CURRICULUM
&
SYLLABUS
Doctorial Program
(PhD – Engineering)



ICFAI Foundation for Higher Education
(Deemed-to-be University under Section 3 of the UGC Act, 1956)

IcfaiTech
Faculty of Science & Technology (FST)

S. Vijayalakshmi
REGISTRAR
ICFAI FOUNDATION FOR HIGHER EDUCATION
(Deeemed-to-be-University establishes under section 3 of UGC Act 1956.)

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1. Introduction

1.1 The ICFAI Foundation for Higher Education

The ICFAI Foundation for Higher Education (IFHE) is declared as a Deemed-to-be University, under Section 3 of the UGC Act, 1956. It has evolved a comprehensive student-centric learning approach consisting of several stages, designed to add significant values to the learner's understanding in an integrated manner, covering relevant knowledge, practical skills and positive attitudes. IFHE comprises of:

- Faculty of Management (IBS Hyderabad),
- Faculty of Science and Technology (IcfaiTech), and
- Faculty of Law (FoL).

Vision and Mission of IFHE

The Vision of IFHE is to emerge as an Institution of Excellence known for research, teaching and practice.

The Mission of IFHE is 'Learning for Leadership'. It aims at developing a cadre of professionals possessing specialized skills having a sense of social and moral responsibility and the ability to address problems from a broader perspective..

1.2 Faculty of Science and Technology (IcfaiTech)

Faculty of Science and Technology (IcfaiTech), Hyderabad is a constituent of the ICFAI Foundation for Higher Education. It has been established to promote quality education in the field of Science andTechnology. IcfaiTech strives to acquire a reputation as a highly purposive, innovative institution setting the pace for workable reforms in professional education suitable and most relevant for the Indian cultural milieu.

VISION

The IcfaiTech campus shall become a leading institute for scientific research as well as innovative teaching and learning, keeping pace with evolving knowledge domains. It shall emerge as an attractive destination for the excellent students and the faculties. IcfaiTech aspires to be highly ranked amongst the group of other peer institutes.

MISSION

The mission of the IcfaiTech is to provide high quality teaching and learning experience through our first degree and higher degree programs.

• Teaching Excellence: IcfaiTech periodically reviews and redesigns existing courses and introduces new courses and programs geared towards current research and industry. It explores new dimensions in teaching and learning and uses various platforms and methodologies.

• Research Excellence: The faculty members of the department carry out research in almost all the major areas. The department is now vigorously scaling up its research activity and giving more visibility to it. The volume of research publications in peer reviewed journals of repute and the research funding received by the department has been increasing steadily.

• Faculty Leadership in Administration: The faculty members of the department make significant contribution to administrative leadership and various institute activities and initiatives.

1.3 Educational Philosophy

The core philosophy of education at IcfaiTech is empowering students with the right knowledge and modern skill sets in order that they are ready to face the challenges of the competitive world. IcfaiTech strives to provide its students with the fine edge that is required in the making of a successful professional. The programs at IcfaiTech have been uniquely designed by including courses drawn from varied areas like humanities, arts, and management combined with science, engineering and industry-based internships. IcfaiTech ensures that students gain exposure and knowledge across different disciplines; develop inter-personal skills and leadership qualities that takes them beyond traditional thinking and practice. Today's era of globalization and integrated economies presents talented professionals huge opportunities from across the world. The curriculum at IcfaiTech is truly global and modern in perspective and exposes its students to the latest practices and techniques. The curriculum offers a cafeteria approach allowing them to

choose courses from across the disciplines. This exposure also helps them to develop interests in tune with the current inter-disciplinary nature of research. The educational philosophy practices at IcfaiTech allow it to integrate into its learning system, an innovative and emerging body of knowledge. The highlights of the academic program are summarized below:

• Cutting-edge course curriculum with contemporary and effective pedagogic methods that lay emphasis on application-oriented learning.

• Encouraging students to not only articulate Science and Technology needs but also provide appropriate solutions.

• Developing appreciation for synthesized multidisciplinary learning by way of workshops, internships and other group learning assignments.

1.4 Objectives of IcfaiTech

• To provide high quality, cutting-edge and career-oriented education programs in Science and Technology.

• To offer practice-oriented, contemporary and flexible programs developed through regular assessment and consultation with leading institutions, academicians, professionals and practitioners.

• To turn out highly motivated and successful Science and Technology graduates to meet the current and projected needs of the knowledge workforce.

1.5 Flexibilities

A few of the flexibilities available to the students are mentioned below. The principle of merit, preference of the students and the facilities available at the Institute generally guide the decisions regarding flexibilities. Transfer: Every year, various branches of engineering are ranked based on the preferences and demands of the admitted batch of students. After two semesters of study (end of the first year), students can seek transfer across branches. Requests from students seeking transfer from a less preferred branch to the most preferred branch of B.Tech would be considered if they maintain a CGPA of not less than 9.00, by the end of the first year of degree program. For a branch transfer to the second most preferred branch, a student should have a CGPA of not less than 7.00 by the end of the first year of degree program. A branch transfer from a more preferred branch to a less preferred branch would be permitted without any restrictions on CGPA. Audit: Over the years of study at IcfaiTech, a student may develop interest in areas that go beyond the scope of his/her program of studies. IcfaiTech permits students to take such courses as audit courses. Certain courses like Foreign Languages, Music, etc. which are not the

part of a degree program could be opted for on an audit basis, on payment of additional fees. Audit courses do not count for the CGPA calculation.

Other Flexibilities: The Academic Regulations also provide flexibilities like choice of electives, number of electives, repetition of courses, departure from normal pace, withdrawal from or substitution of course(s).

2. PhD in Engineering

1. Ph.D. Programme

1.1. About the Program

Ph.D. in Engineering and Sciences Program of IcfaiTech consists of procedure starting from eligibility for admission in to Ph.D. program to the submission of Ph.D. Thesis.

1.2. Eligibility Criteria for admission into Ph.D. programs

Students with minimum 60% marks in aggregate (overall percentage; not only in majoring subject) or CGPA 6 on a 10-point scale in Master's degree from any university recognized by UGC are eligible. The broad areas of research and eligibility criteria in each department for both engineering and Science disciplines are as follows:

Ph.D. in Engineering

Broad areas of research

Department	Research Areas	Eligibility
Civil Engineering	1. Structural Dynamics and Earthquake Engineering 2. Green Building Technologies 3. Ground Improvement Techniques	Bachelor's degree in Civil engineering followed by a Master's degree in an appropriate area with consistently good academic background.
Computer Science and Engineering	1. Software Engineering 2. Computer Networks 3. Cloud Computing 4. Artificial Intelligence 5. Big Data & Analytics 6. Blockchain 7. Internet of Things (IoT)	Bachelor's degree in Computer Science and Engineering followed by a Master's degree in an appropriate area with consistently good academic background.
Electrical, Electronics and Communication Engineering	1. Wireless Network 2. Image Processing 3. VLSI Design 4. Antennas 5. Sensors & Measurements 6. Power Electronics 7. Embedded Systems 8. Satellite Communication	Bachelor's degree in Electrical/ Electronics/ Communications/ Computer Science/ Instrumentation Engineering followed by a Master's degree in an appropriate area with consistently good academic background.

Mechanical Engineering	1. Energy Systems 2. CAD/CAM 3. Machine Design 4. Robotics	Bachelor's degree in Mechanical Engineering followed by a Master's degree in an appropriate area with consistently good academic background.

Ph.D. in Sciences

Broad areas of research

Department	Research Areas	Eligibility
Mathematics	1. Number Theory 2. Boolean Algebra 3. Algebra 4. Computational Fluid dynamics 5. Optimization Techniques	Master's degree in Mathematics.
Physics	1. Energy systems 2. Mathematical Physics 3. Condensed matter physics 4. Laser-matter interaction 5. Statistical and Computational physics	Master's degree in Physics

1.3. Time-line of the programmes

1.3.1. Duration: Both Ph.D. full time/part-time programme shall be 3-5 years duration which includes course work and submission of thesis.

1.4. Selection Procedure

Eligible candidates seeking admission to Ph.D. programmes in engineering and Science disciplines shall appear for entrance test conducted by IcfaiTech. Candidates qualified in the written test will be called for interview and final selection is based on performance in the interview. IcfaiTech shall issue a notification in the leading newspapers and institution website inviting applications for admissions in to Ph.D. programmes.

1.5. Details of the entrance test

Entrance test will be conducted through online mode. The maximum marks for the written test is 75 (15 for aptitude and 60 for specific subject). The test comprises of objective type questions. Candidates who secures 60% marks shall be eligible for interview. Interview is conducted for 25 marks. The merit list for admission shall be prepared based on the marks obtained both in entrance test and interview. Admission will be carried out by research committee. Candidate shall register after paying the prescribed fee.

1.6. Course work

Course work is mandatory and candidates have to maintain 75% attendance per course are eligible to appear for examinations. The credits required for course work is 32. The overall Ph.D. program structure and the distribution of credits comprises of the following:

	SEMESTER I		SEMESTER II	
	Course Title	**Credits**	**Course Title**	**Credits**
Year I	Research Methodology-I	4	Research Methodology-II	4
	Advanced Disciplinary Course-I	4	Advanced Disciplinary Course -II	4
	Specialization Elective -I	4	Specialization Elective -II	4
	Interdisciplinary Course-I	4	Interdisciplinary Course-II	4
	Total credits	**16**	**Total credits**	**16**
Summer Research Project Ph.D. Qualifying Examination				
Year II	Independent Study	08	Independent Study	08
	Seminar	03	Seminar	03
	Total Credits	**11**	**Total Credits**	**11**
Summer Term				
Year III	Ph. D. Thesis	08	Ph. D. Thesis	08
	Seminar	03	Seminar	03
	Practice Lecture Series	1	Practice Lecture Series	1
	Total Credits	**12**	**Total Credits**	**12**
Summer Term				
Year IV	Ph. D. Thesis	08	Ph. D. Thesis	08
	Seminar	03	Seminar	03
	Total Credits	**11**	**Total Credits**	**11**
Total Credits: 100				

The student takes eight courses in the first year of the following categories

Category	**Credits**
Advanced Courses in the discipline	8
Elective courses in the area of specialization	8
Interdisciplinary courses	8
Courses on research methods	8
Total Credits	**32**

1.5.1. Ph.D. Qualifying examination: The candidate who successfully completes their course work would take the qualifying viva exam based on the elective courses taken in the area of specialization. The candidate has to give one seminar in every semester related to thesis work. The qualifying viva voce would be conducted by a panel of examiners. Based on the overall performance, the result of the qualifying examination will be declared in terms of 'pass' or 'fail'. The student may avail a maximum of two attempts for clearing the qualifying viva examination. If a student fails to qualify in two attempts, he/she will be discontinued from the programme. Students receiving scholarships are required to maintain CGPA of 8/10 at the end of every semester. Further, a student is also required to secure a minimum grade of 'C' in each course in order to continue the Ph.D. programme. If a student gets a grade lower than C, he/she would normally be given one more chance to repeat the course and improve the grade. At the end of semester-1, if GPA falls within the range of 6-7.8, students are allowed to register for semester-2. However, they may have to improve the GPA of semester-2. However, the fellowship would be suspended until the student improve his/her grade.

