & Embedded C – Pipeline – ARM & Thumb Instruction Set **(12 lectures)**

Unit III: Networking for embedded systems – Introduction to robotics and control – Actuators and Drives – Kinematics - Constraints **(9 lectures)**

Unit IV: Position analysis – Redundant robot manipulators – Dynamic analysis of robot manipulators and mobile robots – Trajectory planning – Motion control - Sensors and Navigation - Internet of Things **(9 lectures)**

Engineering Kitchen Activity [Laboratory]

- Design and rapid prototyping of embedded system using FPGA
- VHDL and RTOS implementation
- Study and implementation of networking protocols
- Networking using Internet of Things
- Design and fabrication of robots
- Path planning and navigation for robots

Course Learning Outcomes:

- Understand the different type of microcontroller and microprocessor
- Programing based on assembly language
- Interfacing of microprocessor with microcontroller
- Application of microcontroller and microprocessor in real time system

Teaching Plan (**Theory**)

Week 1:	Introduction of Microcontroller and Microprocessor
Week 2: and 3:	Introduction to RTOS, VHDL, FPGA - Embedded system Development (Memory, Interfaces, Peripheral devices, Sensors)
Week 4:	Basic RISC, CISC, I/O Ports
Week 5:	Instructions Sets, Addressing Modes
Week 6:	Clock System, Timers & Counters ,Interrupts
Week 7:	ADC, DAC, Assembly Language & Embedded C
Week 8:	Pipeline – ARM & Thumb Instruction Set
Week 9:	Networking for embedded systems
Week 10: and 11:	Introduction to robotics and control, Actuators and Drives , Kinematics, Constraints
Week 12: and 13:	Position analysis, Redundant robot manipulators, Dynamic analysis of robot Manipulators and mobile robots , Trajectory planning, Motion control - Sensors and Navigation
Week 14:	Internet of Things

References

1. *Embedded System Design* – Santanu Chattopadhyay, PHI Learning, 2013
2. *Embedded System*– Raj Kamal, TMH, 2008
3. *Robotics: Modeling, Planning and Control,* B. Siciliano, L. Sciavicco, L. Villani and G. Oriolo, Springer, 2009.
4. *Introduction to Robotics: Mechanics and Control,* J. J. Craig, Pearson, 2005.

V.5.3 Biological Instrumentation Kitchen: Genomics and Proteomics [Practical] [Semester V] [0-0-8]

Course Objective: The objective of this module is to introduce the theoretical component of techniques in Genomics and Proteomics. In the past few decades DNA and Protein sequencing has revolutionized the experimental approach in life sciences.

This course delves into the background, principles and mechanisms of these techniques.

- Isolation and analysis of plasmids
- Expression of proteins as inclusion bodies
- Isolation and refolding of the inclusion bodies
- Agarose Gel Electrophoresis
- SDS PAGE analysis
- Primer design
- Polymerase Chain Reaction (PCR)
- Restriction Digestion
- Cloning Strategy (Introductory Gene Cloning)

Course Learning Outcomes: Engineering kitchen being an integral part of Systems Biology, this laboratory module gives an opportunity to the students to relate all the studied theoretical concepts with the experiments. The experiments in this course will help students to understand the basic Biochemistry, Molecular and Systems Biology as well as enable them to link the current fields of like Genomics, Proteomics and Bioinformatics.

Teaching Plan (**Practical**)

Week 1:	Isolation and analysis of plasmids
Week 2:	Isolation and analysis of plasmids
Week 3:	Expression of proteins as inclusion bodies
Week 4:	Expression of proteins as inclusion bodies
Week 5:	Isolation inclusion bodies
Week 6:	refolding of the inclusion bodies
Week 7:	Agarose Gel Electrophoresis
Week 8:	SDS PAGE analysis
Week 9:	SDS PAGE analysis
Week 10:	Primer design
Week 11:	Polymerase Chain Reaction (PCR)
Week 12:	Restriction Digestion
Week 13 and 14:	Cloning Strategy (Introductory Gene Cloning

References

1. *Principles and Techniques of Biochemistry and Molecular Biology,* Wilson & Walker, Cambridge University Press, 2010
2. *Principles of Gene Manipulation and Genomics,* Primrose and Twyman, Wiley-Blackwell 2013

V.6.1 Efficient manufacturing process: Production and Operations Management [Theory + Practical] [Semester V] [3 – 0 – 2]

Course Objectives: This course is concerned with the *design, management, and improvement of operating systems and processes.* The module focuses on manufacturing and the development of physical products. The course is designed to encompass new issues in information technology, supply chains, and service industries. As we seek to understand the challenges confronting firms competing in today's demanding environment, the focus of our work has broadened to include the multiple activities comprising a firm's "operating core":

Keywords: Production and Operation technology; Inventory Management; Computer Integrated Manufacturing Systems

Unit I: Concept, Operations Strategy, Management of Quality, Definition, Basic Approach, Gurus of TQM, TQM Framework, Defining Quality, Historical Review, Benefits of TQM, Continuous Process Improvement, Juran Trilogy, The PDSA Cycle **(12 lectures)**

Unit II: Improvement Strategies, Problem Solving Methods, Kaizen, Six Sigma, Statistical Process Control, Process Capability: Introduction of Process Capability, Measures of Process Capability **(15 lectures)**

Unit III: Different Control Chart for Variables, Control Charts for Attributes., Elements & Objective of Supply Chain Management, Inventory Management Model **(9 lectures)**

Unit IV: Evaluation and Selection of Appropriate Production and Operations Technology, Computer Integrated Manufacturing Systems **(6 lectures)**

Engineering Kitchen Activities [Laboratory]

- Case study discussion on the company's productivity problem from the viewpoints of classical and modern organization theories and linking it with the real life problem.
- Case study discussion on the development of new production techniques which is being practiced in different sectors
- Creating live models which could be tested and used in companies linking mathematical models with the production techniques and strategies.

Course Learning Outcomes:

- Demonstrate an awareness and an appreciation of the importance of the operations and supply management to the sustainability of an enterprise.
- Explain the importance of quality control.
- Apply techniques to measure quality control.
- Demonstrate a basic understanding of the problems of waiting lines.
- Demonstrate an understanding of the principles of just-in-time systems.
- Explain the importance of forecasting.
- Demonstrate the ability to apply some mathematical forecasting techniques.

- Demonstrate an understanding of the concept of aggregate planning.
- Demonstrate an understanding of the problems involved in inventory management.
- Demonstrate an understanding of the principles underlying materials requirements planning.
- Develop basic materials requirement schedules.
- Demonstrate an understanding of the concepts of operations scheduling.

Teaching Plan (**Theory**)

Week 1:	Concept, Operations Strategy
Week 2:	Management Of Quality, Definition, Basic Approach, Gurus Of TQM, TQM Framework
Week 3:	Defining Quality, Historical Review, Benefits Of TQM,
Week 4:	Continuous Process Improvement, Juran Trilogy, The PDSA Cycle
Week 5:	Improvement Strategies, Problem Solving Methods,
Week 6:	Kaizen, Six Sigma,
Week 7:	Statistical Process Control (Part-1): Pareto Diagram, Process Flow Diagram, Casue& Effect Diagram, Check Sheet
Week 8:	Statistical Process Control (Part-2): Histogram, Control Charts, Variable Control Charts, State Of Control, Out Of Control Process
Week 9:	Process Capability : Introduction Of Process Capability, Measures Of Process Capability
Week 10:	Different Control Chart For Variables, Control Charts For Attributes,
Week 11:	Elements & Objective Of Supply Chain Management
Week 12:	Inventory Management Model
Week 13:	Evaluation And Selection Of Appropriate Production And Operations Technology
Week 14:	Computer Integrated Manufacturing Systems

References

1. *Production and Operations Management*, K. Aswathappa K and K. S. Bhat, Himalaya Publishing House, 6th Edition, 2010.
2. *Production and Operations Management*, R. Pannerselvam, Prentice Hall India, 3rd Edition, 2013.
3. *Operations Management*, N. Gaither and G. Frazier, South Western Cengage Learning, 2006.

V.6.2 Signals & Systems Engineering [Theory + Practical] [Semester V] [3 – 0 – 2]

Course Objective: This interactive learning module intends to provide capabilities and basic understanding of signals and systems. It will emphasize on time and frequency domain analysis of signal communication. It will also provide the interface to understand real time analogue and digital communication and applications to filter design.

Keywords: Linear Time Invariant System; Laplace, Fourier, z transforms; Convolution; Modulation; Filters

Unit I: Discrete-time systems - Continuous-time systems	**(12 lectures)**
Unit II: Laplace transforms – Z transforms – Convolution	**(9 lectures)**
Unit III: Frequency response – Fourier series and transform	**(12 lectures)**
Unit IV: Feedback – Sampling – Modulation – Filters design techniques	**(9 lectures)**

Engineering Kitchen Activity [Laboratory]

- Study of Convolution types.
- Computation of DFT & IDFT using DSP Processors
- FIR & IIR Filter Implementation using the DSP Processors.
- MATLAB implementation of different signal types
- Sampling theorem and reconstruction of signal from its samples using natural sampling

Course Learning Outcomes:

- Identify, understand and differentiate between discrete time system and continuous time system
- Application of mathematical tools – Laplace transform, Z transform and Fourier transform to various signals
- Implement different signal types on MATLAB
- Design different types of filters
- Reconstruction of signal from its samples using natural sampling

Teaching Plan (**Theory**)

Week 1:	Classification of signals; Basic operation on signals; Elementary signals, Properties of a system
Week 2:	Convolution; Impulse response representation of LTI system and its properties
Week 3:	Differential and Difference equation representation of LTI system
Week 4:	Discrete and Continuous time periodic signals – Fourier Series
Week 5:	Discrete and Continuous time non-periodic signals – Fourier Transform
Week 6:	Properties of Fourier transform; Frequency response of LTI system; Fourier Transform representation for periodic signals
Week 7:	Convolution and Modulation with mixed signal classes; Fourier transform representation for Discrete Time Signals
Week 8:	Sampling; Reconstruction of Continuous Time signals from samples
Week 9:	Modulation; Full amplitude modulation and its variants; Pulse amplitude modulation
Week 10:	Laplace Transform; Inverse Laplace Transform
Week 11:	Solving Differential equation with initial conditions using Laplace Transform
Week 12:	z-Transform; Properties of z-Transform; Inverse of z-Transform
Week 13 and 14:	Design of Filters; Low pass, High pass and band pass filters; Passive Filter; Digital Filters

References

1. *Oppenheim, Alan, and Alan Willsky*. Signals and Systems. 2nd ed. Prentice Hall, 1996.
2. *Haykin, S. and Van Been, B.*, "Signals and Systems" 2 Ed., John Wiley & Sons, 2003.

