Course of Study

B. Tech. (Information Technology & Mathematical Innovations)

Scheme of study and examination

CLUSTER INNOVATION CENTRE
UNIVERSITY OF DELHI

INDEX

Content: B.Tech. (IT & Mathematical Innovations)

B. Tech. (IT & Mathematical Innovations)

Preamble

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 specialization streams – Management, Electronics & Embedded System and Systems Biology – important fields of education with significant interface with Mathematics and IT currently. 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.

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.

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 conducted at Delhi.

COURSE FEE: As notified by the university time to time

B. Tech. (IT & Mathematical Innovations)

COURSE STRUCTURE

Key: T: Theory, L: Lab, P: Project/Internship

Semester I

Paper No.	Interactive Learning Modules (Paper Title)	Credits				Marks			
		T	L	P	Total	T	L	P	Total
I.1	Seeing the world through ***Calculus***. First steps through symbolic mathematics	3	3	0	6	75	75	0	150
I.2	Linearity in Nature: Engineering through ***Linear Algebra***. First steps through numerical algorithms	3	3	0	6	75	75	0	150
I.3	Optimizing memory use through ***Data Structure and Design***	4	0	0	4	100	0	0	100
I.4	The Science and Art of Logic and Programming: **Algorithms**	4	0	0	4	100	0	0	100
I.5	Physics at work I: ***Deconstructing Machines***	3	3	0	6	75	75	0	150
I.6	***Business, Entrepreneurship and Innovation Management***	4	0	0	4	100	0	0	100
I.7	***Environment Science & Ecosystem Management***	2	0	0	2	50	0	0	50
	Grand Total	23	9	0	**32**	575	225	0	800

Key: T: Theory, L: Lab, P: Project/Internship

Semester II

Paper No.	Interactive Learning Modules (Paper Title)	Credits				Marks			
		T	L	P	Total	T	L	P	Total
II.1	Modeling continuous changes through ***ordinary differential equations and complex analysis***	3	3	0	6	75	75	0	150
II.2	Understanding real life situations through ***Discrete Mathematics***	4	0	0	4	100	0	0	100
II.3	Decoding ***Computation Structure & Logic***	4	0	0	4	100	0	0	100
II.4	Reflecting thought processes via ***Object Oriented Programming***	3	3	0	6	75	75	0	150
II.5	Physics at work II: ***Deconstructing devices***	3	3	0	6	75	75	0	150
II.6	Art of ***Communication & Creative Writing***	3	0	0	3	75	0	0	75
II.7	**Knowing specialization streams (Electives)**								
II.7.1	***Business processes and strategic IT alignment***	3	0	0	3	75	0	0	75
II.7.2	***Electronics at work & circuit simulations***	3	0	0	3	75	0	0	75
II.7.3	***Exploring Biology - Systems Approach***	3	0	0	3	75	0	0	75
	Grand Total	23	9	0	**32**	575	225	0	800

Note:

1. 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.

2. At the end of second semester, the student will opt for only one of the streams and will pursue papers meant for that stream in the subsequent semesters.

Key: T: Theory, L: Lab, P: Project/Internship

Semester III

Paper No.	Interactive Learning Modules (Paper Title)	Credits				Marks			
		T	L	P	Total	T	L	P	Total
III.1	Modeling change in the world around us: ***Partial Differential Equations***	4	0	0	4	100	0	0	100
III.2	Handling information through ***Data Modeling & Design***	3	3	0	6	75	75	0	150
III.3	Instructing computing devices: ***Operating System***	4	0	0	4	100	0	0	100
III.4	Language and Communication: ***Computational Linguistics***	4	0	0	4	100	0	0	100
III.5	**Specialization Stream – 1**								
III.5.1	Understanding ***Economic Behavior***: The ***micro*** level	4	0	0	4	100	0	0	100
III.5.2	***Electronics circuit elements and instruments***	4	0	0	4	100	0	0	100
III.5.3	***Integrative Biology***	4	0	0	4	100	0	0	100
III.6	**Specialization Stream – 2**								
III.6.1	***Principles of Management***	4	0	0	4	100	0	0	100
III.6.2	***Electronics circuit elements and instruments – Innovation Lab***	0	4	0	4	0	100	0	100
III.6.3	***Cell: Biochemical and Molecular perspective***	4	0	0	4	100	0	0	100
III.7	Summer Internship : projects drawn from the world around us	0	0	6	6	0	0	150	150
	Grand Total	23	3	6	**32**	575*	75*	150	800

Note:

1. The students will attend papers in III.5 & III.6 only from the opted stream

2. * For students opting for Electronics stream, the total marks for theory in this semester will be 475 and total marks for practical will be 175

3. The student will execute the internship III.7 during the preceding summer break.

Key: T: Theory, L: Lab, P: Project/Internship

Semester IV

Paper No.	Interactive Learning Modules (Paper Title)	Credits				Marks			
		T	L	P	Total	T	L	P	Total
IV.1	Does Nature play dice?: The amazing world of ***probability and statistics***	3	3	0	6	75	75	0	150
IV.2	Understanding Computing ***Systems Architecture***	3	3	0	6	75	75	0	150
IV.3	***Software Engineering***	3	0	0	3	75	0	0	75
IV.4	***Science, Philosophy, Truth: Impact of technology***	3	0	0	3	75	0	0	75
IV.5	**Specialization Stream – 3**								
IV.5.1	Understanding ***Economic Behaviour***: The ***macro*** level	4	0	0	4	100	0	0	100
IV.5.2	***Digital electronics and logic design***	4	0	0	4	100	0	0	100
IV.5.3	***Genes to Genomes***	4	0	0	4	100	0	0	100
IV.6	**Specialization Stream – 4**								
IV.6.1	Bringing Companies and clients together: **Sales & Marketing management**	4	0	0	4	100	0	0	100
IV.6.2	***Digital electronics and logic design*** – Innovation Lab	0	4	0	4	0	100	0	100
IV.6.3	***Flow of information in living systems***	4	0	0	4	100	0	0	100
IV.7	Semester long innovation project	0	0	6	6	0	0	150	150
	Grand Total	20	6	6	**32**	500*	150*	150	800