1.5.2. Doctoral Advisory Committee: After successful completion of Ph.D. qualifying viva examination, the student can register for independent study course and work for the preparation of the research proposal to be submitted for approval of the Research committee along with the topic and Supervisor. The document is prepared under the guidance of Doctoral Advisory Committee (DAC). The student is expected to complete and submit the research proposal for thesis within two semesters after passing the qualifying viva examination. The Doctoral Advisory Committee (DAC) for each research scholar which will be constituted by research committee.

1.5.3. Ph.D. Proposal Screening Committee: Each faculty can have their own proposal screening committee. This committee reviews the thesis proposals submitted by candidates, approves and allots thesis & supervisor after the candidate defends his/her thesis proposal.

The screening committee checks for the objectives of the proposed work, literature review, proposed methodology and followed by the data analysis (not exceeding 20 pages) and will decide on one of the following:

a. Committee accepts the proposal and recommends approval of the same.

b. Recommends the student to make revisions in the proposal and resubmit the proposal.

c. Rejects the proposal, stating reasons.

By beginning of third academic year, students are required to defend their thesis proposals. Proposals approved by the committee are scheduled for defense seminar, attended by DAC, department faculty members, fellow Ph.D. students and the screening committee. There is no provision of transfer of Ph.D. candidate from IcfaiTech to any other University.

1.6. Allocation of Ph.D. Thesis Supervisor

1.6.1. The allocation of a supervisor for a research scholar shall be decided by the research committee. The available specialization among the supervisors and research interests of the scholars as indicated at the time of interview.

1.6.2. A retired teacher may be permitted to continue to guide Students already registered under him/her before retirement.

1.6.3. Research committee may recommend a second supervisor considering the nature of the research topic of the student within or outside IcfaiTech who fulfill the same eligibility criteria as the main supervisor.

1.6.4. In exceptional cases, where the research topic of the candidate is interdisciplinary in nature, research committee may recommend a third supervisor.

1.6.5. In case a supervisor moves out of IcfaiTech before the submission of the Thesis by the candidate then a new supervisor is to be recommended by Research Committee. However, original supervisor who has supervised the scholar for at least one year may continue as a co-supervisor, subject to approval of Vice Chancellor. In case a supervisor proceeds on long leave i.e., for six months, then he/she shall cease to continue as a supervisor provided he/she has supervised the candidate for less than one year and/or moved out of India. In all such cases, a new supervisor will be appointed. In case supervisor has proceeded on long leave, supervised the candidate for at least one year and is located within India then he/she may continue as co-supervisor subject to the limit that number of supervisors should not exceed three.

1.6.6. In case a supervisor (s) is not available due to any reason and a Ph.D. thesis has been submitted, Research Committee will appoint an administrative supervisor to take care of the process of evaluation of the thesis.

1.7. Nomination of Panels of Examiners:

1.7.1. Panels of examiners consisting of five experts will be proposed by IcfaiTech in consultation with research committee.

1.7.2. The panel of examiners includes two from within the state, one from outside the state, one from IISc/IIT's/NIT's and one from outside India.

1.7.3. The research committee will finalize the examiners, to whom the thesis will be sent for evaluation after obtaining their approval.

1.7.4. The approved examiners will be approached, along with the copy of the Ph.D. Synopsis seeking their approval.

1.8. Submission of Ph.D. Thesis

1.8.1. In the fourth academic year, students are required to complete the Ph.D. thesis work and submit the thesis for evaluation.

1.8.2. Candidates have to qualify in the course work and is eligible for Ph.D. thesis submission.

1.8.3. Candidates have to submit the report to the Doctoral Committee and the meetings are conducted twice in an academic year where the candidate's progress is assessed.

1.8.4. Candidates shall publish research paper in two National and one international Journal (with A* or A or B category)

1.8.5. Change of the title of the thesis by the student is permitted in exceptional cases on prior approval from screening committee. supervisor has to provide justifications for the change of title and request for the same in the prescribed format.

1.8.6. Transfer of the candidate from one supervisor to other supervisor will be based on screening committee's decision.

1.8.7. While submitting the thesis for evaluation, the thesis shall have an undertaking from the student and a certificate from the thesis supervisor attesting the originality of the work, ensuring that the thesis is free from plagiarism and the work has not been submitted for the award of any degree of same University or any other University.

1.8.8. Plagiarism percentage can be less than 10%.

1.9. Fellowship/Teaching Assistantship

1.9.1. IcfaiTech offers a fellowship/teaching assistant ship of Rs. 40,000/- per month. However, there are also merit based fellowships scheme are introduced.

S. No.	Fellowship/Assistantship amount
1.	10% Full assistantship + Full fee waiver
2.	15% Full assistantship + Half fee waiver
3.	25% Full assistantship + Half fee waiver
4.	15% Full assistantship + Full fee waiver
5.	15% Full assistantship + Half fee waiver
6.	20% Full assistantship + No fee waiver

1.9.2. After successful defense of thesis proposal, full time Ph.D. students may be required to involve in teaching, research or any other academic related activities.

1.9.3. Students are required to work up to 20 hours per week as a part of teaching assistantship.

1.10. Evaluation of Ph.D. Thesis

1.10.1. The external examiners are supposed to give their evaluation reports with their recommendations within 10 weeks of the receipt of the Ph.D. thesis.

1.10.2. If the evaluation reports are not received by the external examiner within a period of 10 weeks then the research committee may send a reminder to the concerned examiner(s) to send the reports within 2 weeks of the receipt of the reminder.

1.10.3. In case if the reports are not received even after the extended period, then research committee would take appropriate decision to evaluate the Thesis.

1.10.4. The evaluation reports and recommendations from the external examiner will be submitted to research committee for further action.

1.10.5. If the reports and recommendations are not satisfactory from all examiners, then the Ph.D. Thesis will be rejected.

1.11. Extension/rejection of Ph.D. Thesis

1.11.1. The candidate is allowed to renew his/her registration to continue the work on the same topic and under the same supervisor(s) based on research committee's recommendation. Research committee has all rights to extend/reject the registration.

1.11.2. Re-registration will be totally terminated if the student fails to submit the fresh thesis within the stipulated time from the date of re-registration decided by the research committee.

1.11.3. No renewal will be allowed for second time.

1.12. Open Ph.D. Defense

1.12.1. The candidate is required to defend his/her Ph.D. work once the thesis is accepted and an open Viva-Voce examination will be held. If the student defends satisfactorily at the time of Viva-Voce examination then the degree will be awarded.

1.12.2. On the completion of final Viva-Voce examination, the examiners will give their report in the prescribed format. The candidate is required to submit the final thesis in the required format, incorporating all the suggestions of the external examiners both in soft and hard copies within the time limit specified by the research committee.

1.12.3. After receiving the final form of the thesis, Registrar will present the same along with the reports of all the examiners to the Research Committee. Chairperson who in turn will forward all the required documents to the Vice Chancellor and finally the Vice Chancellor will decide the award of the Ph.D. degree to the candidate. A provisional certificate will be issued to the candidate.

1.12.4. The original Ph.D. degree will be awarded in Convocation.

The Academic Year

At IcfaiTech, the academic year is divided into two semesters (First Semester and the Second Semester) and a term called Summer Term. Each semester is of 18 weeks duration and summer term of 8 weeks duration.

The eligibility for a degree is determined on the basis of number of units completed. The minimum stipulated number of units for various degree programs are given below

The various components of the Ph.D programme are: Course-work, Qualifying Examination, Foreign language, Teaching Practice/Practice Lecture series, Seminar/Independent Study and Thesis.

Course work

Year	Semester I		Semester II	
	Course Title	**Credits**	**Course Title**	**Credits**
I	Research Methodology-I	5	Research Methodology-II	5
	Course - II	5	Course - II	5
	Course -III	5	Course -III	5
	Course -IV	5	Course -IV	5
	Total credits	**20**	**Total credits**	**20**
PhD Qualifying Examination				

Student admitted for Ph.D in Engineering will be required to complete Research Methodology-I and II as part of the course work, if they have not been completed during M.Tech. He may also be required to register for other courses if He/she intends to do research in an area different from his/her area of higher degree or if the Select Committee identifies some deficiency areas that need improvement. Number of courses will be decided by the Select Committee in order to prepare the candidate to undertake research in chosen area.

The courses taken can be of the level of M.Tech or Ph.D.

A candidate should not obtain E grades and not more than one D grade in a semester and should maintain a minimum CGPA of 5.50. If a student does not maintain the stipulated minimum grades or has a CGPA of less than 5.50, the DCC can give a student one more opportunity to repeat the course(s).

The student must clear the allotted course work within the prescribed time, namely, two semesters after admission. However, Doctoral Counselling Committee can give additional time, a maximum of one semester, if a student fails to obtain the minimum prescribed grades and CGPA.

Courses offered from the department in the current semester are

- Research Methodology-I
- Applied Machine Learning
- Communication Protocols in IoT

Course No: RM501	Course Title: Research Methodology-I	L	P	U
		3	0	5

Course Objectives:

- To know current state of affairs in area of integration of a research scholar.
- ability of survey, summarized and identify gapes as well as feasibility.
- demonstrate ability of technical writing as well as usage of relative s/w tools.
- technology forecasting next two decades.

Prerequisite:

Real & Complex Analytics (Two books of Walter Rudin); Linear Algebra (1st three chapters of CR Rao); Operation Research and Graph Theory (Any popular book, must be able to tell Larry Page Rank Algo).

Course Contents

UNIT-I

Introduction to Philosophy, Nature & Scope Concept & Branches. Introduction to Ethics, Moral Philosophy, Nature of moral judgments and reactions.

Scientific Conduct, Ethics with respect to science and research, Intellectual honesty and research integrity, Scientific Misconduct Falsification, Fabrication, Plagiarism. Redundant Publication, Duplicate and Overlapping publications ,Salami Slicing, Selective Reporting and Misrepresentation of data

UNIT-II

Definition, Introduction and Importance, Best Practices/Standards setting initiatives and guidelines: COPE, WAME, etc.

Conflicts of Interest, Publication Misconduct, Definition, Concept, Problems that lead to unethical behavior and vice versa, types, Violation of publication ethics, Authorship and Contributions, Identification of publication misconduct, complaints and appeals.