V.6.3 Applied Genomics and Proteomics: Methods and techniques [Theory] [Semester V] [3-1-0]

Course Objective: In this Instrumentation Kitchen, students will explore the tools and techniques of molecular and systems biology with hands on experience. Techniques as simple from Agarose gel or SDS-PAGE electrophoresis to different types of PCR and molecular cloning will be taught. Students will practice and improvise the techniques routinely used in molecular biology laboratories.

Keywords: DNA technology; Cloning; Microarray; Electrophoresis; *in situ* hybridization

Unit I: Introduction to Recombinant DNA technology, cloning and expression vectors, Artificial chromosome, PCR and its types, expression and purification of heterologous proteins, DNA and Protein sequencing **(12 lectures)**

Unit II: Microarray - MALDI -RAPD - RFLP - *in situ* hybridization - Site directed mutagenesis - Gene transfer and gene therapy **(12 lectures)**

Unit III: Electrophoresis - Spectrometry - X-ray crystallography - NMR - Genomic and cDNA library **(9 lectures)**

Unit IV: Two hybrid systems - Plant and Mammalian tissue culture **(9 lectures)**

Course Learning Outcomes: This course is in sync with the Biological instrumentation Kitchen and the laboratory module is based on the theoretical component covered here.

- This course basically gears up all students for understanding the importance of all methods or techniques, which are utilized for relevant biological experiments.
- Characterizing techniques like Spectrometry, MALDI, NMR, X-ray crystallography are extremely important to understand, as all biomolecules like nucleic acids and proteins would have to be identified using them as one of the basic methods.
- Students are exposed to lot of biological concepts like gene cloning, recombinant DNA technology, DNA/ protein sequencing, genomic/ c-DNA library etc. which are obviously important, as these would be a prior knowledge before going in to more complex and upcoming branches like genomics, proteomics and bioinformatics.

Teaching Plan (**Theory**)

Week 1:	Introduction to Recombinant DNA technology
Week 2:	Cloning and expression vectors, Artificial chromosome
Week 3:	PCR and its types, expression and purification of heterologous proteins
Week 4:	DNA and Protein sequencing
Week 5:	Microarray, MALDI- RAPD - RFLP
Week 6:	in situ hybridization
Week 7:	Site directed mutagenesis
Week 8:	Gene transfer and gene therapy
Week 9:	Electrophoresis
Week 10:	Spectrometry - X-ray crystallography - NMR
Week 11:	Genomic and cDNA library
Week 12:	Two hybrid systems
Week 13 and 14:	Plant and Mammalian tissue culture

References

1. *Principles and Techniques of Biochemistry and Molecular Biology,* Wilson & Walker, Cambridge University Press, 2010
2. *Principles of Gene Manipulation and Genomics,* Primrose and Twyman, Wiley-Blackwell 2013

SEMSTER – VI

VI.1 Linear Construction of Actions: Engineering through Linear Programming and Game Theory [Theory + Practical] [Semester VI] [3 – 0 – 2]

Course Objective: To provide an understanding of the optimization of linear models in the many areas. This course starts with the definition of LPP, underlying assumptions and modeling of problems. Illustration of graphical method will help to conceive the idea behind the solution of LPP. This will also help the reader to visualize the overall concept though explained for only two decisions variables. Once the concept becomes clear, theoretical as well as logical approach of most popularly used simplex method will be explained. Discussion on revised simplex method, duality in LPP, Primal-Dual relation, Dual simplex method and sensitivity or post-optimality analysis will help the reader to understand the practical application of LPP. This provides an understanding how to formulate Transportation problem, Assignments problems and many more applications. It also explains the Formulation of two person zero sum games and Solving two person zero sum games with mixed strategies, Graphical solution procedure and Linear programming solution. Students will also learn how to use and analyse the results of TORA software, MS Excel and LP Assistant for LPP.

Keywords: Simplex method; Duality; Transportation problem; Assignment problem; Game theory

Unit I: Formulation of Linear Programming Models - Theory of simplex method - optimality and unboundedness - the simplex algorithm - simplex method in tableau format - Computational efficiency of the technique **(9 lectures)**

Unit II: Introduction to artificial variables – two-phase method, Big-M method and their comparison - Formulation of the dual problem, Primal-dual relationships, Economic interpretation of the dual **(12 lectures)**

Unit III: Introduction to Post optimality analysis - Dual Simplex Method and its application - Formulation of the Transportation problem - Algorithm for solving transportation problem - Northwest - corner method, least cost method and Vogel approximation method for determining the starting basic solution **(9 lectures)**

Unit IV: Assignment problem and its mathematical formulation,-Hungarian method for solving assignment problem - Formulation of two person zero sum games - Solving two person zero sum games - Games with mixed strategies - Graphical solution procedure -Linear programming solution of games **(12 lectures)**

Engineering Kitchen Activity [Laboratory]

Program with Solver and its application to simple models

- Formulation of the model in Solver
- Solution of LPP with Solver
- Sensitivity analysis with Solver
- Solution of Transportation and Assignment problem with Solver
- Innovation Project

Course Learning Outcomes: After completing this course, student should be able to

- Formulate linear programming models for given real situations
- Learn simplex method and its computational efficiency
- Formulate dual problems and understand economical interpretation of primal dual relationship
- Analyze post optimality and its economical interpretation
- Solve Transportation problems and assignment problems
- Learn some basic concepts of game theory
- Learn linear programming solution of games with mixed strategies

Teaching Plan (**Theory**)

Week 1:	Formulation of Linear Programming Models
Week 2 and 3:	Theory of simplex method; optimality and unboundedness; the simplex algorithm; simplex method in tableau format; Computational efficiency of the technique
Week 4 and 5:	Introduction to artificial variables; two-phase method, Big-M method and their comparison
Week 6 and 7:	Formulation of the dual problem, Primal-dual relationships, Economic interpretation of the dual
Week 8:	Introduction to Post optimality analysis; Dual Simplex Method and its application
Week 9 and 10:	Formulation of the Transportation problem; Algorithm for solving transportation problem; Northwest - corner method, least cost method and Vogel approximation method for determining the starting basic solution for Transportation problems
Week 11 and 12:	Assignment problem and its mathematical formulation; Hungarian method for solving assignment problem
Week 13 and 14	Formulation of two person zero sum games; Solving two person zero sum games; Games with mixed strategies; Graphical solution procedure; Linear programming solution of games

References

1. *Linear Programming and Network Flows,* Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, (2nd edition), John Wiley and Sons, India, 2004.
2. *Introduction to Operations Research,* F. S. Hillier and G. J. Lieberman, (9th Edition), Tata McGrawHill, Singapore, 2009.
3. *Operations Research, An Introduction,* Hamdy A. Taha, (8th edition), Prentice-Hall India, 2006.

VI.2 Decoding Computation Structure and Logic [Theory] [Semester VI] [3 – 1 – 0]

Course Objectives: The objective is to introduce students to the mathematical foundations of computation including automata theory; the theory of formal languages and grammars; the notions of algorithm, decidability, complexity, and computability.

Keywords: Digital abstraction; Automata; Combinatorial Logic; Randomness; Context free languages

Unit I: Sets - Graphs	**(12 lectures)**
Unit II: Digital abstraction - Automata	**(12 lectures)**
Unit III: Combinatorial Logic	**(6 lectures)**
Unit IV: Randomness - Context free languages	**(12 lectures)**

Course Learning Outcomes:

- Understanding of Sets and Graphs
- Understanding and implementation of Digital abstraction
- Philosophy of automata and machine
- Exposure to the Combinatorial Logic
- Critical analysis of Randomness
- Introduction to Context-free languages and their significance

Teaching Plan (**Theory**)

Week 1 and 2:	Sets; Alphabets; string; language; Basic Operations on language
Week 3 and 4:	Graphs; Transition Graphs
Week 5 and 6:	Digital abstraction
Week 7 and 8:	Automata; Finite Automata; Deterministic and non-deterministic finite automata, NFA to DFA Conversion

Week 9 and 10:	Combinatorial Logic; Randomness
Week 11 and 12:	Context free grammars; parse trees, ambiguities in grammars and languages; Pushdown automata (Deterministic and Non-deterministic)
Week 13 and 14:	Pumping Lemma; Properties of context free languages, normal forms

References:

1. *Introduction to Automata Theory, Languages, and Computation*, John E. Hopcroft, Rajeev Motwani, Jeffrey D Ullman, 3rd Edition, 2013
2. *Introduction To Computer Theory*, Daniel I. A. Cohen, 2nd Edition, 2007
3. *Computation Structures*. Stephen Ward & Robert Halstead, MIT Electrical Engineering and Computer Science, 1989.
4. *Discrete computational structures*, Robert R. Korfhage, Academic Press, 1974

VI.3 Internet and Web Technology [Theory + Practical] [Semester VI] [3 – 0 – 2]

Course Objectives: The objective is to introduce with the fundamentals of how the Internet and the Web function, a basic understanding of graphic production with specific stress on creating graphics for the Web, and a general grounding introduction to more advanced topics such as programming and scripting. This will also expose students to the basic tools and applications used in Web publishing.