Note:

1. The student will attend papers in IV.5 & IV.6 only from the opted stream

2. * For students opting for Electronics stream, the total marks for theory in this semester will be 400 and total marks for practical will be 250

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: T: Theory, L: Lab, P: Project/Internship

Semester V

Paper No.	Interactive Learning Modules (Paper Title)	Credits				Marks			
		T	L	P	Total	T	L	P	Total
V.1	Algorithms for Computational Mathematics: ***Numerical Methods***	3	3	0	6	75	75	0	150
V.2	Information exchange in computing devices: ***Data Communication & Networking***	4	0	0	4	100	0	0	100
V.3	Computer and Brain: Knowledge Discovery and ***Artificial Intelligence***	3	0	0	3	75	0	0	75
V.4	***History, culture & civilization***	3	0	0	3	75	0	0	75
V.5	**Specialization Stream – 5**								
V.5.1	Maximizing performance: ***Human Resource management and Organizational Behavior***	4	0	0	4	100	0	0	100
V.5.2	***Embedded systems studio - I***	4	0	0	4	100	0	0	100
V.5.3	***Biological Networks***: from Micro to Macro niche	4	0	0	4	100	0	0	100
V.6	**Specialization Stream – 6**								
V.6.1	Efficient manufacturing process: ***Production and Operations Management***	3	3	0	6	75	75	0	150
V.6.2	***Signals & Systems Engineering***	3	3	0	6	75	75	0	150
V.6.3	***Applied Genomics and Proteomics***: Methods and techniques	3	3	0	6	75	75	0	150
V.7	Industrial mini project	0	0	6	6	0	0	150	150
	Grand Total	20	6	6	**32**	500	150	150	800

Note:

1. The Student will attend papers in V.5 & V.6 only from the opted stream

2. The student will execute the Industrial mini project V.7 during the preceding summer break

Key: T: Theory, L: Lab, P: Project/Internship

Semester VI

Paper No.	Interactive Learning Modules (Paper Title)	Credits				Marks			
		T	L	P	Total	T	L	P	Total
VI.1	Linear Construction of Actions: Engineering through ***Linear Programming and Game Theory***	4	0	0	4	100	0	0	100
VI.2	***Computer Graphics and Visualization***	3	3	0	6	75	75	0	150
VI.3	***Advanced Algorithm Design***	3	0	0	3	75	0	0	75
VI.4	***Art & Design***	3	0	0	3	75	0	0	75
VI.5	**Specialization Stream – 7**								
VI.5.1	Handling money: ***Finance management***	4	0	0	4	100	0	0	100
VI.5.2	***Embedded systems studio – II***	4	0	0	4	100	0	0	100
VI.5.3	***Biodefense and Bioengineering***	4	0	0	4	100	0	0	100
VI.6	**Specialization Stream – 8**								
VI.6.1	***e - Business***: Organization and Strategy	3	3	0	6	75	75	0	150
VI.6.2	***Control systems***	3	3	0	6	75	75	0	150
VI.6.3	***In silico Biology***	3	3	0	6	75	75	0	150
VI.7	Project in Industry, Society and Villages	0	0	6	6	0	0	150	150
	Grand Total	20	6	6	**32**	500	150	150	800

Note:

1. The student will attend papers in VI.5 & VI.6 only from the opted stream

2. Students 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: T: Theory, L: Lab, P: Project/Internship

Semester VII

Paper No.	Interactive Learning Modules (Paper Title)	Credits				Marks			
		T	L	P	Total	T	L	P	Total
VII.1	Fluidity in nature: computational interpretations	4	0	0	4	100	0	0	100
VII.2	***Computer Language Design & Engineering***	3	0	0	3	75	0	0	75
VII.3	***Software Project Management***	3	3	0	6	75	75	0	150
VII.4	***Visual arts & aesthetics***	3	0	0	3	75	0	0	75
VII.5	**Specialization Stream – 9**								
VII.5.1	***Environment Management***	4	0	0	4	100	0	0	100
VII.5.2	Engineering at Molecular Scale: ***Devices and Nanotechnology***	4	0	0	4	100	0	0	100
VII.5.3	Modeling and Simulating Brain Functions: ***Computational Neuroscience***	4	0	0	4	100	0	0	100
VII.6	**Specialization Stream – 10**								
VII.6.1	***Business automation strategies***. ERP. Case studies and project in industry	3	3	0	6	75	75	0	150
VII.6.2	***Circuit Analysis and Synthesis***	3	3	0	6	75	75	0	150
VII.6.3	***Systems Biology***	3	3	0	6	75	75	0	150
VII.7	Industrial mini project, Simulation of real time cases	0	0	6	6	0	0	150	150
	Grand Total	20	6	6	**32**	500	150	150	800

Note:

1. The student will attend papers in VII.5 & VII.6 only from the opted stream

2. Students will execute the Industrial mini project VII.7 during the preceding summer break

Key: T: Theory, L: Lab, P: Project/Internship

Semester VIII

Paper No.	Interactive Learning Modules (Paper Title)	Credits				Marks			
		T	L	P	Total	T	L	P	Total
VIII.1	Industrial Internship/Major Project	0	0	32	32	0	0	800	800
	Grand Total	0	0	32	**32**	0	0	800	800

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.

B. Tech. (IT & Mathematical Innovations)

PROMOTION CRITERIA

1. The minimum marks required to pass in any paper in a semester, whether theory or practical, shall be 40%. For theory paper, the student must secure 40% in the end semester evaluation and 40% in "Internal + end semester evaluation" of the paper.

Nature of paper	Credits	Minimum passing marks requirements
Theory	2	14 marks in end semester written examination and 20 marks in total
	3	22 marks in end semester written examination and 30 marks in total
	4	10 marks in semester long innovation project, 20 marks in end semester written examination and 40 marks in total
Practical	3	12 marks in the innovation project, 18 marks in the lab activities and 30 marks in total
	4	16 marks in the innovation project, 24 marks in the lab activities and 40 marks in total
Internship, Semester long projects,	6	36 marks in mentor assessment and 24 marks in the board evaluation.
Semester long Industrial internship, Major Projects	32	320 marks

2. A student who does not satisfy the criteria (1) above in any paper shall have to repeat the paper. The student shall be awarded ER (Essential Repeat) in that paper.