Open access publications and Initiatives, SHERPA/ROMEO online resource to check publisher copyright & self-archiving policies, Software tool to identify predatory publications developed by SPPU, Journal finder/Journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggested, etc.

UNIT-III

Group Discussions Subject specific ethical issues. FFP, Authorship, Conflicts of Interest, Complaints and Appeals, Examples and Fraud from India and abroad. Software Tools Use of plagiarism like Turnitin, Urkund and other open source software tools, For empirical studies/simulation etc.: Matlab / Octave; R, Python among others.

UNIT-IV

Databases and Research Metrics Indexing databases, Citation databases: Web of Sciences, Scoupus, etc. Research Metrics, Impact Factor of journal as per Journal Citation Report, SNIP, SJR, IPP, Cite Score, Metrics: h-index, g index, i10index, almetrics.

Technical Report Writing , Documentation Survey of research papers on an area of interest. Passion, Capability & Marketability will be validated ,To be updated on weekly basis, Current advances, summary, bibliography, Technology Forecasting: Possible areas that are feasible and are likely to be future, New ideas & Feasibility.

UNIT-V

Software Tools & Prototypes / Simulation of Algos: This will run parallel and is essential for technical report, Must learn and prove can use software tool for writing.

Student has to prove capability in at least two computational tools among: Python, Mat Lab / Octave; R; SAS; Mathematical

Reference Books:

1. Dr. Ron Iphofen , "Handbook of Research Ethics and Scientific Integrity", Springer International Publishing, 2020
2. David Koepsell, "Scientific Integrity and Research Ethics", Springer International Publishing, 2017.
3. Hub Zwart, "Tales of Research Misconduct", Springer International Publishing, 2017.

Learning Outcomes:

Upon successful completion of the course, student should have skill development through

- Ability to understand and practice Ethics, Integrity in Research
- Ability to read, refer, papers in area of interest and produce Technical Paper
- Ability to use Software Tools such as MatLab, SAS, R among others

Research Methodology-II
L P U: 4 0 4

Course Objectives:

- To recognize the analogies that can be drawn between the fundamental elements of all four types of systems: electrical, mechanical, fluid and thermal.
- To perform frequency analysis and plot the frequency responses.
- To learn first order, second and higher order math models.
- To learn different optimization techniques and genetic algorithms

Contents:

Unit I- Basic building blocks for modeling engineering systems: Introduction, Electrical elements, Mechanical components, Fluid elements, Thermal elements, Importance of analogies.

Unit II- Constructing, analyzing and practical applications of first-order math models: Introduction to math models, Tools for developing math models, First –order math models, Response to a step input, Response to a sinusoidal input, Response to other input functions, power analysis, Applications through case study.

Unit III- Constructing, analyzing and practical applications of second-order math models: Constructing second order math models, Analyzing second order math models using numerical solution methods, Analyzing second order math models using exact solution methods, Applications through case study.

Constructing, analyzing higher order math models: Constructing and analyzing higher-order math models.

Unit IV- Optimization techniques and genetic algorithms: Overview of optimization techniques, Case study. Fundamentals of genetic algorithms, Single objective genetic algorithm, Multi objective evolutionary algorithm.

Unit V- Qualitative analysis: Nature and applications of qualitative research in social and organizational research, Conceptualization of qualitative research and formulation of problem statements and research questions, Qualitative research study design, Qualitative data collection procedures.

References:

1. Modeling Engineering Systems, Jack W. Lewis, High Text Publication, Inc, 1994.
2. Neural Networks, Fuzzy Logic, and Genetic Algorithms: Synthesis And Applications- S. Rajasekaran, G. A. Vijayalakshmi Pai, PHI Learning Pvt. Ltd , Kindle edition, 2003.
3. Nptel: Optimization Methods - Web course
4. Nptel: Design and Optimization of Energy Systems- Course syllabus.

5. Swayam: Modeling and Simulation of Dynamic Systems by Pushpa Raj Mani Pathak
6. Link: https://swayam.gov.in/courses/3557-modelling-and-simulation-of-dynamic-systems

Course Outcomes: Skill development

- To construct a math model of a real world engineering system
- To analyze power requirements for engineering systems
- To analyze and solve higher order math models using various techniques
- To solve real world problems using genetic algorithms
- To perform qualitative analysis

Course No: CS501	Course Title: Applied Machine Learning	L	P	U
		2	2	5

Course Objectives:

- The course objective is to study the theory and practice of constructing algorithms that learn (functions) and make optimal decisions from data and experience.
- Machine learning is a field with goals overlapping with other disciplines, in particular, statistics, algorithms, engineering, or optimization theory.
- It also has wide applications to a number of scientific areas such as finance, life sciences, social sciences, or medicine.

Course Contents

UNIT-I

Mathematical foundations of machine learning:

Random variables and probabilities, probability distributions, high-dimensional spaces, overview of machine learning, supervised, semi-supervised, unsupervised learning, inductive and transductive frameworks, Basics of parameter estimation, maximum likelihood and maximum a posteriori, Bayesian formulation.

UNIT-II

Classification algorithms:

Linear and non-linear algorithms, perceptron, logistic regression, naive Bayes, decision trees, neural networks, support vector machines, regression algorithms, least squares linear regression, neural networks.

UNIT-III

Kernel Methods:

Kernels with classification and regression)**:** Representation learning and matrix factorization (nonlinear), dimensionality reduction, sparse coding, and basics of graphical models, Bayesian networks, e.g., hidden Markov model, inference and estimation.

UNIT-IV

Ensemble Methods:

Bagging, boosting, random forests, practical aspects in machine learning, data preprocessing, over fitting, accuracy estimation, and parameter and model selection.

UNIT-V

Special Topics: Introduction to PCA learning, sample selection bias, learning from graph data, learning from sequential data.

Reference Books:

1. Pattern Recognition and Machine Learning,- by C. M. Bishop, Springer 2006.
2. Machine Learning - by Tom M. Mitchell, McGraw-Hill, 1997
3. The Elements of Statistical Learning - by T. Hastie, R. Tibshirani, and J. Friedman, 2009.

Learning Outcomes:Skill development

Upon successful completion of the course, student will be able to

- Understand the Mathematical Models which are applicable for Machine Learning.
- Demonstrate ability to manipulate with maximum likelihood and maximum a posteriori, Bayesian formulation.
- Apply the concept of Correlation and Regression to the engineering problems.
- Apply various kernel methods to the complex problems in Machine Learning.

Course No: CS502	Course Title: Communication Protocols in IoT	L	P	U
		3	0	5

Course Objectives

1. Understand the basic building blocks of IoT Technology
2. Explore the vast communication technologies in IoT
3. Develop IoT Application
4. Explain to analyze the performance of various communication protocols of IoT
5. Describe to choose the appropriate communication protocol for the given requirements
6. Describe to Customize the communication technologies for the given applications

UNIT-I

Intoduction :Cellular systems- Frequency Management and Channel Assignment- types of handoff and their characteristics, dropped call rates & their evaluation -MAC – SDMA – FDMA – TDMA – CDMA – Cellular Wireless Network. Introduction to IoT-Definition & Characteristics of IoT , Physical Design of IoT- Things in IoT , IoT Protocols, Logical Design of IoT- IoT Functional Blocks.IoT Levels. 3 Layer and 5 Layer Architecture of IoT

UNIT -II

MAC Layer Protocols : IEEE 802.15.4, Blue Tooth, Bluetooth Low Energy, Blue Tooth 5, IEEE 802.11 AH, LoRAWAN Technology, Sigfox, NB IOT.

UNIT -III

Network layer and Service Layer Protocols : IPV4, Mobile Ad Hoc Routing Protocols: AODV, DSR, DSDV Zigbee, - WSN routing – OLSR- data aggregation, IPV6, 6LowPAN, RPL

Transport Layer Protocols : Indirect TCP – Snooping TCP – Mobile TCP – Fast Retransmit / Fast Recovery – Transmission/Timeout Freezing-Selective Retransmission – Transaction Oriented TCP-, UDP over wireless Networks

UNIT -IV

Application Layer : CoAP, MQTT, XMPP, AMQP & WebSockets, Application Development: Interfacing LoRAWAN end module with Gateway, Raspberry PI Programming :Interfacing with Bluetooth and database, Clent server communication with Wi-Fi, IoT with cloud via Thinsspeak, MQTT Client server Communication,CoAP Client server communication

UNIT -V

M2M communications--Difference between IoT and M2M, SDN for IoT-Software Defined Networking, NFV for IoT-Software Defined Networking, Network Function Virtualization.

References:

1. Jochen Schiller, "Mobile Communications", Second Edition, Pearson Education,200
2. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), —Architecting the Internet of Things‖, Springer, 2011.
3. Olivier Hersent, David Boswarthick, Omar Elloumi , —The Internet of Things – Key applications and Protocols‖, Wiley, 2012
4. Robert Davidson, Akiba, Carles Cufi, Kevin Townsend ,- Getting Started with Bluetooth Low Energy, O'Reilly Media, Inc.May 2014
5. Sethi and Smruti R. Sarangi- Internet of Things: Architectures, Protocols, and Applications, Hindawi Journal of Electrical and Computer EngineeringVolume 2017
6. C. Siva Ram Murthy, and B. S. Manoj, "Ad Hoc Wireless Networks: Architectures and Protocols ", Prentice Hall Professional Technical Reference, 2008.
7. ArshadeepBagha, Vijay Madisetti, "Internet of Things-A hands-on Approach", Universal Press 2018.Introduction to Expert Systems, Jackson P., 3rd edition, Addison Wesley, ISBN 0-201-87686-8

Learning Outcomes: Skill development

Upon successful completion of the course, student will be able to:

1. Understand the basic building blocks of IoT Technology
2. Understand and differetiate the vast communication technologies in IoT
3. Develop IoT Application
4. Analyze the performance of various communication protocols of IoT
5. Choose the appropriate communication protocol for the given requirements
6. Customize the communication technologies for the given applications

Research Methodology-I
L P U: 4 0 4

Course Objectives:

- To develop research orientation among the scholars with the fundamentals of research methods
- To introduce the basic concepts in research, research methods and their approach
- To include literature survey, research design, techniques, collection and analysis of data
- To develop an understanding of the ethical dimensions of conducting applied research

Contents:

Unit I - Introduction to research and research process overview: Research: Meaning of Research, research motivation and objectives, research and scientific method. Research Approaches: Descriptive vs. analytical research, applied vs. fundamental research, quantitative vs. qualitative research, conceptual vs. empirical research. Significance of research. Research methodology: An introduction. Research Process: Basic overview, Criteria of Good research, Formulating the research problem, Defining the research problem. Research questions, research methods vs. research methodology.