Keywords: Search Engines-Architecture; Internet Security; Cyber Laws; Web Design

Unit I: Web Technologies - HTTP, HTTPs, WWW, URL, Email, Domain Name Service, Web Browsers, Search Engines-Architecture, Crawlers, Type of crawlers, search tools **(12 lectures)**
Unit II: Chat & Bulletin Board Services, SNMP, VPN, VoIP & Internet Telephony. Security - Concept of Internet security, Firewall-Functioning, types of Firewall. Sniffing, spoofing, viruses, worms, Trojan horses, and their security **(12 lectures)**
Unit III: Cyber Laws - Introduction, The rights the various parties have with respect to creating, modifying, distributing, storing and copying digital data- concurrent responsibilities and potential liabilities **(6 lectures)**
Unit IV: Web Design - Key issues in web site design, Use of Different HTML tags in web pages, Building HTML documents, Cascading Style Sheets-Internal, Inline and external style sheets, Javascript, Dynamic HTML with Javascript, Web programming, PHP, database connectivity with MySQL **(12 lectures)**

Engineering Kitchen Activity (Programming Software) [Laboratory]

- Exercise based on developing websites and portals using HTML.
- Exercise based on developing websites and portals using CSS.
- Exercise based on developing websites and portals using Java Script.
- Projects based on PHP and MySQL to be implemented.
- Innovation Project

Course Learning Outcomes:

- Acquire knowledge of web protocols and develop understanding of concepts of Internet security.
- Able to implement studied technologies in systematically developing a website with due regard to ethical and environmental issues.
- Understand the significance of emerging web technologies for the advancement of society.

Teaching Plan (**Theory**)

Week 1 and 2:	Web Technologies HTTP; HTTPs; WWW; URL; Email; DNS; Browsers
Week 3 and 4:	Search Engines Architecture; Crawlers; Type of crawlers; search tools

Week 5 and 6:	Chat & Bulletin Board; SNMP; VPN; VoIP & Internet Telephony
Week 7 and 8:	Security; Internet security; Firewall Functioning; types of Firewall; Sniffing; spoofing; viruses; worms; Trojan horses and their security
Week 9 and 10:	Cyber Laws Introduction; The rights the various parties have with respect to creating, modifying, distributing, storing and copying digital data
Week 11 and 12:	Web Design; Key issues; HTML tags in web pages; Building HTML documents; Cascading Style Sheets; Dynamic HTML with JavaScript
Week 13 and 14:	Web programming; PHP; database connectivity with MySQL

References:

1. *Data Communication and Networking,* Forouzan, B.A., Tata McGraw-Hill. 2013
2. *Professional JAVA Server Programming,* Allamaraju and Buest, SPD Publication. 2007
3. *Internet and World Wide Web: How to Program,* 5th Edition, Deitel and Deitel, Pearson Education. 2008

VI.4 Art & Design [Theory] [Semester VI] [2 – 0 – 0]

Course Objective: This interactive learning module intends to provide basic understanding of design process, design thinking and ability to convert an innovative product idea to a prototype.

Keywords: Orthographic projections; Computing in Interface Designs; Design thinking; innovation in product designing; Prototyping; Proof of concept

Unit I: Exercises in design to understand principles of design - Distribution of space - Language of proportion and the process of form synthesis **(6 lectures)**
Unit II: Introduction to orthographic projections in simple positions – Drawing of plan, elevation and section of simple objects to scale, full size, reduced or enlarged – User interface and user experience design elements – Affective Computing in Interface Designs **(8 lectures)**
Unit III: Design thinking and innovation in product designing - Empathy research – Prototyping **(8 lectures)**
Unit IV: Proof of concept - Product testing and validation **(6 lectures)**

Course Learning Outcomes:

- Understanding of design thinking and innovation in product designing.
- How to do empathy research.
- Designing product brief and proof of concept.
- Prototyping.
- Product testing and validation

Teaching Plan (**Theory**)

Week 1:	Principles of design
Week 2:	Distribution of space
Week 3:	Language of proportion and the process of form synthesis
Week 4:	Introduction to orthographic projections in simple positions
Week 5:	Drawing of plan, elevation and section of simple objects to scale, full size, reduced or enlarged
Week 6:	User interface and user experience design elements
Week 7:	Affective Computing in Interface Designs
Week 8:	Design thinking and innovation in product designing
Week 9:	Empathy research
Week 10:	Prototyping
Week 11:	Proof of concept
Week 12:	Product testing
Week 13 & 14:	Product testing and validation

References
1. *Design Basics*, David Lauer, Stephen Pentak, Cengage Learning, 2011
2. *A Textbook of Geometrical drawing,* William Minifie, W.M. Minifie & Company, 1845 (Paperback reprinted in 2007)

VI.5.1 Handling money: Finance management [Theory] [Semester VI] [3 – 1 – 0]

Course Objectives: The objective of this course is to equip students about the basic concepts of financial management, contemporary theories and techniques for making apt decision to run profitable business.

Keywords: Financial Statement Analysis; Fundamental of valuation; Sources of finance; Online Financial Management

Unit I: Basic Concepts of finance- Financial Statement Analysis: Income Statement, Position Statement, Statement of Changes in Owner's Equity, Statement of Changes in Financial Position, Techniques in Financial Statement Analysis, Funds Flow Statement, Cash Flow Statements, Ratio Analysis **(12 lectures)**
Unit II: Fundamental of valuation: assets valuation & investment return, valuation & security option, risk & expected return, cost of capital **(9 lectures)**
Unit III: Sources of finance**,** Investment decision, financing decision, dividend decision, working capital decision **(15 lectures)**
Unit IV: Online Financial Management, Global financial information using Information Technology **(6 lectures)**

Course Learning Outcomes
- Understand the basic principles of finance, their importance, and the importance of ethics and trust.
- Understand the mechanics behind valuation of money
- Discuss the difficulty encountered in finding profitable projects in competitive markets and the importance of the search.
- Determine whether a new project should be accepted or rejected using the payback period, the net present value, the profitability index, and the internal rate of return.
- Explain how the capital-budgeting decision help in deciding investment option
- Understand the relationships among operating, financial, and combined leverage.
- Discuss the concept of an optimal capital structure.
- Analyse the risk–return trade-off involved in managing working capital and net working capital.
- Understand and classified the sources of long term finances.
- Role of IT in disseminating information from financial market and institutions player.

Teaching Plan (**Theory**)

Week 1:	Goal And Function Of Finance
Week 2:	Financial Statement Analysis :Income Statement, Position Statement, Statement Of Changes In Owner's Equity, Statement Of Changes In Financial Position,
Week 3:	Techniques In Financial Statement Analysis, Funds Flow Statement
Week 4:	Cash Flow Statements, Ratio Analysis
Week 5:	Fundamental Of Valuation: Assets Valuation & Investment Return, Valuation & Security Option
Week 6:	Valuation & Security Option, Risk & Expected Return
Week 7:	Cost Of Capital
Week 8:	Sources of Finance
Week 9:	Investment Decision
Week 10:	Financing Decision
Week 11:	Dividend Decision
Week 12:	Working Capital Decision

Week 13: Online Financial Management
Week 14: Global Financial Information Using Information Technology

References

1. *Financial Management*, V. K. Bhalla, New Delhi: Anmol Publications, 2009.
2. *Fundamentals of financial Management*, E. F. Brigham, & J. F. Houston, USA: Thomson, 11th Edition, 2007
3. *Financial management, Text, Problems and cases*, M. Y. Khan and P. K. Jain, Tata McGraw Hill, 5th Edition, 2008.
4. *Financial Management*, I. M. Pandey, Vikas Publishing House Pvt. Ltd., 10th Edition, 2007.

VI.5.2 Embedded systems studio – II [Theory] [Semester VI] [3 – 1 – 0]

Course Objective: This interactive learning module intends to provide capabilities and basic understanding of hardware description language (VHDL) and FPGA architecture. It will emphasise on design of advanced robotic systems and embedded devices for varied applications like virtual reality, robot vision and sensors network.

Keywords: VHDL Language; FPGA Architecture; Sensors Network; Vision Robotics

Unit I: VHDL Language - Concurrent and Sequential Assignment – Hardware specification **(12 lectures)**

Unit II: FPGA Architecture – Design of advanced robotic systems and embedded devices for varied applications – Virtual Reality and Computer Vision **(12 lectures)**

Unit III: Sensors Network: Wired and Wireless – Interfacing of various sensors **(6 lectures)**

Unit IV: Vision Robotics – MEMS – Biomedical Sensors – Applications **(12 lectures)**

Course Learning Outcomes:

- Understand the hardware description language(VHDL)
- Application of VHDL on digital system design
- Interfacing the embedded devices with Robotics, MEMS etc.

Teaching Plan (**Theory**)

Week 1: Introduction of VHDL Language
Week 2: and 3: Introduction to different type of statements like concurrent and sequential assignments etc. in VHDL
Week 4: Design different digital circuits using VHDL
Week 5: and 6: Hardware specification; FPGA Architecture
Week 7: and 8: Design of advanced robotic systems and embedded devices for varied applications; Virtual Reality and Computer Vision
Week 9: Sensors Network: Wired and Wireless
Week 10: Interfacing of various sensors
Week 11 and 12: Vision Robotics; MEMS
Week 13 and 14: Biomedical Sensors and its applications

References

1. *Asada, H., and J. J. Slotin*e. Robot Analysis and Control. New York, NY: Wiley, 1986
2. *Leslie Pack Kaelbling*. Learning in Embedded Systems. MIT Press, 2008

VI.5.3 Biological Networks: from Micro to Macro Niche [Theory + Practical] [Semester VI] [3-0-2]

Course Objective: Plethora of networks have been discovered in biological systems which include but are not limited to protein-protein interaction network, gene regulation network, feedback and feed-forward loops, neural network and ecological networks. This module will teach students the concept of networks in Biology.