3. 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.

4. A student who reappears in any paper (theory or practical) shall carry forward the marks of the internal assessment originally awarded to him/her.

5. Total credit in eight semesters is 256. A student passing a paper will earn the total credit assigned to that paper.

6. 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 256 credits during Semester I to Semester VIII.

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

8. A student who does not satisfy criterion (6) is required to repeat a year. However, he/she can retain the marks of all or some of the papers that do not carry an ER.

SPAN PERIOD

The span period to complete the course shall be six 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)

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. Students will be shown the evaluated end semester answer books within ten days of the completion of the end semester evaluation. Any discrepancy may be brought to the notice of ERC. The case will be examined by ERC with one outside expert to be appointed by the Program Coordinator, and the decision of the ERC shall be final.

g. To review and moderate end semester results of each class with a view to maintain uniformity of standard.

h. To prepare the consolidated results semester wise and sending them to the University Examination Branch for declaration of results, and also to ensure reconciliation with university database for future reference and issue of marksheets/transcripts.

EVALUATION

a. The evaluation or assessment for each theory paper with 4 credits shall be based on regular internal assessment throughout the semester (25 marks), a semester long innovation project in the field (25 marks, evaluated as part of the end semester examination) and a final end-semester written examination (50 marks).

b. The evaluation or assessment for each theory paper with 3 credits shall be based on regular internal assessment throughout the semester (20 marks), and a final end-semester written examination (55 marks).

c. The evaluation or assessment for each theory paper with 2 credits shall be based on regular internal assessment throughout the semester (15 marks), and a final end-semester written examination (35 marks).

d. The evaluation or assessment for a laboratory paper with 3 credits shall be based on regular internal assessment throughout the semester (45 marks for laboratory activities and 30 marks for the innovation project).

e. The evaluation or assessment for a laboratory paper with 4 credits shall be based on regular internal assessment throughout the semester (60 marks for laboratory activities and 40 marks for the innovation project).

f. 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 6 credits.

(i) A candidate/group of candidates will be mentored by a teacher OR 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. 60% weightage (90 marks) will be given to the continuous performance (by the mentor) and 40% weightage (60 marks) for the final assessment (by the board of examiners) after the completion of the project.

II. Evaluation of 32 Credits Industrial Internship/Major Project (Semester VIII)

A dissertation should be submitted at the end of VIII semester. However, ERC may grant extension, not exceeding the maximum duration of the semester but not more than six months at a time. 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.

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 + 3]

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 - Integration - Parametric equations of curves, arc length and surface area - Vector valued functions, differentiation and integration of vector valued functions - Sequences, infinite series including Taylor approximations, Power series - 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 - Multiple Integrals, line, surface and volume integrals - Applications of Green's, Stokes and Gauss's Theorem.

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

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 Linearity in Nature: Engineering through Linear Algebra. First steps through numerical algorithms [Theory + Practical] [Semester I] [3 + 3]

Algebra of matrices – 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 - Eigenvalues and eigenvectors, minimal polynomial, Cayley-Hamilton therorem and diagonalisation - Sets, relations, functions - Groups, subgroups - Abstract vector spaces, subspaces - Finite dimensional vector spaces - Linear independence and dependence of vectors, bases, dimension of vector spaces - Finite dimensional inner product spaces - Orthogonal sets and projections, Gram Schmidt process, orthogonal diagonalisation

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

References

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

I.3 Optimizing Memory use through Data Structure and Design [Theory + Project] [Semester I] [4]

Basic concepts - Dynamic optimization - Memory Hierarchy - Hashing - Networks and Graphs - Search - Heaps

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

I.4 The Science and Art of Logic and Programming: Algorithms [Theory + Project] [Semester II] [4]

Algorithmic analysis and modeling - Algorithmic proofs - Computational complexity - Asymptotic notation and analysis - NP Completeness

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.

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

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

Engineering Kitchen Activities [Laboratory]

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

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 + Project] [Semester I] [4]

Understanding Business - Types of Business Activities - Evaluating the Business - Business organization - Starting a Business - Entrepreneurship concept - Entrepreneurial attributes & characteristics – Leadership - Business Plan preparation - B2B and B2C models - Creativity & its components - Invention vs. Innovation - Types of innovation - Innovation and Technology - Innovation policy & IPR - 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] [2]

Relationship between environment and public health - Sustainable development: policy and practices - Biodiversity: Hotspots, Threats, Conservation - Ecosystem: Structure, Function, Energy flow, cycles - Environmental pollution & public health - Mitigation strategies - Policy - Collection and processing of environmental data - IT in ecosystem & environment management - Social and Cultural parameters - Environmental Risk & Impact Assessment.

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 Modeling continuous change through ordinary differential equations and complex analysis [Theory + Practical] [Semester II] [3 + 3]

First order differential equations - Variable separable, homogeneous, linear, exact differential equation - Integrating factors - Existence and uniqueness of solution - 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 - Planar autonomous linear systems with graphical representation - Determination of stability and classification of equilibrium of a planar nonlinear system by linearization - 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 methods applied to differential equations - Analytic functions of a complex variable: Power-series expansions, Laurent expansions and Liouville's theorem - Complex integration - Cauchy Integral Theorem - Residue Theorem and applications to evaluate real integrals.

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

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.