Unit II - Essence of research methodology: Stages of research problem: Selecting the research topic, defining the research problem, importance of literature survey and reference collection in defining a problem. Literature review: Primary and secondary sources, journals, patents, web as a source. Development of working methodology.

Unit III - Designing and planning of experiments, time management: Research design: Meaning of research design, need for research design, different research designs, Observation of Laws and theories, predictions and explanation. Experimental design: Basic principles of experimental designs, planning of experiments for achieving aims and objectives, Importance of reproducibility of research work.

Unit IV – Methods of data collection and analysis: Collection of data: Collection of primary data, secondary data, sampling merits and demerits of experiments, procedure and observation methods, sampling errors. Statistical data analysis: Introduction to statistics: Probability theories, Conditional probability, Poisson distribution, binomial distribution and normal distributions, estimates of means and proportions, Chi-Square Test, Association of attributes: T-test, standard deviation, coefficient of variations. Types of analysis: Correlation and regression analysis. Introduction to statistical packages, plotting of graphs.

Unit V – Interpretation, report and thesis writing: Meaning of interpretation and its precautions, significance of report writing, different steps in writing report- layout and structure, layout of research report. Types of report writing: research papers, thesis, research project reports, pictures and graphs, citation styles and oral presentation. Application of results and ethics: Research ethics, copy right, intellectual property right and patent law, reproduction of published material, plagiarism, citation and acknowledgement, reproducibility and accountability.

References

1. Research Methodology: Methods and techniques, C. R. Kothari, 2nd revised edition, New Age International Publishers (2004).
2. The preparation of reports, R. P. Baker, A. C. Howell, New York: Ronald Press (1938).
3. Statistical methods, Edwards, L. Allen, 2nd edition, New York: Holt, Rinehart and Winston (1967).
4. Statistical methods for research workers, R. A. Fisher, 13th edition, New York: Hafner Publishing Co., (1960).
5. The design of experiments, R. A. Fisher, 7th revised edition, New York: Hafner Publishing Co., (1960).
6. Introductory statistical analysis, Harnett, L. Donald and Murphy, L. James, Philippines: Addison Wesley Publishing Co., Inc., (1975).
7. The research report: A guide for the beginner, Johnson, Ellen, New York: Ronald Press (1951).
8. Elementary Statistics, Ullman, R. Neil, New York: John Wiley and Sons, Inc., (1978).
9. Statistics: An Introductory Analysis, T. Yamane, 3rd edition, New York: Prentice-Hall (1960).
10. Research design: Qualitative, Quantitative and Mixed methods approaches, John W. Creswell, 2nd edition, Sage publications (2003).
11. Practical Research: Planning and Design, P. D. Leedy and J. E. Ormrod, Prentice Hall (2004).
12. Conducting research literature reviews: From the internet to paper, A. Fink, Sage Publications (2009).
13. Research Methodology: Concepts and cases, Chawla, Deepak and Sondhi, Neena, Vikas Publishing House Pvt. Ltd. Delhi (2011).
14. Data collection and analysis, 2nd edition, Edited by Roger Sapsford and Victor Jupp, Sage publications (2006).
15. Fundamental of Research methodology and statistics, Yogesh Kumar Singh, New Age International Publishers (2006).

Course Outcomes: Skill development

- To establish a common basis for the PhD research education as well as to provide insight into the history and theory of science, qualitative and quantitative research methodology and research ethics
- To apply the knowledge and skills for the interpretation of data analysis and presentation in user friendly formats
- To provide insight into the theory of science, research methodology and research ethics

Research Methodology-II
L P U: 4 0 4

Course Objectives:

- To recognize the analogies that can be drawn between the fundamental elements of all four types of systems: electrical, mechanical, fluid and thermal.
- To perform frequency analysis and plot the frequency responses.
- To learn first order, second and higher order math models.
- To learn different optimization techniques and genetic algorithms

Contents:

Unit I- Basic building blocks for modeling engineering systems: Introduction, Electrical elements, Mechanical components, Fluid elements, Thermal elements, Importance of analogies.

Unit II- Constructing, analyzing and practical applications of first-order math models: Introduction to math models, Tools for developing math models, First –order math models, Response to a step input, Response to a sinusoidal input, Response to other input functions, power analysis, Applications through case study.

Unit III- Constructing, analyzing and practical applications of second-order math models: Constructing second order math models, Analyzing second order math models using numerical solution methods, Analyzing second order math models using exact solution methods, Applications through case study.

Constructing, analyzing higher order math models: Constructing and analyzing higher-order math models.

Unit IV- Optimization techniques and genetic algorithms: Overview of optimization techniques, Case study. Fundamentals of genetic algorithms, Single objective genetic algorithm, Multi objective evolutionary algorithm.

Unit V- Qualitative analysis: Nature and applications of qualitative research in social and organizational research, Conceptualization of qualitative research and formulation of problem statements and research questions, Qualitative research study design, Qualitative data collection procedures.

References:

7. Modeling Engineering Systems, Jack W. Lewis, High Text Publication, Inc, 1994.
8. Neural Networks, Fuzzy Logic, and Genetic Algorithms: Synthesis And Applications- S. Rajasekaran, G. A. Vijayalakshmi Pai, PHI Learning Pvt. Ltd , Kindle edition, 2003.
9. Nptel: Optimization Methods - Web course
10. Nptel: Design and Optimization of Energy Systems- Course syllabus.

11. Swayam: Modeling and Simulation of Dynamic Systems by Pushpa Raj Mani Pathak
12. Link: https://swayam.gov.in/courses/3557-modelling-and-simulation-of-dynamic-systems

Course Outcomes: Skill development

- To construct a math model of a real world engineering system
- To analyze power requirements for engineering systems
- To analyze and solve higher order math models using various techniques
- To solve real world problems using genetic algorithms
- To perform qualitative analysis

Advanced Discipline Course
Computational Intelligence
L P U: 4 0 4

Course Objectives:

- To introduce the fundamental theory and concepts of computational intelligence methods, in particular neural networks, fuzzy systems, genetic algorithms and their applications in the area of machine intelligence
- To gain comprehensive theoretical knowledge as well as practical skills related to the CI approaches, algorithms and methods

Contents:

Unit I: Introduction to soft computing: Soft computing constituents and conventional artificial intelligence, Neuro-fuzzy, Soft computing characteristics.

Unit II: Fuzzy sets: Introduction, Basic definitions and terminology, Set-theoretic operations, MF formulation and parameterization, More on fuzzy union, Intersections, Complement.
Fuzzy rules and fuzzy reasonings: Extension principles and fuzzy relations, Fuzzy If-Than rules and Fuzzy reasoning. Fuzzy inference systems: Mamdani fuzzy models, Sugeno fuzzy models, Tsukamoto fuzzy models, Other considerations.

Unit III: Derivative free optimization: Genetic algorithm, simulated annealing, Random search, Downhill simplex search.

Unit IV: Adaptive networks: Architecture, Back propagation for feed forward networks, Extended back propagation for recurrent networks, hybrid Learning rule.
Supervised learning neural networks: Perceptions, Adaline, Back propagation multi layer perceptions, Radial basis function networks, modular Networks. Learning from reinforcement: Introduction. Unsupervised learning and other neural networks: Competitive learning networks, Kohonen self organizing networks, Learning vector quantization, Hebbian learning, Principal component networks, and The Hopfield networks.

Unit V: Adaptive Neuro-Fuzzy inference systems: ANFIS architecture, Hybrid learning Algorithms, Learning methods that cross fertilize ANFIS and RBNF, Simulation examples.

References:

1. Neuro Fuzzy and Soft Computing, S. R. Jang, C. T. Sun, E. Mizutani, Pearson Education 2009.
2. Neuro - Fuzzy & Soft Computing : A Computational Approach to Learning and Machine Inttelligence, J. S. R. Jang, C. T. Sun, E. Mizutani, Pearson Education, First Edition, 2015

Course Outcomes: Skill development

- To design and build CI algorithms and approaches to real-life problems
- To analyze and solve major challenges and risks in computational intelligence
- To implement solutions for various problems in computational intelligence

Advanced Discipline Course
Next Generation Computing
L P U: 4 0 4

Course Objective:

8. To get knowledge on Systems on chips (SoCs) systems.
9. To study how the process information and execute critical tasks at higher speed and lower power on a tiny chip.
10. To study evolution of multicore system from fairly simple unicore single memory designs to complex homogeneous/heterogeneous multicore SoC.

Contents:

Unit I: Introduction to multicore systems on-chip: The Multicore revolution, Multicore SoC basics, Multicore SoCs design challenges. Multicore SoCs design methods: Design space exploration, Parallel software development phase, Generic architecture template (GAT) for Real multicore SoC design.

Unit II: Multicore SoC organization: MCSoC building blocks, MCSoC memory hierarchy, Memory consistency in multicore systems. Multicore SoC on-chip interconnection networks, Network-on-chip architecture, Hardware design of on-chip network.

Unit III: Advanced multicore SoC interconnects: Three-dimensional on-chip interconnect, Photonic on-chip interconnect for high-bandwidth multicore SoCs. 3D Integration technology for multicore systems on-chip: 3D integration technology, Fault-tolerant TSV cluster for 3D integration, Adaptive Online TSV Sharing Algorithm.

Unit IV: Parallelizing compiler for single and multicore computing: Parallel queue compiler, Parallelizing compiler framework, Parallelizing compiler development results.

Unit V: Power optimization techniques for multicore SoCs: Power-Aware technological-level design optimizations, Power-aware logic-level design optimizations, Power-aware system level design optimizations.

References:

1. Advanced Multicore Systems-On-Chip Architecture, On-Chip Network, Design, Abderazek Ben Abdallah, Springer, 2017.
2. Multicore Technology Architecture, Reconfiguration, and Modeling and Modeling, Muhammad Yasir Qadri, Stephen J. Sangwine, CRC Press Taylor & Francis Group, 2014.
3. Fundamentals of Multicore Software Development, Victor Pankratius, Ali-Reza Adl-Tabatabai, Walter Tichy, CRC Press Taylor & Francis Group, 2012.
4. High Performance Computing, Kevin Dowd, Charles R. Severance, Second Edition, O'REILLY, 1993.
5. Multicore Systems On-Chip: Practical Software/Hardware Design, Abderazek Ben Abdallah, Atlantis Press, 2010.

Course Outcomes: Skill development

1. To expertise in the areas of SoCs, Multicore system Architectural design and many core systems.
2. To analyze basic network topology, design with multicore chip network design and communication.