Keywords: Networks in biological systems; Signal transduction in prokaryotes; Regulatory pathway

Unit I: Importance of pathways and networks in biological systems - Examples of networks from biological systems **(6 lectures)**
Unit II: Ecological network, circulatory network, neurological network, metabolic network, cellular networks and gene regulation networks - Protein interaction networks - Inter and intra-cellular networks **(21 lectures)**
Unit III: Signal transduction in prokaryotes Regulatory pathway and components - Secretion systems in prokaryotes and eukaryotes **(9 lectures)**
Unit IV: Tree of life and macroevolution **(6 lectures)**

Engineering Kitchen Activity [Laboratory]

- Practical exposure to STRING and Cytoscape for building and analysis of protein and gene networks
- Microarray Analysis
- Building Ecological Models
- Neural Networks
- Energy calculations in complex ecological food webs
- Analysis of models related to gene regulation, epigenetic and other networks

Course Learning Outcomes: After completion of this paper the students will have understanding from a macro level (interaction with the environment) to a micro-level (molecular network). The interaction of an individual with the environment through environmental networks, networks in within an organism such as neural and circulatory network, cellular network and molecular network. The students will also be equipped with building and analysing gene and protein interaction networks which are now the most essential components of advanced Molecular Biology.

Teaching Plan (**Theory**)

Week 1:	Importance of pathways and networks in biological systems
Week 2:	Examples of networks from biological systems: ecological network
Week 3:	Circulatory network
Week 4:	Neurological network
Week 5:	Metabolic network,
Week 6:	Cellular networks
Week 7:	Gene regulation networks
Week 8:	Protein interaction networks
Week 9:	Inter and intra-cellular networks
Week 10:	Signal transduction in prokaryotes
Week 11:	Regulatory pathway and components
Week 12:	Secretion systems in prokaryotes and eukaryotes
Week 13 and 14:	Tree of life and macroevolution

References

1. *Molecular Biology of the Cell*, Alberts et al., Garland Science, 5 edition 2007.
2. *Molecular Cell Biology*, Lodish et al., W. H. Freeman & Company, 7 edition, 2012.

3. *Biochemistry & Molecular Biology of Plants*, Buchanan et al., Wiley-Blackwell 1 edition, 2002.
4. *Essentials of Ecology*, Begon, Howarth, Townsend et al., Wiley-Blackwell, 2014.

VI.6.1 e-Business: Organization and Strategy [Theory + Practical] [Semester VI] [3 – 0 – 2]

Course Objectives: This course unit studies how to employ Internet-based IT/IS to do business. It aims to provide participants with opportunities to learn the theory and practice of IT/IS in the business context. It examines the emerging IT and new business models. It will also discuss e-commerce and e-business issues

Keywords: e-business; e-commerce; Information Systems in Business; ICT in B2B: Business models

Unit I: Foundation of e-business and e-commerce, organizational models **(9 lectures)**
Unit II: Role of Information Systems in Business, various approaches in ICT Systems, Emerging models in e-business, e-business and organizational changes **(12 lectures)**
Unit III: Productivity and industries transformations, Perspectives and requirements for starting online business, Processes associated with managing website development ICT in B2B: Business models **(12 lectures)**
Unit IV: Revenues and sources, performance trends, e-business and organization management, Internet Marketing and e-Tailing **(9 lectures)**

Engineering Kitchen Activities [Laboratory]

- Case study discussion on real life cases of the companies that exploited the competitive advantage of IT to leverage their growth and expansion.
- Management quiz on the recent updates of the happenings in the e-business market scenario.
- Case study discussion on the development of new e-business which emerged out of market space and other concepts.

Course Learning Outcomes:

- Understanding the current changing business environment
- Understanding the elements of Business models
- Indepth review and analysis of organisation and functioning of various categories of Business models based on transactions and Business entity
- Functions of e marketing and analysis of all e marketing techniques
- Theoretical framework of e- marketing planning and Web analytics through KPI's
- Awareness of Information systems being used at various managerial levels and across different sectors
- Detailed understanding of important strategic elements of e- SCM ,e-CRM ,e-procurement ,e-security
- Brief Introduction to Financial requirements for a start up and website management
- Creating awareness of change requirement and Understanding Evaluation parameters for e-Business.

Teaching Plan (**Theory**)

Week 1	Understanding e-business , e-commerce and the current changing business environment
Week 2	Classifying the elements of a Business model
Week 3	Analysis of organisation and functioning of Business models based on business entities
Week 4&5	In depth review of evolving business models in various categories based on transaction and content
Week 6	Theoretical framework of e- marketing planning and Web analytics through KPI's
Week 7	Functions of e marketing and analysis of all e marketing techniques
Week 8	Understanding of ICT systems and Information systems being used at various managerial levels and across functional departments

Week 9	Understanding the e-business strategies and implementation
Week 10	Detailed understanding of important strategic elements of e- SCM ,e-CRM , e-procurement
Week 11	Understanding the features of security in e-commerce
Week 12	Introduction to financial requirements for a starting online business and website management
Week 13	Creating awareness of change requirement and understanding its essential elements
Week 14	Understanding Evaluation parameters for eBusiness.

References

1. *Internet Business Models and Strategies: Text and Cases*, A. Afuah and C. L. Tucci, McGraw-Hill., 2003.
2. *Information Technology and the Corporation of the 1990s: Research Studies*, T. J. Allen and M. S. Morton, Oxford University Press, New York 1994.
3. *Strategies for e-Business: Creating Value through Electronic and Mobile Commerce*, T. Jelassi and A. Enders, Prentice Hall, 2005.
4. *Competitive Advantage: Creating and Sustaining Superior, Performance*, Michael E. Porter, The Free Press, New York, 1985.
5. *E-Learning Tools and Technologies*, Horton and Horton, Wiley Publishing, 2003.

VI.6.2 Control Systems [Theory + Practical] [Semester VI] [3 – 0 – 2]

Course Objectives: This interactive learning module intends to provide capabilities and basic understanding of functionality and control of a system or a device. It will emphasise on the conceptual know how of the behavioral aspects and mechanism of different machines, equipment or a system, their manageability, efficiency and performance as per controlled parameters.

Keywords: Control System; Frequency domain; Time domain; PID Controller

Unit I: Introduction to Control Systems - Analysis and design objectives - The design process - Classification and modeling of control systems **(9 lectures)**
Unit II: Modeling in the frequency domain - Modeling in the time domain - Time response - Reduction of multiple subsystems **(9 lectures)**
Unit III: Signal flow graphs - Mason's rule. Stability - Routh Hurwitz Criterion - Steady state errors - Root locus techniques - Frequency Response Techniques **(12 lectures)**
Unit IV: Design via state space -– Non-linear analysis – PID Controller and its applications **(12 lectures)**

Engineering Kitchen Activity [Laboratory]

- Designing the model of a DC motor.
- Design of controllers for speed and position control
- Compensator design
- Circuit simulation
- State space model design.
- Design of temperature controller.
- Hands on experiments with PID controller
- Innovation Project

Course Learning Outcomes:

- Able to understand the building blocks of basic and modern control systems.
- A good understanding of the concept of stability analysis of control systems in both time and frequency domain.
- A good understanding of the concept of MATLAB and SIMULINK toolbox to simulate the control systems.
- Learn how to use different controllers for a given problem.

- Able to perform comparative study of electrical systems using simulation software - Multisim, Eagle, LTSpice and experimental set-up.
- Understand the complex mathematical operations associated with building blocks of various control systems.

Teaching Plan (**Theory**)

Week 1:	Introduction to control systems; Analysis and design objectives
Week 2 and 3:	The design process; Classification and modeling of control systems
Week 4:	Modeling in the frequency domain
Week 5:	Modeling in the time domain; Time response
Week 6:	Reduction of multiple subsystems
Week 7:	Signal flow graphs; Mason's rule
Week 8 and 9:	Stability; Routh-Hurwitz criterion; Steady state errors
Week 10:	Root locus techniques; Frequency response techniques
Week 11:	Design via state space
Week 12:	Non-linear analysis
Week 13 and 14:	PID controller and its applications

References

1. *Control Systems Engineering, 6th Edition*, Norman S Nise, Wiley, 2011.
2. *Linear Control Systems With MATLAB Applications, 11th Edition,* B. S. Manke, Khanna Publishers, 2013
3. *Discrete-Time Control Systems,* K. Ogata, Prentice Hall, 1995.
4. *Control Tutorials for MATLAB and Simulink,* W. Messner and D. Tilbury, Addison-Wesley, 1998.

VI.6.3 Genes to Genomes [Theory + Practical] [Semester VI] [3-0-2]

Course Objective: From classical Mendelian inheritance to non-Mendelian epistasis to modern Genomics, this module is all about the genes. The analysis of pedigree, linkage and ploidy gets amalgamated with genome, transcriptome and non-coding RNAs in this course which is traditional yet renewed.

Keywords: Gene interaction; Genetics and diseases; Genomes; Epigenetics; Gene expression

Unit I: Discovery of the gene concept - Mendelian and non-Mendelian inheritance - Gene interaction - Epistasis - Linkage and recombination **(12 lectures)**
Unit II: Population genetics and diseases - Genomes (Organization of pro and eukaryotic Genome and importance of junk DNA, Characteristics, Genome mapping techniques, Genome evolution) **(15 lectures)**
Unit III: Epigenetics - Transposable elements **(6 lectures)**
Unit IV: Coding and non-coding RNA - Gene expression **(9 lectures)**

Engineering Kitchen Activity [Laboratory]

- Punnett square, T-test
- Analysis of gene mapping
- Pedigree analysis
- Calculations to understand genome evolution
- Mathematical equations and models for prediction of epigenetic mechanism and inheritance

Course Learning Outcomes: This paper deals with genetics and genome structures of various organisms. This is a unique paper where classical genetics is combined with modern genomics.