II.2 Understanding real life situation through Discrete Mathematics [Theory + Project] [Semester II] [4]

Combinatorics: Sets, counting of sets - Permutation - Combination - Inclusion - exclusion - Generating functions - Recurrence relations - ***Graph Theory***: Introduction - Basic terminologies

- Graph representation - Euler relation - Isomorphism - Connectivity - Cut vertices and edges - Covering - Euler and Hamilton paths and circuits - Shortest Path Algorithms: Dijkstra's algorithm - Travelling salesman problem - Scheduling problems - Matching - Independent sets - Coloring - **Planar graph**: idea of region - Euler formula - Kuratowski theorem and application - **Tree**: basic terminology, traversal, Prefix code - Idea of data compression: Huffman code - 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 Decoding Computation Structure and Logic [Theory + Project] [Semester III] [4]

Sets - Graphs - Digital abstraction - Automata - Combinatorial Logic - Randomness - Context free languages

References:

1. *Computation Structures*. Stephen Ward & Robert Halstead, MIT Electrical Engineering and Computer Science, 1989.
2. *Discrete computational structures*, Robert R. Korfhage, Academic Press, 1974

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

Background Programming Systems - Migration of Objects & Classes - Theory of OOPS paradigms & Concepts - OOPS Features in Real Systems - Applications and Framework

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

References:

1. *C++ For Artists: The Art, Philosophy, and Science Of Object-Oriented Programming*. Rick Miller, Pulp Free Press, 2008
2. *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 I] [3+3]

Basics of Electrostatics and Electrodynamics - Electric Circuit elements and function - Current, voltage, capacitance, resistance - Power and efficiency in electrical appliances - Joule heating - Electrical safety devices - Basics of Electromagnetism - Electromagnets and induction - Transformers. DC motors and generators - AC motors - Using electromagnetic spectrum - Information transfer and broadcasting - 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.

Engineering Kitchen Activities [Laboratory]

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

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] [3]

Language and Communication - Context - Barriers to communication - speech and writing - writing skills - linguistic unity, coherence, and cohesion - scientific and technical writing - oral interactional skills - formal and informal speech - public speaking - negotiation - group discussion - comprehension - intelligent listening.

Creativity - Poetry - Narrative - Dramatic writing - Creative process - Cultural experience - Creative communication skills in daily life - Retention of traditional narratives - Story telling

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]

Introduction to different business Processes: Human Resources, Production, Operations, Marketing and Finance - Business process linkage with IT - IT enabled Businesses - IT governance & architecture - IT enabled change management - Business Analysis strategies & planning - Cost Benefit analysis - Enterprise Resource Planning - Digital Marketing and Media - Internet, Multimedia, and 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]

Analog World: resistor, capacitor, inductor, power source, transducer, sensor, detector, switch – Potentiometer - Integrated Circuit – Transformer; ***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 – ***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 - ***Signal and System:*** Types, Generation, Audio and Video Signals and their applications, 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]

Organism: origin of life and what organisms do, Biological sciences: from descriptive to reductionist to systems biology, Metabolism in living state, Living systems as energy machines, Cycles and life, Life cycles, Cell cycle & turnover, Origin and diversification of living systems, Hierarchy of organization of living systems (molecular, cellular, and population levels), Evolution of living systems: probabilistic versus deterministic.

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 + Project] [Semester III] [4]

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 - method of characteristics, - Monge's cone - Classical methods for simple PDE models. - 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 - Fourier Series and Fourier transforms - Boundary value problem: Dirichlet and Neumann - Lagrange – Green's identity - 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 Handling Information through Data Modeling & Design [Theory + Practical] [Semester III] [3 + 3]

Traditional Files & Databases – Database Management Systems – Relational Model - ER Modeling – Constraints, Query language & features – Normalization – Indexing – Transaction Processing & Concurrency Control – PL/SQL Basics – Graph Databases - Data Modeling Techniques & UML – Analysis of Data using Mining Techniques – Study of Real World Applications

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

References:

1. *Database System Concepts*, Abraham, H. and Sudershan, S., 5 Ed., McGraw-Hill, 2013

2. *Introduction to Data Mining*, Pang, N. T., Pearson Education, 2013

3. *Database System : The Complete Book*, Jeffrey Ullman, Jennifer Widom, and Héctor García-Molina, Pearson Education, 2008

4. *Data Modeling: A Beginners Guide*, Andy Oppel, McGrew Hill, 2010

III.3 Instructing Computing Devices: Operating System [Theory + Project] [Semester III] [4]

Operating System Structures – Process, Memory & CPU management – Processes, Threads & Dispatching – Scheduling – Deadlocks – Linkers – Virtual Memory – Dynamic Storage Management – Demand Paging – Storage Devices – File System – Flash Memory – Virtual Machines – Distributed Operating System - Study & Analysis of Unix/Linux/Windows/Android

References:

1. *John. Lions' Commentary on UNIX® 6th Edition with Source Code*. John Lion, San Jose, CA: Peer-to-Peer Communications, 1996

2. *Exokernel: An Operating System Architecture for Application-Level Resource Management.,* Engler, Dawson R., M. Frans Kaashoek, and James O'Toole Jr., ACM Press, 1995.

3. *Operating System Concepts*, Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, John Wiley & Sons, 2009

III.4 Language and Communication: Computational Linguistics [Theory + Project] [Semester III] [4]

Introduction to Natural Language Processing (NLP) - Language structure and Analyzer - Morphological Analysis - Local Word Grouping - Parsing - Computational grammar and requirements - Machine Translation - Lexical semantics and algorithms – Spoken Language System – Tagging – 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 + Project] [Semester III] [4]

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 - Determinants of individual demand & supply - Demand-Supply schedule and curves - Market versus individual demand & supply - Shifts in the demand & supply curve, 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 - government policies towards competition, Imperfect information in the product market - The information problem - The market for lemons and adverse selection and Input Markets.