Interdisciplinary Course
Internet of Things
L P U: 4 0 4

Pre-requisites: Basic Programming Knowledge

Can be offered to: CE, ECE, EEE and ME

Course Objective:

- To understand the application areas of IOT
- To realize the revolution of Internet in Mobile Devices, Cloud & Sensor Networks
- To understand building blocks of Internet of Things and characteristics
- To understand IoT principles, design and abstraction of developing IoT systems

Contents:

UNIT I: Introduction to Internet of things: Introduction-definition & characteristics of IoT , Physical design of IoT- things in IoT , IoT protocols, Logical design of IoT- IoT functional blocks, IoT communication models, IoT communication APIs , IoT enabling technologies-Wireless sensor networks , Cloud computing, Big data analytics, Communication protocols , Embedded systems, IoT levels & deployment templates.

UNIT II: Domain specific IoTs and home automation: Smart lighting, Smart appliances, Intrusion detection, smoke/gas detectors. Cities-smart parking, Smart lighting, Smart roads, Structural health monitoring, Surveillance, Emergency response. Environment-weather monitoring, Air pollution monitoring, Noise pollution monitoring, Forest fire detection, River floods detection .Energy- smart grids , Renewable energy systems , Prognostics. Retail-inventory management, Smart payments, Smart vending machines. Logistics-Route generation & scheduling, Fleet tracking, Shipment monitoring, Remote vehicle diagnostics. Agriculture-smart irrigation, Green house control. Industry –Machine diagnosis & prognosis indoor air quality monitoring. Health & lifestyle –Health & fitness monitoring, Wearable electronics.

UNIT III: IoT and M2M: Introduction, M2M-Difference between IoT and M2M, SDN and NFV for IoT-Software defined networking, Network function virtualization.

UNIT IV: IoT platforms design methodology: IoT design methodology-purpose & requirements specification, Process specification, Domain model specification, Information model specification, Service specifications, IoT level specification, Functional view specification , Operational view specification , Device & component integration , Application development, Case study on IoT System for weather monitoring, Motivation for using python IoT physical devices & endpoints.

What is an IoT Device-Basic building blocks of an IoT Device, Exemplary device: Raspberry Pi, About the board, Linux on Raspberry Pi , Raspberry Pi interfaces – Serial, SPI , I2C , programming Raspberry Pi with Python-Controlling LED with Raspberry Pi , Interfacing an LED and switch with Raspberry Pi ,Interfacing a light sensor (LDR) with Raspberry Pi , Other IoT Devices- PCDuino, Beagle bone black , Cubieboard.

UNIT V: IoT & beyond: Use of big data and visualization in IoT, Industry 4.0 concepts. Overview of RFID, Low-power design (Bluetooth Low Energy), Range extension and data intensive IoT for continuous recognition applications. Overview of Android / IOS App Development tools & Internet of Everything.

References:

- Internet of Things, A Hands on Approach, Arshdeep Bahga, Vijay audisetti, Orient Blackswan Private Limited - New Delhi; First edition, 2015.
- The Internet of Things How Smart TVs, Smart Cars, Smart Homes, and Smart Cities Are Changing the World, Michael Millen, Pearson Education, Inc., 2015.

Course Outcomes: Skill development

- To design and develop IoT on a variety of open source devices and software services
- To integrate a variety of IoT devices, sensors and services to build complex applications

Interdisciplinary Course
Modern Computer Architecture
L P U: 4 0 4

Pre-requisites: Computer Organization and Architecture

Can be offered to: ECE, EEE

Course Objective:

- Able to describe the operation of modern and high performance computers.
- To undertake performance comparisons of modern and high performance computers.

Contents:

Unit I: Introduction- Review of basic computer architecture, Quantitative technique in computer design measuring and reporting performance, Amdahl's law, Flynn's classification, CISC and RISC processors.

Unit II: Pipelining- Basic concepts, Instructions and arithmetic pipelines, Structural hazards, data hazards and control hazards, Techniques for handling hazards, Exception handling, Pipeline optimization technique.

Unit III: Hierarchical memory technology- Multi cache problem, Inclusion, Coherence and locality properties, Cache memory organizations, Technique for reducing cache misses, Virtual memory organization techniques and management techniques, Memory replacement policies.

Unit IV: Instruction level parallelism- Basic concepts, technique for increasing ILP, Super-scalar, Super-pipelined VLIW processor architectures, Array and vector processors, SMT, Hyper threading.
Multiprocessor architectures: Taxonomy of parallel architecture.

Unit V: Centralized shared Memory Architecture- Synchronization, memory consistency inter connection networks, Distributed shared memory architecture, Cluster computing, Cloud Computing, Grid technology.

References

1. Computer Architecture: A Quantitative Approach, John Hennessy, David Patterson; Imprint: Morgan Kaufmann, November 2017.
2. Computer Architecture and Parallel Processing, K. Hwang and F.A. Briggs, Mc-Graw Hill, 1984.
3. Advanced Computer Architecture: Parallelism, Scalability and Programmability, Kai Hwang, Mc-Graw Hill. 2008

4. Advanced Concepts of Operating System, M. Singhal and N.G.Sivaratri, Tata-Mc-Graw Hill Publication, 2005

Course outcomes: Skill development

- To solve computationally intensive problems
- To improve the performance of applications on modern and high performance computers.
- To develop procedures to improve the performance of modern and high performance computers.

Specialization Elective
Machine Learning
L P U: 4 0 4

Course Objective:

- To introduce well defined learning problems.
- To summarize classification and regression.
- To gain knowledge in Artificial Neural Networks.
- To understand dimensionality reduction, clustering and association analysis.
- To introduce reinforcement learning.

Contents:

Unit I: Introduction- Well defined learning problems, Designing a learning system, Issues in machine learning; The concept learning task - General-to-specific ordering of hypotheses, Find-S, List then eliminate algorithm, Candidate elimination algorithm, Inductive bias.

Unit II: Classification- Linear classification, Logistic regression, Linear discriminant analysis, Quadratic discriminant analysis, Support vector machines, Decision Trees, Baye's optimal classifier, Naive Baye's, Regression- Linear regression, Ridge regression, Lasso.

Unit III: Artificial neural networks: Perceptron, Gradient descent and the Delta rule, Adaline, Multilayer networks, Derivation of back-propagation, rule-Back-propagation Algorithm-Convergence, Generalization.

Unit IV: Dimensionality reduction: Principal component analysis, Partial least squares clustering: K-means, K-medoids, Fuzzy C- Means ,Hierarchal, Gaussian mixture, Association analysis: Apriori, FP –Growth, Hidden Markov model, SVD.

Unit V: The learning task, Q Learning, Nondeterministic rewards and actions, Temporal difference learning, Generalizing from examples, Relationship to dynamic programming.

References:

1. Machine Learning, Tom M .Mitchell, McGraw Hill, 1997.
2. Pattern Recognition and Machine Learning Christopher Bishop, Springer, 2006.
3. Data mining : practical machine learning tools and techniques, I. H.; Frank, Eibe.; Hall, Mark A. 3rd ed. : Burlington, MA : Morgan Kaufmann, cop. 2011.
4. Neural Networks - A Class Room Approach, Satish Kumar, Second Edition, Tata McGraw-Hill, 2013.
5. Neural networks Fuzzy logics and Genetic algorithms, S. Rajasekaran and G.A. Vijayalakshmi Pai, Prentice Hall of India, 2004

Course Outcome: Skill development

- To understand real word learning problems.
- To develop supervised learning application.
- To design unsupervised learning application

Specialization Elective

Natural Language Processing
L P U: 4 0 4

Course Objective:

- To introduce the fundamental concepts and techniques of natural language processing (NLP)
- To gain an in-depth understanding of the computational properties of natural languages and the commonly used algorithms for processing linguistic information
- To examine NLP models and algorithms using both the traditional symbolic and the more recent statistical approaches

Contents:

Unit I: Language processing and python- Computing with language, Back to Python, Automatic natural language understanding.
Processing raw text- Accessing text from the web and from disk, Strings, Text processing with unicode, Regular expressions for detecting word patterns, Useful applications of regular expressions, Normalizing text, Regular expressions for tokenizing text.

Unit II: Categorizing and tagging words- Using a tagger, Tagged corpora, Mapping words to properties using python dictionaries, Automatic tagging, N-Gram tagging, Transformation-Based tagging.
Learning to classify text- Supervised classification, Further examples of supervised classification, Evaluation, Decision trees, Naive Bayes classifier, Maximum entropy classifiers, Modeling linguistic patterns.

Unit III: Extracting information from text- Information extraction, Table of contents, Chunking, Developing and evaluating chunkers, Recursion in linguistic structure, Named entity recognition, Relation extraction.
Analyzing sentence structure: Some grammatical dilemmas, Context-Free grammar, Parsing with context-free grammar, Dependencies and dependency grammar, Grammar development.

Unit IV: Building feature based grammars- Grammatical features, Processing feature structures, Extending a feature-based grammar.
Analyzing the meaning of sentences: Natural language understanding, propositional logic, First-order logic, Semantics of english sentences, Discourse semantics.

Unit V: Information extraction- Named entity recognition, Relation extraction, Extracting times, Extracting events and their times, Template filling.

References:

1. http://nptel.ac.in/courses/106105152/
2. Machine Learning, An Algorithmic Perspective, Stephen Mars Land, II Edition-, CRC Press, 2009.

Course Outcomes: Skill development

- To develop language processing with the Natural Language Tool Kit (NLTK)
- To Compare and contrast the approaches of natural language processing
- To build applications using Python to work on natural language processing
- To analyze different classification and extraction techniques

Specialization Elective
Mobile Computing
L P U: 4 0 4

Course Objective:

- To introduce the field of Mobile and Wireless Technology, its history and Research scope.
- To understand the motivation and importance of various wireless MAC schemes.
- To gain knowledge about GSM (Global System for Mobile Communication), UMTS (Universal Mobile Telecommunication Systems) etc.
- To introduce Mobile IP and Mobile Transport Layer for Mobile Computing.
- To have knowledge on MANETs and WAP.

Contents:

Unit I: Introduction- A short history of wireless communication, A market for mobile communications, Open research topics, Simplified reference model. Wireless transmission-frequencies, Signals, Antennas and Signal propagation.

Unit II: MAC: Motivation for a specialized MAC, SDMA, FDMA, TDMA and CDMA, Comparisons.

Unit III: Telecommunication systems: GSM, DECT, TERA, UMTS and IMT-2000.
Satellite systems: History, Applications, Basics, Routing, Localization and handover. Broadcast systems- Overview, Cyclical repetition of data, Digital audio broadcasting, Digital video broadcasting, Convergence of broadcasting and mobile communications.

Unit IV: Wireless LAN: Infrared Vs Radio transmission, Infrastructure and Adhoc networks, IEEE 802.11, HIPERLAN, Bluetooth.