Upon completion of the course, the student will be able

- To understand Mendelian and non-Mendelian Genetics
- To create linkage map and to analyse pedigree chart
- To interpret epistasis and gene interactions at various levels
- To grasp epigenetics and population genetics
- To know the structural and functional aspect of genome and proteome

Teaching Plan (**Theory**)

Week 1:	Discovery of the gene concept
Week 2:	Mendelian and non-Mendelian inheritance
Week 3:	Genomes Gene interaction
Week 4:	Epistasis - Linkage and recombination
Week 5:	Population genetics and diseases
Week 6:	Organization of pro and eukaryotic Genome
Week 7:	importance of junk DNA, Characteristics
Week 8:	Genome mapping techniques
Week 9:	Genome evolution
Week 10:	Epigenetics
Week 11:	Transposable elements
Week 12:	Coding and non-coding RNA
Week 13 and 14:	Gene expression.

References

1. *Introduction to Genetic Analysis*, Griffiths et al., W H Freeman & Company, 10 edition, 2010.
2. *Genomes*, TA Brown, Garland Science, 3 edition, 2006.
3. *Molecular Biology of the Cell*, Alberts et al., Garland Science, 5 edition 2007.

SEMSTER – VII

VII.1 Algorithms for Computational Mathematics: Numerical Methods [Theory + Practical] [Semester VII] [3 – 0 – 2]

Course Objective: In practical scenarios, the governing mathematical models are usually too complex to be solved analytically and numerical techniques become the only way out to approximate the solutions. This paper aims to teach the student solutions of nonlinear equations in one variable with error analysis, interpolation and approximation, numerical differentiation and integration, direct methods for solving linear systems, numerical solution of ordinary differential equations. By the end of this paper, students should have the ability to compare the computational methods for advantages and drawback and choose the suitable computational method among several existing methods for underlying physical problem. In this paper, students will write codes in C/C++ for implementation of numerical methods.

Keywords: Nonlinear Equations; System of nonlinear equations; Interpolation; Numerical integration and differentiation

Unit I: Solving Nonlinear Equations - Graphical method - Bracketing and Non-bracketing approach. - Bisection, Method of false position, Iterative method, Newton-Raphson method and Secant method - Errors and rate of convergence **(12 lectures)**
Unit II: Matrix notation of a system of linear equations - Gaussian elimination and Gauss-seidel method – Pivoting - Row-echelon form - LU factorization - Cholesky's method - ill-conditioning – norms - Solution of a system of nonlinear equations **(9 lectures)**
Unit III: Polynomial interpolation - Forward, Backward and Divided differences - Piecewise linear and Cubic Spline interpolation - Errors in interpolation **(9 lectures)**
Unit IV: Newton-Cotes Integration Formula - Trapezoidal and Simpson's rules - Gaussian quadrature - error formulae - Euler, Modified Euler and Runge-Kutta methods for solution of differential equations - Power method, QR method, Gershgorin's theorem for Eigen Value problems **(12 lectures)**

Engineering Kitchen Activity [Laboratory]

- Writing C/C++ programs for finding root of the equations using Bisection, Newton-Raphson, Iterative and Secant methods
- Writing C/C++ programs for solving system of linear equations
- Writing C/C++ programs for interpolation, forward, backward and divided difference
- Writing C/C++ programs for methods of numerical integration
- Writing C/C++ programs for Euler and Runge-Kutta methods

Course Learning Outcomes: After completing this course, student should be able to;

- Understand the need of numerical techniques and their importance in real situations
- Learn different techniques of solving non-linear equations such as Bisection method, Newton Raphson method, Regula falsi method, Secant method & Iterative methods
- Analyze errors associated with these methods and their rate of convergence
- Learn Gauss elimination, Gauss seidel, LU decomposition methods for solving system of linear equations with pivoting concepts
- Learn polynomial interpolation, linear and cubic spline interpolations
- Analyze errors of interpolation
- Conceptualize numerical integration and errors associated with it
- Learn Euler's method and Runge-Kutta method for numerical solution of differential equations
- Write programs of all these numerical methods in C/C++

Teaching Plan (**Theory**)

Week 1	Solving Nonlinear Equations ; Graphical method ; Bracketing and Non-bracketing approach
Week 2	Bisection Method; Method of false position
Week 3	Iterative method; Newton-Raphson method and Secant method
Week 4	Errors and rate of convergence for above mentioned techniques
Week 5	Matrix notation of a system of linear equations ; Gaussian elimination and Gauss Seidel method
Week 6	Pivoting ;Row-echelon form; LU factorization; Cholesky's method ; ill-conditioning; Norms
Week 7	Solution of a system of nonlinear equations
Week 8	Polynomial interpolation; Forward, Backward and Divided difference
Week 9	Piecewise linear and Cubic Spline interpolation
Week 10	Errors in interpolation
Week 11	Newton Cotes Integration Formula; Trapezoidal and Simpson's rule
Week 12	Gaussian quadrature; Error formulae
Week 13	Euler; Modified Euler and Runge-Kutta methods for solution of differential equations
Week 14	Power method; QR method; Gershgorin's theorem for Eigen Value problems

References

1. *Applied Numerical Analysis*, C. F. Gerald and P. O. Wheatly, Pearson Education India, 2007.
2. *Introduction to Applied Numerical Ananlysis,* R. W. Hamming, Dover Publications, 2012.
3. *Elementary Numerical Analysis- An Algorithmic Approach*, S. D. Conte and Carl de Boor, McGraw-Hill, 1980.
4. *Numerical Recipes: The Art of Scientific Computing*, 3rd Edition, William H. Press, Saul A. Teukolsky, William T. Vetterling, Brian P. Flannery, Cambridge University Press, 2007

VII.2 Software Engineering and Project Management [Theory + Practical] [Semester VII] [3 – 0 – 2]

Course Objectives: This course objective is to train students in developing software and large scale software products in a systematic manner through requirement analysis, design principles, quality assurance, software process models, estimation of schedules, productivity and cost.

Keywords: Software Engineering; Software Process Models; Scheduling Estimation Models; Productivity Estimation

Unit I: Introduction to software Engineering – Software Engineering Principles – Software metrics – Software development life-cycle **(12 lectures)**
Unit II: Software Process Models – Software Requirement Process -– System Design – Testing **(12 lectures)**
Unit III: Scheduling Estimation Models **(6 lectures)**
Unit IV: Productivity Estimation – Cost Estimation – Schedule Estimation – Risk Management – Case Study **(12 lectures)**

Engineering Kitchen Activity [Laboratory]

- Analysis of a desktop/enterprise Software Applications under lens of software design fundamentals
- Requirement gathering, verification and specification of a new Software Project
- Creating Prototypes and outlines of problems in the frame of Software engineering aligned with design methodologies
- Reverse engineering management aspects any Open Source Software Project and identify Software

- Software Projects sign off with Project Charter and management of project plans
- Hands on Experiment on Requirement Management, Deliverable attributes of Software projects
- Design a Software Application, Product, and Service and integrate with existing system
- Estimation of Costing of Software, Time sheet management in estimation of Effort, Resource Management
- Design of User Guides, Software Manuals, Update Documentation, Release Guides, Deployment Guides, FAQs
- Basic Understanding on use of Agile & Scrum
- Innovation Project

Course Learning Outcomes:

- Will have understanding of Software Engineering basics.
- Will have understanding of Software Process Models.
- Will have understanding of Software Requirement Process.
- Will have understanding of System Design.
- Will have understanding of Testing Approaches.
- Will have understanding of Scheduling Estimation.
- Will have understanding of Productivity Estimation.
- Will have understanding of Cost Estimation.
- Will have understanding of Risk Management.

Teaching Plan (**Theory**)

Week 1 and 2:	Introduction to Software Engineering; Software Engineering Principles
Week 3 and 4:	Software metrics; Software development life-cycle
Week 5 and 6:	Software Process Models; Software Requirement Process
Week 7 and 8:	System Design Process; Software Testing
Week 9 and 10:	Scheduling Estimation Models
Week 11 and 12:	Productivity Estimation; Cost Estimation
Week 13 and 14:	Schedule Estimation; Risk Management

References:

1. *Requirements Risks Can Drown Software Projects*, Leishman and Cook, Computer (November 2001).
2. *Software Engineering: A Look Back and A Path to the Future.* Leveson, Nancy, December 14, 1996. 3. Applied Software Project Management, Andrew Stallman & Jennifer Greene, O`Reilly, 2005.
3. *R . S. Pressman, "Software Engineering – A practitioner's approach",* 5th Ed., McGraw Hill Int. Ed., 2001.
4. *K. K. Aggarwal&Yogesh Singh, "Software Engineering",* 2nd Ed., New Age International, 2005.

VII.3.1: Computer Language Design & Engineering [Theory] [Semester VII] [3 – 1 – 0]

Course Objectives: The objective is to introduce the students the basic techniques that underlie the practice of Compiler Construction. The course will introduce the theory and tools that can be standardly employed in order to perform syntax-directed translation of a high-level programming language into executable code.

Keywords: Micro programming; Lexical analyzer; Tokens; Parsing; Code generation

Unit I: Micro programming - Function and structure of compilers	**(9 lectures)**
Unit II: Lexical analyzer – Tokens – Parsing – Type system	**(12 lectures)**
Unit III: Run time environment	**(9 lectures)**
Unit IV: Code generation and optimization – Intro Optimization – XML parser	**(12 lectures)**

Course Learning Outcomes:

- Introduction to the compilers and their components
- Basics of language design and requirements
- Learning about several types of languages and their advantages and disadvantages
- Understanding various phases of the compiler and their practical implementation.
- Practical demonstration of tokenization, parsing and lexical analyses
- Understanding and implementation of the Runtime environment
- Learning about Code generation and code optimization using C, C++ or Java as an example.