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 + Project] [Semester III] [4]

AC Fundamentals - Concept of voltage and current sources - KVL and KCL - Node voltage analysis and method of mesh currents - Network theorems - PN Junction: variants and applications - Bipolar Junction Transistor (BJT) biasing and amplifier design - Field Effect Transistor (FET) variants – FET biasing and amplifier design - Structure and working of SCR. Structure and operation of LDR, Photo voltaic cell, Photo diode, Photo transistors and LED, Operational Amplifiers basics and practical circuits - Feedback and oscillator circuits - Voltmeters- Multimeters - 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 + Project] [Semester III] [4]

Demystifying living state – Nature of biological processes – Approaches to study Biology: Observational and Experimental, Physiology and Behavior - the regulated activities – Communication (external & internal) as the basis of regulation – Circuits and regulations in living systems – Interaction of biological components – Information flow in living systems: Proximate and Ultimate causes – 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 + Project] [Semester III] [4]

Evolution of Management Thoughts - contribution of selected management thinkers - Environmental Analysis, Growth Strategies, Decision making and Decision Support System, Organizational Citizenship Behavior - Group Dynamics - Approaches to management - Contemporary Management practices in Global Environment - Management Functions: Planning, Organizing, Staffing and controlling - Introduction to various streams of management Motivation Theories – Leadership Theories - Management of Change - Knowledge Management Case studies - IT Applications

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 + Project] [Semester III] [4]

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
- Innovation Project

III.6.3 Cell: Biochemical and Molecular perspective [Theory + Project] [Semester III] [4]

Molecular interactions – Enzyme kinetics – Bioenergetics and Metabolism – energy transduction in the living organisms (photosynthesis and respiration) – Cell organelles – Cell membrane and extracellular matrix – Cytoskeleton and membrane trafficking – Cell division and checkpoints – Cell signaling – Origin of eukaryotes: hypothesis.

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 + 3]

Probability space - Conditional probability - Bayes theorem – Independence - Descriptive measures (Mean, median, mode, standard deviation, dispersion, moments) - Random variables - Joint distributions - 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) - Joint, marginal and conditional distributions - Weak and strong law of large numbers, -Central limit theorem - Sampling distributions - Hypothesis testing, interval estimation - Likelihood, analysis of categorical data - Curve fitting - linear regression, Correlation - Test statistic and their significance.

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
- Innovation Project

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 Understanding Computing Systems Architecture [Theory + Practical] [Semester IV] [3 + 3]

Complex Instruction Set Computers – RISC - Pipelining – Cache – Virtual Memory – Superscalar Architecture – VLIW – EPIC – Buses and Arbitrations – Power Management –

Performance Analysis and Optimization Models - Multithreaded Processors – Parallel Processors – Datacenter architecture

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 & interfacing with Sensors
- Parallel Programming using OPENMP, OpenMPI & CUDA
- Programming on HPC Interfaces
- Innovation Project

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, 1996

IV.3 Software Engineering [Theory] [Semester IV] [3]

Introduction – Software Lifecycle – Software Design Patterns – Development – Costing – Planning & Monitoring – Quality – Maintenance – Migration of Software Engineering to Latest Technology Trends – Software Architecture – CASE – Software Engineering for Web Applications

References

1. *Software Engineering*, Ian Sommerville, Addison-Wesley; 9 edition, 2010

2. *Software Engineering: A Look Back and A Path to the Future*, Leveson, Nancy. December 14, 1996

3. *No Silver Bullet.* In Information Processing. Brooks, Frederick, Jr. Edited by H. J. Kugler. North-holland, BV: Elsevia Science Publishers, 1986.

4. *Design pattern: Elements of Reusable Object – Oriented Software,* Gamma, Erich, Richard Helm, Ralph Johnson, and John Vlissides, Addison Wesley, 1995

IV.4 Science, Philosophy, Truth: Impact of technology [Theory] [Semester IV] [3]

Philosophy of Science – Methodology of Science – Science as a pursuit of truth: Theory of falsification by Karl Popper and theory of paradigm shift by Thomas Kuhn – Evolution of science driven technology and technology driven science – Exploring scales - Aristotelian logic – Galileo: the concept of quantitative measurement and physical laws – Newtonian Mechanics and Industrial Revolution – Modern Physics and Quantum Mechanics – Brain, Consciousness and Singularity

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.
8. *The Singularity is Near*, Raymond Kurzweil, Viking Press, 2005

IV.5.1 Understanding Economic Behaviour: The macro level [Theory + Project] [Semester IV] [4]

GDP Measurement Techniques, Classical and Keynesian Theories- Macroeconomic Equilibrium, labor market, product market, Full Employment, Aggregate Expenditure Model, , Role of money and the Government, Monetary and Fiscal Policy, The multiplier effect, Inflation, Exploring the macroeconomics of an open Economy: international Economics; Balance of Payments - The current and capital account; 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

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 + Project] [Semester IV] [4]

Boolean algebra – Logic Gates – CMOS circuits – PLA - Digital IC families – Combinatorial circuits – Sequential circuits – MSI and PLD components – ADC – DAC – Semiconductor memories – Microprocessor – Assembly Language – I/O Interfacing – 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 Genes to Genomes [Theory + Project] [Semester IV] [4]

Mendelian and non-Mendelian inheritance – Gene interaction – Epistasis – Linkage and recombination – Population genetics and diseases – Genomes (Characteristics, Genome mapping techniques, Genome evolution) – Epigenetics – Transposable elements – Coding and non-coding RNA – Gene expression.

References

1. *Introduction to Genetic Analysis*, Griffiths et al., W H Freeman & Company, 10th edition, 2010.
2. *Genomes*, TA Brown, Garland Science, 3rd edition, 2006.
3. *Molecular Biology of the Cell* , Alberts et al., Garland Science, 5th edition 2007.
4. *Biochemistry*, Berg, Tymoczko and Stryer, W H Freeman & Company, Intl edition 2011.
5. *Leninger's Principles of Biochemistry*, Nelson and Cox, W H Freeman & Company, 6th edition, 2012.