Unit V: Mobile network layer- Mobile IP, Mobile IP, DHCP, MANETs. Mobile transport layer: Traditional TCP, Classical TCP improvements and WAP, TCP over 2.5/3G wireless networks, Performance enhancing proxies. Support for mobility- File systems, WWW, Wireless application protocol, I-mode, SyncML, WAP 2.0.

References:

1. Mobile Communications, JochenSchiller, Second Edition, Pearson publication, 2003.
2. Hansmann, Merk, Nicklous, Stober, "Principles of Mobile Computing", Springer, second edition, 2003.
3. Martyn Mallick, "Mobile and Wireless Design Essentials", Wiley DreamTech, 2003.

Course Outcome: Skill development

- To analyze Compare 3G Cellular telephone data transfer rates with those over Wireless LAN
- To analyze different variations of Mobile IP and Mobile Transport Layer.
- To formulate various challenges involved in MANETs

Specialization Elective
Distributed Systems
L P U: 4 0 4

Course Objective:

- To learn the characteristics of a distributed OS
- To study issues related to the principles and paradigms of distributed system environment
- To study the various shared memory approaches and issues related to it
- To get knowledge about various cache concurrency control protocols

Contents:

Unit I: Introduction: Definition, Relation to computer system components, Relation to parallel multiprocessor/multicomputer systems, Message passing systems versus shared memory systems, Primitives for distributed communication, Synchronous versus asynchronous executions, Design issues and challenges. Model of distributed computations, Model of distributed executions, Models of communication network, Global state of a distributed system, Cuts of a distributed computation, Models of process communications.

Unit II: Architectures: System architectures, Centralized architectures, Decentralized architectures, Hybrid architectures, Architectures versus middle ware, Self-management in distributed systems. Process: Threads, Visualization, Clients, Servers, Code migration.

Unit III: Communication: Fundamentals, Remote procedure call, Message-oriented communication, Stream-oriented communication, Multi-cast communication.
Synchronization: Clock synchronization, Logical clock, Mutual exclusion, Global positioning of nodes, Election algorithms.

Unit IV: Deadlock detection in distributed systems: System model, Preliminaries, Preliminaries, Knapp's classification of distributed deadlock detection algorithms, Mitchell and Merritt's algorithm for the single-resource model, Chandy-Misra-Haas algorithm for the AND model, Chandy-Misra-Haas algorithm for the OR Model, Kshemkalyani-Singhal algorithm for P-out-of-Q Model.
Global predicate detection: Stable and unstable predicates, Modalities on predicates, Centralized algorithm for relational predicates, Conjunctive predicates, Distributed algorithms for conjunctive predicates, Further classification of predicates.

Unit V: Distributed shared memory: Abstraction and advantages, Memory consistency models, Shared memory mutual exclusion, Wait-freedom, Register hierarchy and wait-free simulations, Wait-free atomic snapshots of shared objects.
Check pointing and rollback recovery: Background and definitions, Issues in failure recovery, Checkpoint based recovery, Log-based rollback recovery, Koo-Toueg coordinated check pointing algorithm, Manivannan-Singhal Quasi-Synchronous check pointing algorithm, Peterson-Kearns algorithm based on vector time.

References:

1. Distributed Systems Principles and paradigms, Andrew S.Tanenbaum, Maarten Van Steen, Second Edition, International Edition, Pearson Education, 2007.
2. Distributed Systems Principles and paradigms, Ajay D. Kshemkalyani, Mukesh Singhal, Cambridge Press, 2007.
3. Distributed Systems Concepts and Design, George Coulouris, Jean Dollimore, Tim Kindberg, Gordon Blair, Fifth Edition, Addison-Wesley, 2012.
4. Design and Analysis of Distributed Algorithms, Nicola Santoro, john wiley & sons, inc., publication, 2007.
5. Distributed Operating Systems Theory and Practice, Yakup Paker, Jean-Pierre Banatre, Muslim Bozyigit, NATO Advanced Science Institutes Series, Springer - Verlag, 1986.

Course Outcomes: Skill development

1. To analyze distributed platforms
2. Expertizing about standard distributed algorithms and approaches
3. Ability to develop distributed mutual exclusion algorithms

Specialization Elective
Parallel computing
L P U: 4 0 4

Course Objective:

- To introduce the foundations of parallel computing, including parallel architectures, parallel programming methods and techniques
- To know about parallel algorithm designs, and parallel performance analysis

Contents:

Unit I: Introduction to parallel computing, Motivating parallelism, Scope of parallel computing, Parallel programming platform, Principles of parallel algorithm design, Preliminaries, Decomposition techniques, Characteristics of tasks and interactions, Mapping techniques for load balancing, Methods for containing interaction overheads, Parallel algorithm model.

Unit II: Basic communication operations- One-to-All broadcast and All-to-One reduction, All-to-All broadcast and reduction, All-Reduce and Prefix-Sum operations, Scatter and Gather, All-to-All personalized communication, Circular shift, Improving the speed of some communication operations.

Unit-III: Analytical modeling of parallel programs- Sources of overhead in parallel programs, Performance metrics for parallel systems, Effect of granularity on performance, Scalability of parallel systems, Minimum execution time and minimum cost-optimal execution time, Asymptotic analysis of parallel programs.

Unit-IV: Programming using the message-passing paradigm- Principles of message, Passing programming, Building blocks: Send and receive operations, MPI: the message passing interface, Topologies and embedding, Overlapping communication with computation, Collective communication and computation operations, Groups and communicators.

Programming shared address space platforms- Thread basics, POSIX Thread API, Synchronization primitives, Controlling thread and synchronization attributes, Thread cancellation, Composite synchronization constructs.

Unit V: Dense matrix algorithms, Sorting, Graph algorithms, Search algorithms for discrete optimization problems, Dynamic programming- Overview of dynamic programming, Serial monadic DP formulations, Nonserial monadic DP formulations, Serial polyadic DP formulations, Nonserial polyadic DP formulations

References:

1. Introduction to Parallel Computing, Ananth Grama, Anshul Gupta, George Karypis, Vipin Kuma,r Addison Wesley, 2nd edition, 2003.
2. https://onlinecourses.nptel.ac.in/noc18_cs55/preview

Course Outcomes: Skill development

- To analyze how large scale parallel systems are architectured and how massive parallelism are implemented in accelerator architectures
- To write parallel programs for large scale parallel systems, shared address space platforms, and heterogeneous platforms
- To design efficient parallel algorithms and applications

Specialization Elective
Software Project Management
L P U 4 0 4

Course Objectives

- To deliver successful software projects that support organization's strategic goals
- To match organizational needs to the most effective software development model
- To plan and manage projects at each stage of the software development life cycle (SDLC)
- To create project plans that address real-world management challenges
- To develop the skills for tracking and controlling software deliverables

Contents

Unit I: Activities in software project management, Overview of project planning, Stepwise planning, Contract management, Software processes and process models, Cost benefit analysis, Cash flow forecasting, Cost-benefit evaluation techniques, Risk evaluation. Project costing.

Unit II: COCOMO 2, Staffing pattern, Effect of schedule compression, Putnam's equation, Capers Jones estimating rules of thumb, Project sequencing and scheduling activities, Scheduling resources, Critical path analysis, Network planning, Risk management, Nature and types of risks, Managing risks.

Unit III: Hazard identification, Hazard analysis, Risk Planning and control, PERT and monte carlo simulation techniques, Monitoring and control, Collecting data, Visualizing progress, Cost monitoring, Review techniques, Project termination review, Earned value analysis, Change control.

Unit IV: Software configuration management (SCM), Managing contracts, Types of contracts, Stages in contract placement, Typical terms of a contract, Contract management and acceptance, Quality management and people management.

Unit V: Introduction, Understanding behavior, Organizational behaviour, Selecting the right person for the job, Motivation, Oldman – Hackman Job characteristics model, Working in groups, Organization and team structures, Decision making, Leadership, Organizational structures, Stress, Health and safety, ISO and CMMI models, Testing, Software reliability, Test automation.

References:

1. Software Project Management, Bob Hughes, Mike Cotterell, , Fifth Edition, Tata McGraw Hill, 2011.
2. http://nptel.ac.in/courses/106101061/29
3. Effective Software Project Management, Robert K. Wysocki, Wiley desktop editions, 2009.

Course Outcomes: Skill development

- To analyze issues and challenges faced while doing the software project management.
- To explore how the failure probability can be reduced effectively in software project management
- To implement project scheduling, tracking, Risk analysis, Quality management and Project Cost estimation using different techniques.

Specialization Elective
Information Security Management (Security Analyst – I)
LPU 4 0 4

Course Objective:

- To introduce the information security terminology, technology and its applications
- To introduce the concept of security analyst
- To introduce the tools, technologies & programming languages which is used by security analyst

Contents:

Unit I: Information security management- Information security overview, Threats and attack vectors, Types of attacks, Common vulnerabilities and exposures (CVE), Security attacks, Fundamentals of information security, Computer security concerns, Information security measures etc.

Unit II: Fundamentals of information security- Key elements of networks, Logical elements of network, Critical information characteristics, Information states etc.

Unit III: Data leakage- What is data leakage and statistics, Data leakage threats, Reducing the risk of data loss, Key performance indicators (KPI), Database security etc.

Unit IV: Information security policies, Procedures and audits- Information security policies- Necessity-key elements & characteristics, Security policy implementation, Configuration, Security standards-guidelines & frameworks etc.

Unit V: Information security management roles and responsibilities- Security roles & responsibilities, Accountability, Roles and responsibilities of information security management, Team-responding to emergency situation-risk analysis process etc.

References:

1. Management of Information Security, Michael E.Whitman ,Herbert J.Mattord Cengage Learning, third edition, 2010.
2. http://www.iso.org/iso/home/standards/management-standards/iso27001.htm
3. http://csrc.nist.gov/publications/nistpubs/800-55-Rev1/SP800-55-rev1.pdf

Course Outcomes: Skill development

- To explore the policies, guideline and framework of information security
- To analyze the Roles and Responsibilities of ISM
- To analyze data leakage statistics, threats, security issues measures and mitigation.
- To design key elements and logical elements of networks.

Specialization Elective
Deep Learning
L P U: 4 0 4

Course Objective:

- To introduce the field of Deep Learning, its history and Research scope.
- To understand the motivation and importance of various Deep Learning/ Deep Neural Networks in the context of Visual Recognition.
- To gain knowledge about Image Classification, Loss Function and Optimization.
- To introduce CNN and RNN.

Contents:

Unit I: Modern practical deep networks- Deep Feedforward Networks, regularization for deep learning, optimization for training deep models, Introduction to CNN, Convolutional networks, Image Classification, Sequence modeling, Recurrent and recursive nets, Practical methodology, Applications.

Unit II: Loss function and optimization, Back propagation in neural networks. Training neural networks, deep learning softwares.

Unit III: CNN architectures, Recurrent neural networks. Detection and segmentation, Visualizing and understanding, Deep reinforcement learning.