Teaching Plan (**Theory**)

Week 1:	Language design basics
Week 2:	Micro programming
Week 3:	Function and structure of compilers
Week 4:	Lexical analyzer; Design of a lexical analyzer generator; context free grammars
Week 5:	Tokens; Parsing; Type system
Week 6:	Top down parsing; recursive descent and predictive parsing; LL(k) parsing
Week 7:	Bottom up parsing; LR parsing; handling ambiguous in bottom up parsers
Week 8:	Top down and bottom up approaches; data types; mixed mode
Week 9:	Expression; subscripted variables; sequencing statement; subroutines
Week 10:	Functions: parameters calling; subroutines with side effects
Week 11:	Syntactic analysis
Week 12:	Run time environment; Code generation and optimization
Week 13 and 14:	XML parser

References:

1. *Engineering a Compiler*, Cooper, K.D. and Torczon, L., MorganKaufmann. 2012
2. *Parsing Techniques: A Practical Guide*, Dick Grune, Ceriel J.H. Jacobs, Springer, 2007
3. *Compilers: Principles, Techniques and Tools*, by Aho, Sethi, Ullman, Addison-Wesley Pub Co, 1986.

VII.3.2: Making Society Smart through Computational Social Systems [Theory] [Semester VII] [3 – 1 – 0]

Course Objectives: This course gives to students basic computational understanding to create knowledge and scientific conclusions in an interdisciplinary manner in the several domains of the real world such as Social Network, Media, Information Systems, E-governance, Smart cities, Digital humanities etc.

Keywords: Social networks analysis; Digital Humanities; Technological Ethics; Security; Urban planning

Unit I: Media & Society **(9 lectures)**
Unit II: Social networks analysis – Digital Humanities – Technological Ethics – Privacy & Security **(12 lectures)**
Unit III: Human Dynamics **(9 lectures)**
Unit IV: Urban planning – Transportation analysis – Financial & business analytics – Health analytics – Smart cities – Smart information systems – Governance **(12 lectures)**

Engineering Kitchen Activity [Laboratory]

- Projects for understanding Social networks.
- Projects for patterns analysis in Digital sociology.
- Projects on Privacy and Security aspects.
- Hands on experiments for Urban planning techniques.
- Projects on Intelligent transportation systems.

- Hands on experiments for problem solving in Smart Cities and Smart governance.
- Innovation Project.

Course Learning Outcomes: The course will have following Course Learning Outcomes.

- Will have understanding of Social networks.
- Will have understanding of the important aspects of Digital humanities.
- Will have understanding of Privacy and Security related issues.
- Will have understanding of applying intelligent approaches for problems in Smart Cities.
- Will have understanding of Intelligent transportation systems.
- Will have understanding Information Systems and Smart governance.

Teaching Plan (**Theory**)

Week 1 and 2	Introduction to Computational Social Systems
Week 3 and 4	Logic of Social Inquiry
Week 5 and 6	Fundamentals of Social Networks Analysis
Week 7 and 8	Digital Humanities; Technological Ethics Privacy & Security
Week 9 and 10	Data and Technology Driven Decisions; Projects planning and execution in social context
Week 11 and 12	Smart Living Environment; Smart Cities; e-Governance: Adoption and Challenges
Week 13 and 14	Information Technology Systems; Management Information Systems

References

1. *Bit by Bit: Social Research in the Digital Age*, Matthew Salganik, 2013
2. *Media and Society, Sixth Edition* Michael O'Shaughnessy, Jane Stadler, and Sarah Casey
3. *Digital Sociology*, Deborah Lupton, 2014
4. *Smart Sustainable Cities of the Future the Untapped Potential of Big Data Analytics and Context–Aware Computing for Advancing Sustainability*, Bibri, Simon Elias, 2018.

VII.3.3: Introduction to Natural Language Processing [Theory] [Semester VII] [3 – 1 – 0]

Course Objectives: This course objective is to train students in advanced understanding of NLP, Deep learning approaches and their implementation. In addition, the course introduces the deep learning framework such as Tensor Flow and solve a real-world problem through projects on sentiment analysis, sentence classification and speech recognition.

Keywords: Deep Learning; Word Vector Representations; Machine Translation; Speech recognition

Unit I: Advanced concepts in NLP – Deep Learning Approaches **(9 lectures)**
Unit II: Simple Word Vector Representations-Advanced word vector representations – Named entity recognition – Introduction to TensorFlow-Language Modeling **(12 lectures)**
Unit III: Machine Translation – Parsing – Sentiment Analysis **(9 lectures)**
Unit IV: Sentence Classification – Speech recognition – Advanced Machine Translation **(12 lectures)**

Engineering Kitchen Activity [Laboratory]

- Projects for understanding Natural language processing.
- Hands on experiments of Deep learning approaches.
- Hands on experiments for Sentiment analysis in Media.
- Hands on experiments for Speech recognition.
- Hands on experiments for Emotion recognition.
- Projects on Machine Translation.
- Innovation Project.

Course Learning Outcomes:

- Will have deep and advanced understanding of Natural Language Processing concepts.
- Will have experiment level knowledge of Deep learning approaches.
- Will have understanding of real world project on NLP in text, audio or video.
- Will have understanding of NLP applications in Emotion recognition, Speech recognition, translation etc.

Teaching Plan (**Theory**)

Week 1:	Advanced concepts in NLP-1: Deep Learning Approaches -1: Deep Feed Forward network; regularizations; training deep models; dropouts
Week 2:	Advanced concepts in NLP-2: Convolutional Neural Network; Recurrent Neural Network; Deep Belief Network
Week 3:	Deep Learning Approaches-2: Object recognition; sparse coding; computer vision
Week 4:	Simple Word Vector Representations: word2vec; GloVe
Week 5:	Advanced word vector representations: language models; softmax; single layer networks
Week 6:	Neural Networks and backpropagation for Named entity recognition
Week 7:	Language Modeling: Recurrent neural networks for language modeling and other tasks
Week 8:	Machine Translation: GRUs and LSTMs
Week 9:	Introduction to TensorFlow
Week 10:	Sentiment Analysis and summarization; Sentence Classification
Week 11:	Advanced Machine Translation; User Interfaces; Man-Machine Interfaces;
Week 12:	Natural language Querying Tutoring and Authoring Systems
Week 13 and 14:	Advanced Speech recognition; Commercial use of NLP, Semantic Interpretation; Information Retrieval

References

1. *Foundations of statistical natural language processing*, Manning, C. D., Manning, C. D., & Schütze, MIT press, 1999.
2. *Speech and language processing: An introduction to natural language processing. Computational linguistics, and speech recognition*, Jurafsky, D, 2010.
3. *Deep Learning (Adaptive Computation and Machine Learning),* Ian Goodfellow , Yoshua Bengio , Aaron Courville, Francis Bach, 2016.
4. *Deep Learning for Computer Vision with Python*, Adrian Rosebrock, 2018.

VII.4 Visual arts & aesthetics [Theory] [Semester VII] [2 – 0 – 0]

Course Objective: This interactive learning module intends to provide basic appreciation of various forms of art and aesthetics, its cultural influence, and how such concepts are to be integrated while designing UI/UX.

Keywords: Visual art; Aesthetics; Art, technology and society

Unit I: Introduction to media art, computer art, digital art and interactive art **(12 lectures)**
Unit II: Aesthetic strategies in processual art - Art, technology and society - Interaction as aesthetic experience **(9 lectures)**
Unit III: Aesthetic of interaction in digital art - Aesthetic and new media **(6 lectures)**
Unit IV: Interpreting visualizations : : Visualizing interpretations - Case studies **(15 lectures)**

Outcome:

- Concept of art and aesthetics in communication.

- How to use art and aesthetic sensibilities in digital media technologies, advertisement, and communication.
- Practical case studies for skill enhancement.
- Learning integration of art and technology for real life experiences.

Teaching Plan (**Theory**)

Week 1:	Introduction to media art
Week 2:	Introduction to computer art
Week 3:	Introduction to digital art
Week 4:	Introduction to interactive art
Week 5:	Aesthetic strategies in processual art
Week 6:	Art, technology and society
Week 7:	Interaction as aesthetic experience
Week 8:	Aesthetic of interaction in digital art
Week 9:	Aesthetic and new media
Week 10:	Interpreting visualizations
Week 11:	Visualizing interpretations
Week 12:	Case studies
Week 13 and 14:	Case studies

References

1. *Aesthetics of Interaction in Digital Art*, Katja Kwastek, MIT Press, 2013
2. *Graphesis: Visual forms of knowledge production*, Johanna Drucker, Harvard University Press, 2014.
3. *SpecLab: Digital Aesthetics and Projects in Speculative Computing*, Johanna Drucker, University of Chicago Press, 2009

VII.5.1 Environment Management [Theory] [Semester VII] [3 – 1 – 0]

Course Objective: Provides an understanding of how to identify and evaluate the environmental impacts of developmental projects or product/service. Understanding the nature of environmental impact and minimizing the impact within the context of Environmental management. It demonstrates the types of information required for assessing the impacts of a proposal on specific environmental parameters. To impart knowledge of geospatial modelling in evaluating and mitigating the environmental impacts.