IV.6.1 Bringing Companies and clients together: Sales & Marketing management [Theory + Project] [Semester IV] [4]

Concepts – Strategies - Market Research, Environmental Scanning, Industry Analysis, Competitive Intelligence and Implementation - Marketing Mix - Buyer Behavior Models - Marketing Research and trends in Marketing - Demographic, Geographical Psychographic, Behavioral, Market Targeting and Market Selection – Product Development – Pricing – Promotion – Distribution - Advertising and Branding - E-Business Marketing – Retail Management - Recent Issues: Social Marketing, Rural Marketing, Digital Marketing, Viral Marketing, Social Media Marketing, Online Marketing, Green Marketing, Marketing Ethics

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 + Project] [Semester IV] [4]

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
- Innovation Projects

IV.6.3 Flow of information in living systems [Theory + Project] [Semester IV] [4]

Nature of genetic material – Process of information transfer (Replication, Transcription and translation machinery) – Energetics and accuracy of information transfer – Problems of information transfer (DNA damage and repair) – Regulation of informational transfer (transcription factors, operon) – DNA packaging and chromatin structure.

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).
- Innovation Project

References

1. *Molecular Biology of the Cell* , Alberts et al., Garland Science, 5th edition 2007.
2. *Genomes*, TA Brown, Garland Science, 3rd edition, 2006.

3. *Molecular Cell Biology*, Lodish et al., W. H. Freeman & Company, 7th edition, 2012.

SEMSTER – V

V.1 Algorithms for Computational Mathematics: Numerical Methods [Theory + Practical] [Semester V] [3 + 3]

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 - 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 –Polynomial interpolation - Forward, Backward and Divided differences - Piecewise linear and Cubic Spline interpolation - Errors in interpolation - 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

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
- Innovation Project

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

V.2 Information exchange in computing devices: Data Communication & Networking [Theory + Project] [Semester V] [4]

Communication Channels - Topologies - Networking Applications – Layered Architecture & Models – Network Devices – Error Management – Network Protocols – Network Security & Cryptography – Network Architectures of Enterprise Applications

Engineering Kitchen Activity [Laboratory]:

- Hands on experiment with Network Topologies on LAN/WAN – Wired & Wireless
- Hands on Experiments with Routing Mechanism in Internet and Intranet
- Setting up TCP/UDP applications on Network Devices
- Socket Programming
- Use of Wire shark for Packet Analysis
- Study Security protocols & certificates
- Study of Streaming Applications and Protocols
- Design of Web/Server Based Applications
- Reverse Engineering the Network Protocols
- Innovation Project

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

V.3 Computer and Brain: Knowledge Discovery and Artificial Intelligence [Theory] [Semester IV] [3]

Data driven reasoning and learning models – Computational Logic and Cognition - Classification - Statistical inferences - Knowledge representation – Role of knowledge in language understanding and analysis – Context awareness – Pattern Recognition - Designing Expert Systems - Biomimetics

References:

1. *Winston, Patrick Henry*, Artificial Intelligence. 3rd ed. Addison-Wesley, 1992.

2. *Kevin P. Murphy and Robert R. Reitano*, Machine Learning: A Probabilistic Perspective, MIT Press, 2012.

3. *The Singularity is Near*, Raymond Kurzweil, Viking Press, 2005

V.4 History, culture & civilization [Theory] [Semester V] [3]

The module has to be taught through projects and case studies by adopting information analysis, mathematical and technological insights associated with History, Culture and Civilization

Rebooting history and historical thoughts through technology, math and science perspective, Pre-Internet and Post-Internet analysis of civilization and culture demonstrated through case studies, Spatio-temporal aspects of culture and civilization.

References

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 + Project] [Semester V] [4]

Evolution of the concept of HRM - HR policies, functions and roles – Leadership – Job Analysis, Job Design, Job Description, Job Specification - Recruitment – Training - Performance & potential appraisal - Statutory laws - Individual & Group Behavior- Leadership & power- Dynamics of Organizational Behavior - Employee Welfare and social Security Schemes - Grievance Handling and Redressal Mechanism - 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 + Project] [Semester V] [4]

Microcontroller and Microprocessor – Introduction to RTOS, VHDL, FPGA - Embedded system development (Memory, Interfaces, Peripheral devices, Sensors) – Basic RISC – CISC – I/O Ports – Instructions Sets – Addressing Modes – Clock System - Timers & Counters – Interrupts – ADC- DAC – Assembly Language & Embedded C – Pipeline – ARM & Thumb Instruction Set - Networking for embedded systems – Introduction to robotics and control – Actuators and Drives – Kinematics and motion control – Sensors and Navigation - Internet of Things

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

- Innovation Project

References

1. *Embedded System Design* – Santanu Chattopadhyay, PHI Learning, 2013
2. *Embedded System*– Raj Kamal, TMH, 2008

V.5.3 Biological Networks: from Micro to Macro Niche [Theory + Project] [Semester V] [4]

Inter and intra-cellular networks – Signal transduction in prokaryotes – Metabolic network – neurological networks – Regulatory pathway and components – Blood – Secretion systems in prokaryotes and eukaryotes – Ecosystem dynamics and sustainability – Tree of life and macroevolution.

References

1. *Molecular Biology of the Cell*, Alberts et al., Garland Science, 5th edition 2007.
2. *Molecular Cell Biology*, Lodish et al., W. H. Freeman & Company, 7th edition, 2012.
3. *Biochemistry & Molecular Biology of Plants*, Buchanan et al., Wiley-Blackwell 1st edition, 2002.
4. *Essentials of Ecology*, Begon, Howarth, Townsend et al., Wiley-Blackwell, 2014.

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

Concept, Operations strategy, Management of Quality, Statistical Process Control, process Capability analysis and Six Sigma, Concept and framework of Total quality management system, Elements and objective of supply chain management, inventory management: models and applications, Evaluation and Selection of appropriate Production and Operations technology - Forecasting, Strategic Importance of forecasting, Associative Forecasting Methods, Monitoring and Controlling Forecasts, Forecasting in service sector - Computer Integrated Manufacturing Systems.

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.
- Innovation Project

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 + 3]

Discrete-time systems - Continuous-time systems - Laplace transforms – Z transforms – Convolution – Frequency response – Fourier series and transform – Feedback – Sampling – Modulation – Filters design techniques

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
- Innovation Project

References

1. *Signals and Systems.* Oppenheim, Alan, and Alan Willsky. 2nd ed. Prentice Hall, 1997.

2. *Signals and Systems 2 Ed.,* Haykin, S. & Van Been, *B.*, John Wiley & Sons, 2007.