Unit IV: Deep learning research-Linear factor models, Autoencoders, Representation learning, Structured probabilistic models for deep learning, Monte Carlo methods, Confronting the partition function, Approximate inference, Deep generative models.

References:

1. Deep Learning- An MIT Press book, Ian Goodfellow and Yoshua Bengio and Aaron Courville, The MIT Press, 2016.
2. http://cs231n.stanford.edu/
3. http://cs231n.stanford.edu/slides/2017/
4. http://cs231n.stanford.edu/slides/2018/

Course Outcome: Skill development

- To analyze deep Learning in the Context of Image/Video Classification/Recognition
- To work on loss function and optimization in deep learning
- To solve the problems using deep learning softwares

Specialization Elective
Information Retrieval System
LPU 4 0 4

Course Objective:

- To define various retrieval strategies
- To explain various utilities of the retrieval system and cross language information retrieval
- To measure the efficiency of retrieval and query processing and explain various retrieval techniques

Contents:

Unit I: Retrieval strategies- Vector space model, Probabilistic retrieval strategies, Language models, Inference networks, Extended boolean retrieval, Latent semantic indexing, Neural networks, Genetic algorithms, Fuzzy set retrieval.

Unit II: Retrieval utilities- Relevance feedback, Clustering, Passage-based retrieval, N-grams, Regression analysis, Thesauri, Semantic networks, Parsing.

Unit III: Cross-Language information retrieval- Introduction, Crossing the language barrier, Cross-language retrieval strategies, Cross language utilities. Efficiency- inverted index, Query processing, Signature files, Duplicate document detection.

Unit IV: Integrating structured data and text- Review of the relational model, Historical progression, Information retrieval as a relational application, Semi-structured search using a relational schema, Multi-dimensional data model.
Parallel information retrieval- Parallel text scanning, Parallel indexing, Clustering and classification, Large parallel systems.

Unit V: Scalability challenges in web search engines: Components, Objectives, Parameters, Scalability issues and open problems

References:

1. Information Storage and Retrieval Systems: Theory and Implementation, Kowalski, Gerald, Mark T Maybury, Springer US, second edition, 2002.
2. Mining the Web: Discovering knowledge from hypertext data, Chakrabarti, Soumen, Morgan Kaufmann, 1st edition, 2002.
3. Information retrieval: Algorithms and heuristics, Grossman, David A, Ophir Frieder, Vol. 15, Springer Science & Business Media, 2012.

Course Outcomes: Skill development

- To compute the similarity measure between collections of documents using different approaches and represent any problem as a state space search.
- To apply various retrieval techniques to improve the efficiency.
- To compute the similarity coefficient for retrieval of relevant documents of cross language in nature.
- To implement various optimization techniques to improve the efficiency of information retrieval.
- To perform information retrieval from various distributed sources in different forms.
- To design and build the working model of information retrieval system.

Specialization Elective
Energy Efficiency in Wireless Sensor Networks
L P U 4 0 4

Course Objective:

- To introduce the field of Wireless Sensor Networks, its history and Research scope.
- To understand the motivation and importance of various Wireless Sensor Networks in the context of limited storage, computation and communication capabilities.
- To gain knowledge about Energy efficient MAC protocols for WSN.
- To introduce Energy Efficient Routing protocols for WSN.
- To introduce several TCP protocols for WSN.

Contents:

Unit I: Introduction and overview of wireless sensor networks, Applications of wireless sensor networks, Basic wireless technology- Sensor node technology, Sensor taxonomy, WN operating environment, WN Trends.
Wireless transmission technology and systems- Radio technology primer, Available wireless technologies.

Unit II: MAC for wireless sensor networks- Fundamentals of MAC protocols, MAC protocols for WSN, Sensor-MAC case study, IEEE 802.15.4 LR-WPANs standard case study.
Routing protocols for wireless sensor networks- Introduction, Background, Data dissemination and gathering, Routing challenges and design issues in wireless, Routing strategies in wireless sensor networks.

Unit III: Transport control protocols for wireless sensor networks- Traditional transport control protocols, Transport protocol design issues, Examples of existing transport control protocols, Performance of transport control protocol.
Middleware for Wireless Sensor Networks- WSN middleware principles, Middleware architecture, Existing middleware.

Unit IV: Network management for wireless sensor networks- Network management requirements, Traditional network management models, Network management design issues, Example of management architecture: MANNA, Other issues related to network management. Operating systems for wireless sensor networks- Operating system design issues, Examples of operating systems.

Unit V: Performance and traffic management- Introduction, Background, WSN design issues, Performance modeling of WSNs, Case study: Simple computation of the system life span.

References:

1. Wireless Sensor Networks – Technology, Protocols and Applications, Kazem Sohraby, Daniel Minoli, TaiebZnati, Wiley India Pvt, Ltd., 2007.
2. Wireless Sensor Networks: A Networking Perspective, Jun Zheng, Abbas Jamalipour, Wiley, 2008.
3. Protocols and Architectures for Wireless Sensor Networks, Holger Karl, Andreas Willig, Wiley, 2006.

Course Outcome: Skill development

- To analyze several energy efficient MAC and routing protocols for WSN.
- To analyze different transport layer protocols for WSN
- To design solutions for challenges involved in WSN.

Specialization Elective
Real Time Systems
L P U 4 0 4

Course Objective:

4. To learn the **characteristics** of real time OS.
5. To study issues related to the methods and analysis of systems with real-time restraints.
6. To study the various uniprocessor and multiprocessor scheduling approaches.
7. To get knowledge about various real time communication protocols.
8. To become master in differentiating traditional and real time databases.

Contents:

Unit I: Introduction to real time computing – Concepts, Example of real-time applications, Structure of a real time system, Characterization of real time systems and tasks, Hard and soft timing constraints, Design challenges, Performance metrics, Prediction of execution time - source code analysis, Micro-architecture level analysis, Cache and pipeline issues, Programming languages for real time systems.

Unit II: Real time OS, Threads and tasks, Structure of microkernel, Time services, Scheduling mechanisms communication and synchronization, Event notification and software interrupt.

Unit III: Task assignment and scheduling, Task allocation algorithms, Single-processor and multiprocessor task scheduling, Clock-driven and priority-based scheduling algorithms, Fault tolerant scheduling

Unit IV: Real time communication, Network topologies and architecture issues, Protocols, contention based, Token based, Polled bus, Deadline based protocol, Fault tolerant routing. RTP and RTCP.

Unit V: Real time databases, Transaction priorities, Concurrency control issues, Disk scheduling algorithms, Two phase approach to improve predictability.

References:

1. Real Time Systems, C.M. Krishna, Kang G. Shin, International Edition, McGraw Hill Companies, Inc., New York, 1997
2. Real-Time Systems, Jane W.S. Liu, Pearson Education India, 2000.
3. Real-Time Systems Design and Analysis: Tools for the Practitioner, Philip A. Laplante and Seppo J. Ovaska, IV Edition IEEE Press, Wiley. 2011.
4. Real-time Simulation Technologies Principles, Methodologies, and Applications, Katalin Popovici, Pieter J. Mosterman, CRC Press is an imprint of Taylor & Francis Group, 2013.
5. Real-Time Systems Development, Rob Williams, Elsevier, 2006.

Course Outcome: Skill development

1. To design communication protocols using real-time programming platforms.
2. To analyze real-time tasks schedulability.
3. To analyze real time communication protocols and databases.
4. To develop real time system tasks.

Specialization Elective
High Performance Computing
L P U 4 0 4

Course Objective:

1. To get knowledge on developments and applications field of computational science.
2. To study basics of modern processor architecture and serial optimization techniques.
3. To study the various uniprocessor and multiprocessor scheduling approaches.
4. To discuss critical issues in data movement.

Contents:

Unit I: Modern processors- Stored program computer architecture, General-purpose cache based microprocessor architecture, Memory hierarchies, Multicore processors, Multithreaded processors, Vector processors. Basic optimization techniques for serial code, Scalar profiling, Common sense optimizations, Simple measures, Large impact, The role of compilers, C++ optimization.

Unit II: Data access optimization- Balance analysis and light speed estimates, Storage order, Algorithm classification and access optimizations. Parallel computers, Taxonomy of parallel computing paradigms, Shared-memory computers, Distributed-memory computers, Hierarchical (Hybrid) systems, Networks, Case Study, Sparse matrix, Vector multiply.

Unit III: Basics of parallelization- Parallelism, Parallel scalability. Shared-memory parallel programming with Openmp- Short introduction to Openmp, Advanced Openmp- wavefront parallelization, Case study- Openmp-parallel Jacobi algorithm.

Unit IV: Efficient Openmp programming- Profiling Openmp programs, Performance pitfalls. Locality optimizations on Ccnuma architectures- Locality of access on Ccnuma, Placement pitfalls, Ccnuma issues with C++, Case study- Parallel sparse matrix-Vector multiply.

Unit V: Distributed-memory parallel programming with MPI: Message passing, Short introduction to MPI, Example: MPI parallelization of a Jacobi solver. Efficient MPI programming: MPI performance tools, Communication parameters, Synchronization, Serialization, Contention, Reducing communication overhead. Hybrid parallelization with MPI and Openmp: Basic MPI/Openmp programming models, MPI taxonomy of thread interoperability, Hybrid decomposition and mapping.

References:

1. Introduction to High Performance Computing for Scientists and Engineers, Georg Hager, Gerhard Wellein, CRC Press Taylor & Francis Group, 2011.
2. Advances in Computers High Performance Computing, Marvin v. zelkowitz, Elsevier, 2008.
3. High Performance Computing, Kevin Dowd, Charles R. Severance, Second Edition, O'REILLY, 1993.

Course Outcomes: Skill development

1. To analyze real-time programming platforms.
2. To expertise in the areas of parallel processing in shared, non-uniform access, and distributed memories.
3. To develop parallel programs in OpenMP and MPI.

Specialization Elective
Software Testing
L P U 4 0 4

Course Objectives:

- To use various test tools
- To know about test processes
- To know about errors, fault models and software testing techniques

Contents:

Unit I: Introduction: Introduction to software testing, software testing terminology and methodology, Verification and validation, Evolution of testing, Software testing life cycle, V-model for software testing, Testing and debugging, Levels of testing, Software defect management, flow graphs, Code-based testing, Logic based testing, Configuration management, Risk analysis, Model based testing, Statistical testing, Formal testing.

Unit II: Testing techniques: Dynamic testing: White-box testing.
Static testing: Sliced based testing, mutation testing, Coverage analysis, Defect seeding.
Regression testing: Regression test process, Test case selection, Test case prioritization, Code based and model based regression testing.