Keywords: Satellite remote sensing; Geographical information system (GIS); Satellite image processing; Waste management; Sustainable development

Unit I: Introduction to Environmental Impact Assessment (EIA) and Environmental Management (EM). EIA: Scoping, Public consultation, Expert appraisal committee and Environmental clearance of various projects; Introduction to Satellite remote sensing and Geographical information system **(12 lectures)**
Unit II: Satellite image processing: Land use Land cover, Spectral bands of vegetation through Normalized difference vegetation index (NDVI), Ecosystem modelling: Satellite topographical data) and NDVI, Urbanization, Urban Planning and Growth - Central Place Theory **(12 lectures)**
Unit III: Geometry and Ordering, Burgess Model for City Planning, Growth Pole and Growth Centre Theory and Demographic Transition Mode, Waste Management; Municipal Solid Waste Management, Hazardous Waste Management & Radioactive Waste Management, Waste Management: Physicochemical Treatment of Solid and Hazardous Waste, Biological Treatment of Solid and Hazardous Waste & landfill design **(12 lectures)**
Unit IV: Environmental management tools and techniques of sustainable development. Environmental Law **(9 lectures)**

Course Learning Outcomes: This paper deals with various tools and techniques to assess environmental impacts caused by anthropogenic activities. Upon completion of the course the students would be able to-

- Have basic knowledge of satellite remote sensing and its application in environmental science.
- Have knowledge of Environmental Impact Assessment (EIA) & Environmental laws in India.
- Able to use Geospatial software (GIS).
- Able to prepare basic maps e.g., elevation, vegetation etc.
- Classify Land use and Land cover through satellite images.
- Assess urbanization through spectral band index.
- Able to quantify the complex environmental impacts through GIS.

Teaching Plan (**Theory**)

Week 1:	Introduction to Environmental Impact Assessment (EIA) and Environmental Management (EM).
Week 2:	EIA: Scoping, Public consultation, Expert appraisal committee and Environmental clearance of various projects.
Week 3:	Introduction to Satellite remote sensing and Geographical information system.
Week 4:	Introduction to Satellite remote sensing and Geographical information system.
Week 5:	Satellite image processing: Land use Land cover
Week 6:	Spectral bands of vegetation through Normalized difference vegetation index (NDVI).
Week 7:	Ecosystem modelling using Satellite topographical data (DEM) and NDVI
Week 8:	Urbanization and its hazards, Urban Planning and Growth - Central Place Theory
Week 9:	Geometry and Ordering, Burgess Model for City Planning, Growth Pole and Growth Centre Theory and Demographic Transition Mode.
Week 10:	Waste Management; Municipal Solid Waste Management, Hazardous Waste Management & Radioactive Waste Management.
Week 11:	Waste Management: Physicochemical Treatment of Solid and Hazardous Waste, Biological Treatment of Solid and Hazardous Waste & landfill design.
Week 12:	Environmental management tools and techniques of sustainable development.
Week 13 and 14:	Environmental Law.

References

1. *Environmental Management: Principles and Practice* (Routledge Environmental Management Series), Chris Barrow, Routledge, 2003.
2. *Environmental Management in Organizations: The IEMA Handbook*, John Brady, Alison Ebbage and Ruth Lunn, Earthscan, Washington, DC., 2011.
3. *Essentials of Environmental Management*, Paul Hyde and Paul Reeve, IOSH Services Ltd. (U. K.), 2004.
4. *Textbook of Environmental Studies*, Erach Bharucha, UGC
5. *Fundamental Concepts in Environmental Studies*, D D Mishra, S Chand & Co Ltd

VII.5.2 Engineering at Molecular Scale: Devices and Nanotechnology [Theory + Project] [Semester VII] [3 – 1 – 0]

Course Objective: This module provides interactive learning of nano-science and its applications. It emphasizes to provide learning in material science, medical, photonics, optical, electronic and magnetic devices at nanoscale. It intends to enlighten about identification, fabrication and characterization of nano based devices

Keywords: Optical devices; Nanoscale photonic devices; Sensor Technology; Nanoscale CMOS design

Unit I: Optical devices, electronic devices, liquid crystal and magnetic devices and their functionality-Spintronic devices (including spin valves and MRAM devices) - Nanoscale semiconductor electronic devices - CMOS at sub-15nm gate length, Carbon nanotubes, III-V and wide-bandgap devices - Devices for quantum computing **(12 lectures)**

Unit II: Nanoscale photonic devices - Basic properties of liquid crystals - Molecular properties of the organic materials and their use in current production and research level electronic devices - Thin Films Growth and Epitaxy, Characterization of Nanomaterials **(9 lectures)**
Unit III: Introduction to Sensor Technology - CMOS scaling challenges at nanoscale regimes - Device technologies for sub 100nm CMOS - Device scaling and ballistic MOSFET **(12 lectures)**
Unit IV: Nanoscale CMOS design, Nanoscale circuits - Non classical CMOS **(9 lectures)**

Course Learning Outcomes:

- For students, this course on devices and nanotechnology becomes very important, as this exposes them to the most versatile and interdisciplinary world of nanotechnology, which is emerging as a branch having its relevance in various fields like medical, biotechnological, industrial, forensic science, material science etc.
- Students would be exposed to the relevant concepts of nanomaterials, their identification and characterization along with studying their applications in optical, electronic and magnetic devices.
- Nano based devices and sensors are a major attraction for students, because this not only make them understand about the basic principles related to them, but it also inculcates the skills among students, which are required to developed nano-based formulations or devices as a whole.

Teaching Plan (**Theory**)

Week 1:	Optical devices, electronic devices
Week 2:	Liquid crystal and magnetic devices and their functionality; Spintronic devices (including spin valves and MRAM devices)
Week 3:	Nanoscale semiconductor electronic devices
Week 4:	CMOS at sub-15nm gate length, Carbon nanotubes, III-V and wide-bandgap devices; Devices for quantum computing
Week 5:	Nanoscale photonic devices
Week 6:	Basic properties of liquid crystals; Molecular properties of the organic materials and their use in current production and research level electronic devices
Week 7:	Thin Films Growth and Epitaxy, Characterization of Nanomaterials,
Week 8:	Introduction to Sensor Technology
Week 9:	CMOS scaling challenges at nanoscale regimes
Week 10:	Device technologies for sub 100nm CMOS
Week 11:	Device scaling and ballistic MOSFET
Week 12:	Nanoscale CMOS design,
Week 13 and 14:	Nanoscale circuits; Nonclassical CMOS.

References

1. *Nanotechnology for Electronic Materials and Devices,* Korkin, A.; Gusev, E.; Labanowski, J.K.; Luryi, S. Springer, 2007
2. *Electronics Composite -Modeling, Characterization, Processing, and MEMS Applications*-Minoru Taya, Cambridge University Press, 2008
3. *Nanotechnologies for Future Mobile Devices* - Tapani Ryhänen, Mikko A. Uusitalo, Olli Ikkala, Asta Kärkkäinen, Cambridge University press, 2010
4. *High-Speed Heterostructure Devices From Device Concepts to Circuit Modeling* **-** Patrick Roblin, Hans Rohdin, Cambridge University press, 2006

VII.5.3 Biodefense and Bioengineering [Theory + Tutorial] [Semester VII] [3-1-0]

Course Objective: In this module immunology meets infection and drugs meet vaccines and immunomodulation. From different defense techniques in our body to strategies of medicine and vaccination are dealt in this course. The students will learn about mechanism of infection processes to thwart the adaptive and acquired immunity.

Keywords: Immunity; Pathogens; Metabolites; Immuno-diffusion

Unit I: Innate and acquired immunity - Passive and active immunity - T cell and B cell mediated immunity - antigen processing, antibody structure and classes **(12 lectures)**
Unit II: Emerging pathogens and host-pathogen interactions - Autoimmune diseases - Cancer and Tuberculosis **(9 lectures)**
Unit III: Secondary metabolites in plants - Innate immunity in insects and plants - Toll Receptors - Engineered single chain antibody - Techniques of biodefense such as RIA, ELISA, Immuno-fluoroscence - production and purification of monoclonal and polyclonal antibody and preparation of immuno-affinity columns **(12 lectures)**
Unit IV: Immuno-diffusion - Rocket electrophoresis - Doping test - Pregnancy test **(9 lectures)**

Course Learning Outcomes: After completion of this paper the students will have understanding about the immune system and its components. They will also have understanding about the diversity and capacity of the immune system to produce defense molecules against newly arising pathogens. They will also develop understanding about doping test, ELISA, pregnancy test etc. They will be conceptually equipped with techniques such as production of polyclonal and monoclonal antibody and antibody engineering.

Teaching Plan (**Theory**)

Week 1:	Innate and acquired immunity
Week 2:	Passive and active immunity
Week 3:	T cell and B cell mediated immunity
Week 4:	Antigen processing, antibody structure and classes
Week 5:	Emerging pathogens and host-pathogen interactions
Week 6:	Autoimmune diseases
Week 7:	Cancer and Tuberculosis
Week 8:	Secondary metabolites in plants
Week 9:	Innate immunity in insects and plants - Toll Receptors
Week 10:	Techniques of biodefense such as RIA, ELISA, Immuno-fluoroscence
Week 11:	Production and purification of monoclonal and polyclonal antibody and preparation of immuno-affinity columns
Week 12:	Engineered single chain antibody
Week 13 and 14:	Immuno-diffusion - Rocket electrophoresis - Doping test - Pregnancy test

References

1. *Kuby Immunology*, Owen and Punt, W. H. Freeman & Company, 7 edition, 2013.
2. *Microbiology: an introduction*, Tortora et al., Benjamin Cummings, 11 edirtion 2012.
3. *Immunology and Immunotechnology*, Ashim K Chakravarty, , O.U. P, 1 edition, 2006.
4. *The Biology of Cancer*, Robert Weinberg, Garland Science

VII.6.1 Business automation strategies ERP: Case studies and project in industry [Theory + Practical] [Semester VII] [3 – 0 – 2]

Course Objective: The objective of the ERP Business Transformation Strategy is to modernize and integrate business processes and systems. This “leapfrog” into the future will empower staff and students to access information and provide services through an intuitive and integrated interface.