V.6.3 Applied Genomics and Proteomics: Methods and techniques [Theory + Practical] [Semester V] [3 + 3]

Recombinant DNA technology – Artificial chromosome – PCR and its types – DNA and Protein sequencing – Microarray – MALDI – RAPD – RFLP – *in situ* hybridization – Site-directed mutagenesis – Gene transfer and gene therapy – Electrophoresis – Spectrometry – X-ray crystallography – NMR – Genomic and cDNA library – Two hybrid systems – Plant and Mammalian tissue culture.

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).
- Innovation Project

References

1. *Molecular Cloning: A Laboratory Manual*, Green and Sambrook, Cold Spring Harbor Laboratory Press, 4th edition 2012.
2. *Principles and Techniques of Biochemistry and Molecular Biology*, Wilson and Walker, Cambridge University Press, 7th edition 2010.

SEMSTER – VI

VI.1 Linear Construction of Actions: Engineering through Linear Programming and Game Theory [Theory + Project] [Semester VI] [4]

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 - 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 - 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 - 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

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 Computer Graphics and Visualization Architecture [Theory + Practical] [Semester VI] [3 + 3]

Display devices – Transformation algorithms – Ray Tracing and shading – Camera and image formation – Computer and machine vision – Object recognition and processing – Motion Capture & Analysis – Data Visualization Techniques – Animations – Virtual Reality and Augmentation

Engineering Kitchen Activity [Laboratory]:

- 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

References:

1. *3D Computer Graphics*. Watt, Alan, Addison-Wesley, 1999.

2. *Fundamentals of Computer Graphics*. Shirley, Peter, Michael Ashikhmin, Steve Marschner, 3rd ed. A K Peters/CRC Press, 2009.

3. *The Illusion of Life – Disney Animations,* Frank Thomas, Ollie Johnston, Walt Disney, 1981

VI.3 Advanced Algorithm Design [Theory] [Semester VI] [3]

Advanced data structure – Geometric algorithms – Graph algorithms – Linear Programming – Search heuristics – Approximation algorithms – Compression and streaming algorithms – Distributed and parallel algorithms

References:

1. *Randomized Algorithms*, Motwani and Raghavan,. Cambridge, UK: Cambridge University Press, 1995.

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

3. *Algorithms on Strings, Trees, and Sequences: Computer Science and Computational Biology,* Gusfield, Dan,. Cambridge, UK: Cambridge University Press, 1997.

4. *Online Computation and Competitive Analysis*, Borodin, Allan, and Ran El-Yaniv, Cambridge, UK: Cambridge University Press, 1998.

5. *Approximation Algorithms for NP-Hard Problems,* Hochbaum, Dorit, ed.. Boston, MA: PWS Publishing Company, 1997.

VI.4 Art & Design [Theory] [Semester VI] [3]

Exercises in design to understand principles of design - Distribution of space - Language of proportion and the process of form synthesis – 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

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 + Project] [Semester VI] [4]

Basic Concepts of Finance, Investment decisions, financing and dividend decision, working capital management, long term sources of finance, strategic financing decisions, online Financial Management, 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 + Project] [Semester VI] [4]

VHDL Language - Concurrent and Sequential Assignment – Hardware specification - FPGA Architecture – Design of advanced robotic systems and embedded devices for varied applications – Virtual Reality and Computer Vision - Sensors Network: Wired and Wireless – Interfacing of various sensors – PID Controller - Vision Robotics – MEMS – Biomedical Sensors – Applications

References

1. *Robot Analysis and Control*, Asada, H., and J. J. Slotine. New York, NY: Wiley, 1986

2. *Learning in Embedded Systems,* Leslie Pack Kaelbling.. MIT Press, 2008

VI.5.3 Biodefense and Bioengineering [Theory + Project] [Semester VI] [4]

Emerging pathogens and host-pathogen interactions – Autoimmune diseases – Receptor Biology – Cancer and Tuberculosis – Antigen processing – Antibody synthesis and secretion – Viruses and Bacteria – Microbial growth kinetics – Secondary metabolites in plants – Innate immunity in insects and plants – Toll Receptors – Engineered single chain antibody.

References

1. *Kuby Immunology*, Owen and Punt, W. H. Freeman & Company, 7th edition, 2013.
2. *Microbiology: an introduction*, Tortora et al., Benjamin Cummings, 11th edirtion 2012.
3. *Biochemistry & Molecular Biology of Plants*, Buchanan et al., Wiley-Blackwell, 1st edition 2002.
4. *The Biology of Cancer,* Robert Weinberg, Garland Science, 2nd Edition 2013.
5. *Immunology and Immunotechnology*, Ashim K Chakravarty, , O.U. P, 1st edition, 2006.

VI.6.1 Business: Organization and Strategy [Theory + Practical] [Semester VI] [3 + 3]

Foundation of e-business and e-commerce, organizational models, role of Information Systems in Business, various approaches in ICT Systems, Emerging models in e-business, e-business and organizational changes, productivity and industries transformations, Perspectives and requirements for starting online business, Processes associated with managing website development ICT in B2B: Business models, revenues and sources, performance trends, e-business and organization management, Internet Marketing and e-Tailing.

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.
- Innovation Project

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 + 3]

Introduction to Control Systems - Analysis and design objectives - The design process - Classification and modeling of control systems – Modeling in the frequency domain - Modeling in the time domain - Time response - Reduction of multiple subsystems - Signal flow graphs - Mason's rule. Stability - Routh Hurwitz Criterion - Steady state errors - Root locus techniques - Design via Root Locus - Frequency Response Techniques - Design via Frequency Response- Design via state space - Digital Control Systems – Non-linear analysis.

Engineering Kitchen Activity [Laboratory]:

- Designing the model of a DC motor.
- Design of controllers for speed and position control
- Compensator design
- State space model design.
- Design of temperature controller.
- Innovation Project

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 *in silico* Biology [Theory + Practical] [Semester VI] [3 + 3]

Sequence analysis and alignment – Promoter domains and motifs – Scoring matrices – Biological databases and data-mining – Phylogeny and cladistics – Structure analysis – Molecular modelling and simulations – Bio-statistics – Stochastic models – Algorithm and programming language.