Keywords: Business Process modeling; ERP; Case studies

Unit I: Business Process modeling, Process Metrics, Overview of Enterprise systems and Business Processes **(12 lectures)**
Unit II: Identify and understand the functionalities in an ERP system, issues of ERP architecture, design development **(9 lectures)**
Unit III: Performance & Capabilities Gaps, Business Process mapping & redesign **(9 lectures)**
Unit IV: Advanced ERP modules, Industry specific case study, Project implementation **(12 lectures)**

Course Learning Outcomes:

- Have a clear understanding of the Business Enterprise and it's processes
- Understanding of ERP system and its advantages
- Indepth analysis of various ERP modules
- Challenges of Integrating these modules with the Legacy systems
- Objectively envision various ERP implementation process
- Identify ERP Market Space in various sectors and verticals
- Detailed Analysis of Total cost of ownership of ERP.
- Understanding ERP architecture and Project teams
- Identify and measure different performance metrics for Processes
- Understanding organisational change management that should be accompanied for efficient implementation of ERP

Teaching Plan (**Theory**)

Week 1	Overview of Enterprise systems and Understanding cross functional Business Processes
Week 2	Business process mapping and redesign
Week 3	Business Process Reengineering
Week 4	Identify and measure different performance metrics for processes
Week 5	Understanding of ERP system and its functionalities
Week 6&7	Indepth analysis of various ERP modules and review challenges of Integrating these modules with the Legacy systems
Week 8	ERP implementation processes and analyse their advantages and disadvantages
Week 9	Detailed Analysis of Total cost of ownership of ERP
Week 10	Understanding ERP architecture and Project teams
Week 11	Identify ERP Market Space in various sectors and verticals and ERP selection criterion
Week 12	Understanding organisational change management for efficient implementation of ERP
Week 13	ERP Maintenance
Week 14	Advanced ERP modules

References

1. *Bradford, M.* (2010). Modern ERP Systems: Select, Implement and Use Today's Advanced Business Systems. 2nd Edition, Lulu.
2. *Desai, S., Srivastava, A.* (2013). ERP to E^2RP A case Study Approach. Eastern Economy Edition: PHI Learning Private Limited.
3. *Magal S.*, Word J. Essentials of Business Processes and Information Systems. Wiley.
4. *Sandoe K., Corbitt G., Boykin* R. (2001). Enterprise Integration. Wiley.

VII.6.2 Circuit Analysis and Synthesis [Theory + Practical] [Semester VII] [3 – 0 – 2]
Course Objective: This module is designed to enable the students with skills (i) for analyzing an electronic circuit and (ii) to synthesis a circuit based on practical needs. All necessary theoretical inputs are explained in details to achieve the said objective. Module also explains the calculation methods to determine voltages, currents, power factors and other attributes of electrical circuits.

Keywords: Circuit analysis; Resonance; Phasor diagram

Unit I: Basic circuits analysis - Ohm's Law - Kirchoffs laws - DC and AC Circuits - Resistors in series and parallel circuits -Mesh current and node voltage method of analysis for D.C and A.C. circuits - Phasor Diagram - Power, Power Factor and Energy (**9 lectures)**
Unit II: Network reduction and network theorems for dc and ac circuits - voltage and current division, source transformation - star delta conversion - Thevenins and Nortons Theorem - Superposition Theorem - Maximum power transfer theorem - Reciprocity Theorem - Resonance and coupled circuits – Series, parallel resonance and their frequency response - Quality factor and Bandwidth (**12 lectures)**
Unit III: Self and mutual inductance - Coefficient of coupling - Tuned circuits - Single tuned circuits- Transient response for DC circuits - Transient response of RL, RC and RLC Circuits using Laplace transform for DC input and A.C. with sinusoidal input (**9 lectures)**
Unit IV: Characterization of two port networks in terms of Z,Y and h parameters. Three phase circuits - Three phase balanced / unbalanced voltage sources - Analysis of three phase 3-wire and 4-wire circuits with star and delta connected loads, balanced & unbalanced - Phasor diagram of voltages and currents - power and power factor measurements in three phase circuits (**12 lectures)**

Engineering Kitchen Activities [Laboratory]

- Verification of nodal voltage and mesh current methods for solving circuits.
- Verification of important network theorems.
- Study of the response of the first order R-C and R-L circuits.
- Study of the response of a series and a parallel RLC circuits.

Course Learning Outcomes:

- To understand difference between various types of electric circuits like DC and AC Circuits with Resistors in series and parallel and understanding related basic laws like Ohm's Law, Kirchhoff's laws
- To understand various circuit analysis methods like Mesh current and node voltage method of analysis for D.C and A.C. circuits, Network reduction and network theorems for dc and ac circuits , voltage and current division, source transformation, star delta conversion, Thevenins and Norton's Theorem, Superposition Theorem, Maximum power transfer theorem, Reciprocity Theorem
- To study resonance and coupled L, C, R circuits : Series, parallel resonance and their frequency response , Quality factor and Bandwidth, Self and mutual inductance, Coefficient of coupling ,Tuned circuits , Single tuned circuits- Transient response for DC circuits , Transient response of RL, RC and RLC Circuits using Laplace transform for DC input and A.C. with sinusoidal input
- To learn about characterization of two port networks in terms of Z,Y and h parameters.
- To familiarize students with Three phase circuits: Three phase balanced, unbalanced voltage sources, Analysis of three phase 3-wire and 4-wire circuits with star and delta connected loads, balanced & unbalanced Phasor diagram of voltages and currents, power and power factor measurements in three phase circuits.

Teaching Plan (**Theory**)

Week 1: Basic circuits analysis, Ohm's Law, Kirchoffs laws, DC and AC Circuits, Resistors in series and parallel circuits.
Week 2: Mesh current and Node voltage method of analysis for D.C and A.C. circuits.
Week 3: Phasor Diagram - Power, Power Factor and Energy.
Week 4: Network reduction and Network Theorems for dc and ac circuits, Voltage and Current division.
Week 5-6: Source transformation, Star delta conversion, Thevenins and Nortons Theorem, Superposition Theorem, Maximum power transfer theorem, Reciprocity Theorem.
Week 7: Resonance and coupled circuits, Series and parallel resonance and their frequency response, Quality factor and Bandwidth.
Week 8: Self and mutual inductance, Coefficient of coupling, Tuned circuits, Single tuned

circuits.

Week 9-10: Transient response for DC circuits, Transient response of RL, RC and RLC circuits using Laplace transform for DC input and A.C. with sinusoidal input.
Week 11: Characterization of two port networks in terms of Z, Y and h parameters.
Week 12: Three phase circuits, Three phase balanced / unbalanced voltage sources.
Week 13: Analysis of three phase 3-wire and 4-wire circuits with star and delta connected loads, balanced & unbalanced circuits.
Week 14: Phasor diagram of voltages and currents, Power and power factor measurements in three phase circuits.

References

1. *Linear circuits: analysis and synthesis* - Ayyagari Ramakalyan, Oxford University Press, 2005,
2. *Linear circuit analysis* - Chi Kong Tse, Addison-Wesley, 1998

VII.6.3 Systems Biology [Theory + Practical] [Semester VII] [2-0-4]

Course Objective: This module approaches the biological equations and events as a whole and combines different streams of biosciences to get a bigger picture. From Biological complexity and circuits to neural models and plasticity, from biophysical properties of macromolecules to developmental biology - this module explores cutting edge technologies of biosciences to novel findings that travel to hitherto unexplored fields.

Keywords: Biological complexity; Cognitive and neural modeling; Neural imaging; Synapse and networks

Unit I: Biological complexity - Biological circuits - Bio-physical properties of macromolecules - Bio-molecular interaction analysis - Developmental biology - Data integration and hypothesis generation - Reversible reactions and feedback loops **(8 lectures)**
Unit II: Transient networks, Behavioral network - Cognitive and neural modelling - Memory and Learning - Neural models (vision, memory function, rhythm) - Synapse and networks – Neural plasticity and computational learning **(8 lectures)**
Unit III: Artificial intelligence - Neural imaging **(4 lectures)**
Unit IV: Biological complexity, biological circits - Biophysical properties of macromolecules - Bio-molecular interaction analysis **(8 lectures)**

Engineering Kitchen Activity [Laboratory]

- Gene Regulation/Interaction networks models.
- Intercellular signalling network analysis.
- Creating biological databases and software.
- Small projects integrating different biological parameters.

Course Learning Outcomes: After completion of this paper the students will have understanding about biological networks and organization of biological systems, designing simple organisms. They will be equipped to do perform biological data analysis, protein-protein interaction networks etc. This course will involve developing small projects integrating various database, software and streams of biological sciences

Teaching Plan (**Theory**)

Week 1: Biological complexity - Biological circuits
Week 2: Bio-physical properties of macromolecules
Week 3: Bio-molecular interaction analysis, Developmental biology
Week 4: Data integration and hypothesis generation, Reversible reactions and feedback loops
Week 5: Transient networks, Behavioral network - Cognitive and neural modelling
Week 6: Memory and Learning

Week 7:	Neural models (vision, memory function, rhythm) - Synapse and networks
Week 8:	Neural plasticity and computational learning
Week 9:	Artificial intelligence
Week 10:	Neural imaging
Week 11:	Biological complexity, biological circuits
Week 12:	Biophysical properties of macromolecules
Week 13 and 14:	Bio-molecular interaction analysis.

References

1. *An Introduction to Systems Biology: Design Principles of Biological Circuits*, Uri Alon, Chapman & Hall
2. *Fundamentals of Computational Neuroscience*, Thomas Trappenberg, Oxford University edition, 2010.
3. *Handbook of Systems Biology: Concepts and Insights*, Marian Walhout, Marc Vidal, Job Dekker (Edited), Academic Press; 1 edition, 2012.