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).
- Innovation Project

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.

SEMSTER – VII

VII.1 Fluidity in nature: computational interpretations [Theory + Project] [Semester VI] [4]

Polar, spherical, cylindrical, Moving and Rotating coordinate systems - Generalized coordinates - Basic equations of fluid dynamics – Conservation of mass, momentum and energy - Mathematical nature of the flow equations and their boundary conditions - Numerical solution of Navier-Stokes equations - Finite difference method - Its application over first order and second order differential equations - Shortcomings of finite difference method - Weak forms of the differential equations -Finite element method - Its shape functions over one dimensional and two-dimensional geometries - Stiffness matrices - Assembly of stiffness matrices over all the elements - Solution of assembled system of equations after applying boundary conditions - Shortcomings of Finite element method.

References

1. *The finite element method in Heat Transfer and Fluid Dynamics,* J. N. Reddy and G K Gartling, CRC Press, 2010
2. *An introduction to the finite element method*, J. N. Reddy, McGraw-Hill Company, New York, 2006
3. *Applied Mathematics*, J David Logan, John Wiley, New Jersey, 2013.
4. *Classical Mechanics with MATLAB Applications*, Javier E. Hasbun, Jones and Bartlett, 2010.

VII.2. Computer Language Design & Engineering [Theory] [Semester VII] [3]

Micro programming - Function and structure of compilers – Lexical analyzer – Tokens – Parsing – Type system – Run time environment – Code generation and optimization – Intro Optimization – 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 Software Project Management [Theory + Practical] [Semester VII] [3 + 3]

Software Design – Project management – Software Management Process Framework – Software Project Management – Quality (CMMI) & Risk Management – Evaluation & Forecasting - Present Frameworks and Strategies

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 any Open Source Software Project and identify Software management aspects
- 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 systems
- 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

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 Stellman & Jennifer Greene, O`Reilly, 2005

VII.4 Visual Arts & Aesthetics [Theory] [Semester VII] [3]

Introduction to media art, computer art, digital art and interactive art - Aesthetic strategies in processual art - Art, technology and society - Interaction as aesthetic experience - Aesthetic of interaction in digital art - Aesthetic and new media - Interpreting visualizations : : Visualizing interpretations - 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 + Project] [Semester VII] [4]

Environment Impact Assessment, Sustainable Development and Millennium Development Goals - Urbanization and its hazards, Urban Planning and Growth - Central Place Theory Geometry and Ordering, Burgess Model for City Planning, Growth Pole and Growth Centre Theory, Demographic Transition Model - Waste Management, Environmental management tools and techniques of sustainable development, Eco system Modeling, Environmental Information System – Environmental Laws.

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

VII.5.2 Engineering at Molecular Scale: Devices and Nanotechnology [Theory + Project] [Semester VII] [4]

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 -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, Introduction to Sensor Technology - CMOS scaling challenges at nanoscale regimes - Device technologies for sub 100nm CMOS - Device scaling and ballistic MOSFET - Nanoscale CMOS design, Nanoscale circuits - Non classical 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 Modeling and Simulating Brain Functions: Computational Neuroscience [Theory + Project] [Semester VII] [4]

Introduction to Neurobiology – Integrative Physiology (whole organism and population) Cognitive and neural modelling – Single Neuron Model – Neural models (vision, memory function, rhythm) – Synapse and networks – Neural plasticity and computational learning – Neural coding – Artificial intelligence – Neural imaging.

References

1. *Theoretical Neuroscience: Computational and Mathematical Modeling of Neural Systems,* Peter Dayan and Larry Abbott, MIT Press 2005.
2. *Fundamentals of Computational Neuroscience*, Thomas Trappenberg, Oxford University Press; 2nd edition, 2010.

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

Business Process modeling, Process Metrics, Overview of Enterprise systems and Business Processes, Identify and understand the functionalities in an ERP system, issues of ERP architecture, design development, Performance & Capabilities Gaps, Business Process mapping & redesign, , Advanced ERP modules, Industry specific case study, Project implementation.

References

1. *Modern ERP Systems: Select, Implement and Use Today's Advanced Business Systems,* Bradford, M. (2010).. 2nd Edition, Lulu.

2. *ERP to E²RP A case Study Approach*, Desai, S., Srivastava, A. (2013). Eastern Economy Edition: PHI Learning Private Limited.

3. *Essentials of Business Processes and Information Systems*, Magal S., Word J., John Wiley & Sons, 2009.

4. *Enterprise Integration,* Sandoe K., Corbitt G., Boykin R., John Wiley & Sons, 2001.

VII.6.2 Circuit Analysis and Synthesis [Theory + Practical] [Semester VII] [3 + 3]

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 - 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 - 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 - 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.

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.
- Innovation Project

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] [3 + 3]

Biological complexity – Biological circuits – Thermodynamics – Bio-physical properties of macromolecules – Bio-molecular interaction analysis – Developmental biology – Data integration and hypothesis generation – Reversible reactions and feedback loops – Transient networks, Behavioral network – Instinct and Learning.

Engineering Kitchen Activity [Laboratory]:

- Gene Regulation/interaction networks models and software (KEGG, CYTOSCAPE). Intercellular signaling network and software.
- Biochemical & thermodynamics properties of Protein – Protein Modeling software.
- Large scale data analysis (high-throughput).

- Molecular markers.
- Deriving mathematical equations from biological phenomenon.
- Innovation Project

References

1. *An Introduction to Systems Biology: Design Principles of Biological Circuits*, Uri Alon, Chapman & Hall, 2nd edition 2013.
2. *A First Course in Systems Biology*, Eberhard Voit, Garland Science; 1 edition, 2012.
3. *Handbook of Systems Biology: Concepts and Insights*, Marian Walhout, Marc Vidal, Job Dekker (Edited), Academic Press; 1st edition, 2012.