Unit III: Testing process: Test Planning: Test policy, Test strategy, Quality plan and test plan, Test estimation, Test scenario, Test scripts, Test log document, Generation of test data, Test progress monitoring.

Test metrics and test reports: Testing data, Categories of product test metrics, Resource consumed in testing, Defect density, Test reports, Project test status reports, Integration, System and acceptance test report, Test process improvement, Benchmarking.

Unit IV: Testing Strategies: Integration and system testing- Top down and bottom up integration, Bi-directional integration, System integration, Scenario testing, Defect bash, Functional vs non-functional testing, Design/architecture verification, Deployment testing, Scalability testing, Reliability testing, Stress testing.
Acceptance testing: Acceptance testing criteria, Alpha, Beta and Gamma testing, Acceptance testing during each phase of SDLC Criticality of requirements, Software acceptance plan, User's responsibility.

Unit V: Test management and automation: Software test automation, Scope of automation, Design and architecture for automation, FSM based testing, generic requirements for test tool framework, Testing tool selections, Testing in object oriented systems, Testing web based system. Current research and emerging trends in software testing.

References:

1. Software Testing: Principles and Practices, S. Desikan and G. Ramesh, Pearson, first edition, 2005.
2. http://nptel.ac.in/courses/106105150/

Course Outcomes: Skill development

- To analyze different testing techniques
- To implement different testing techniques to explore the testing process easier

Specialization Elective
Information Security Assessments & Audits (Security Analyst – II)
L P U 4 0 4

Course Objective:

- To introduce the terminology, technology and its applications
- To understand and knowledge of Security Analyst foundations
- To introduce tools, technologies and programming languages which is used by security analyst

Contents:

Unit I: Information security performance metrics and audit- Security metrics and reporting, Common issues and variances of performance metrics, Introduction to security audit, Servers and storage devices, Infrastructure and networks, Communication routes, Information security Methodologies (Black-box, White-box, Grey-box), Phases of information security audit and strategies, Ethics of an information security auditor etc.

Unit II: Information security audit tasks, Reports and post auditing actions- Pre-audit checklist, Information gathering, Vulnerability analysis, External security audit, Internal network security audit, Firewall security audit, IDS security auditing, Social engineering security auditing, Web application security auditing, Information security audit deliverables & writing report, Result analysis, Post auditing actions, Report retention etc.

Unit III: Vulnerability management-information security vulnerabilities, Threats and vulnerabilities, Human-based social engineering, Computer-based social engineering, Social media countermeasures, Vulnerability management, Vulnerability scanning, Testing, Threat management, Remediation etc.

Unit IV: Information security assessments- Vulnerability assessment, Classification, Types of vulnerability assessment, Vulnerability assessment phases, Vulnerability analysis stages, Characteristics of a good vulnerability assessment solutions &considerations, Vulnerability assessment reports – tools and choosing a right tool, Information security risk assessment, Risk treatment, Residual risk, Risk acceptance, Risk management feedback loops etc.

Unit V: Configuration reviews- Introduction to configuration management, Configuration management requirements, Plan, Control, Development of configuration control policies, Testing configuration management etc

References:

1. Assessing Information Security strategies, tactics, logic and framework, A Vladimirov, K.Gavrilenko, and A.Michajlowski, IT Governance Publishing, 2010
2. The Art of Computer Virus Research and Defense by Peter Szor, Addison-Wesley Professional, 2005.
3. https://www.sans.org/reading-room/whitepapers/threats/implementing-vulnerability-management-process-34180
4. http://csrc.nist.gov/publications/nistpubs/800-40-Ver2/SP800-40v2.pdf

Course Outcome: Skill development

- To analyze the difference between Security Metrics and Audits
- To analyze Information Security Audit Tasks, Reports and Post Auditing Actions
- To understand Information Security Assessments

Specialization Elective
Social Network Analysis
L P U 4 0 4

Course Objective:

- To understand the concept graph essentials and related applications.
- To learn Graph Algorithms and Network Measures.
- To understand Network Models and Community Analysis.
- To learn Data Mining Algorithms.

Contents:

Unit I: Social media mining, Challenges for mining, Graph essentials, Graph basics, Nodes edges, Degree and degree distribution, Graph representation, Types of graphs, Connectivity in graphs, Special graphs, Trees and forests, Special sub-graphs, Complete graphs, Planar graphs, Bipartite graphs, Regular graphs, Bridges, Application.

Unit II: Graph algorithms- Graph/Tree traversal, Shortest path algorithms, Minimum spanning trees, Network flow algorithms, Maximum bipartite matching, Bridge detection. Network measures, Centrality, Degree centrality, Eigenvector centrality, Katz centrality, Page rank, Betweenness centrality, Group centrality, Transitivity and reciprocity: Transitivity, Reciprocity, Balance and status, Similarity- structural equivalence, Regular equivalence

Unit III: Network models- Properties of real-world networks: Degree distribution, Clustering coefficient, Average path length, Random graphs- Evolution of random graphs, Properties of random graphs, Modeling real-world networks with random graphs, Small-World model- Properties of the small-world model, Modeling real-world networks with the small-world model, Preferential attachment model: properties of the preferential attachment model, Modeling real-world networks with the preferential, Attachment model.

Unit IV: Community analysis- Community detection, Community detection algorithms, Member-based community detection, Group-based community detection, Community evolution, How networks evolve, Community detection in evolving networks, Community evaluation: evaluation with ground truth, Evaluation without ground truth.

Unit V: Data mining essentials- Data, Data quality, Data preprocessing, Data mining algorithms- Supervised learning: Decision tree learning, Naive Bayes classifier, Nearest Neighbor classifier. Classification with network information, Regression, Supervised learning evaluation, Unsupervised learning- Clustering algorithms, Unsupervised learning evaluation.

References:

1. Social Media Mining: An Introduction, Reza Zafarani, Mohammad Ali Abbasi, Huan Liu, Cambridge University Press; first edition, 2014.
2. Mastering Social Media Mining with Python, Marco Bonzanini, Packt Publishing. 2016

Course Outcome: Skill development

- To develop social network related applications.
- To implement the graph algorithms and network measures in social network.
- To predict social network behavior and related communities.
- To implement the data mining algorithms in real world network.

Advanced Discipline Course
Wavelets in Signal Processing and Image Processing
L P U: 4 0 4

Course Objectives:

- To implement wavelets and related constructions.
- A particular emphasis will be put on constructions that are amenable to efficient algorithms.
- Establish the relationship between wavelets, multirate filter banks, and multi resolution analysis studied in the mathematics, signal processing, and computer vision communities respectively.

Contents:

Unit I: wavelets, subband coding and multiresolution signal processing. Hilbert spaces, orthonormal bases. Multirate signal processing: review Discrete-time bases.

Unit II: Analysis of Haar and Sinc Expansions of Discrete-Time Signals.Orthonormal and Linear Phase filter banks. onstruction of Daubechies filters.Lattice Factorization of Filter Banks.

Unit III: Construction by lifting: "next-generation" wavelets.Tree-structured filter banks and Wavelet-Packets. Multichannel Filter Banks / IIR filter banks.Discrete-Time Wavelet Series. Lapped Orthogonal Transforms.Series Expansions of Continuous-Time Signals.Haar and Sinc wavelets.

Unit IV: Adapted wavelet and wavelet packet representations.Best Bases algorithms.Arbitrary tilings of the time-frequency plane based on wavelets. Applications to signal compression. Review of Rate-Distortion, KLT, Optimal Bit Allocation principles.Basics of Quantization Theory. pplications to image and video compression.State-of-the-art wavelet image coders:Role of wavelets in next-generation image compression standard JPEG-2000. Applications of multiresolution concept to communications/networking:Joint source-channel coding, broadcast and multicast.Video over the Internet and Wireless Channels

References:

1. M. Vetterli and J. Kovacevic. Wavelets and Subband Coding. Prentice Hall, 1995.
2. S. Mallat. A Wavelet Tour of Signal Processing. Academic Press, 1998
3. G. Strang and T. Nguyen. Wavelets and Filter Banks. Wellesley-Cambridge Press, 1996.

Course Outcomes: Skill development

- Apply wavelets, filter banks, and multiresolution techniques to a problem at hand, and justify why wavelets provide the right tool.
- Analyze and implement algorithms behind wavelets from an interdisciplinary perspective that unifies harmonic analysis (mathematics), filter banks (signal processing), and multiresolution analysis (computer vision).

Specialization Elective
Pattern Recognition and Neural Networks
L P U: 4 0 4

Course Objective:

- To understand Bayes Classification, Nearest Neighbor Rule, Neural Networks
- To explain classification techniques such as Support Vector Machines and Multi classifiers for solving Bio-Medical problems.

Contents:

Unit I: Introduction to pattern recognition, introduction to classifier design and supervised learning from data, classification and regression.

Unit II: Bayesian decision theory, Bayes and nearest neighbour classifiers, parametric and non-parametric estimation of density functions, linear discriminant functions, Perceptron, linear least-squares regression, LMS algorithm

Unit III: Fisher linear discriminant, introduction to statistical learning theory and empirical risk minimization, non-linear methods for classification and regression

Unit IV: Artificial neural networks for pattern classification and regression, multilayer feed forward networks, back propagation, RBF networks, Optimal separating hyperplanes. Applications.

Unit V: Support Vector Machines and some variants, Assessing generalization abilities of a classifier, Bias-variance trade-off, cross validation, bagging and boosting, AdaBoost algorithm, brief discussion of feature selection and dimensionality reduction methods.

References:

1.Neural networks for pattern recognition by Omid Omidvar, Judith Dayhoff,Academic Press,USA,First Edition,1995.
2.R.O.Duda,P.E.Hart and D.G.Stork,Pattern Classification, John Wiley,First Edition 2002.
3.C.M.Bishop, Neural Networks and Pattern Recognition, Oxford University Press (Indian Edition),First Edition 2003

Course Outcomes: Skill development

1.The students would analyze different algorithms for learning pattern classifiers
2.The students would explore different datasets to get a Design for machine learning algorithms.
3.The statistical and optimization principles underlying different algorithms would be emphasized and designed machine learning Applications.

Specialization Elective
Digital Signal Compression
L P U: 4 0 4

Course Objective:

- To understand the fundamental concepts and coding methods of signal compression.
- To understand the Principles of lossless compression.
- To develop the various entropy coding techniques, including Huffman coding, arithmetic coding and Lempel-Ziv coding.

Contents:

Unit I: Data types, Basic compression process,applications, methods, Entropy and lossless coding, Source transformations, set portioning coding, coding systems

Unit II: Lossless source coding and entropy, variable length codes, entropy coding techniques, Huffman codes, Shannon FanoElias, Arithmetic, Run length, modified Huffman, Golomb and Dictionary codes.

Unit III: Lossy compression of scalar sources, coding of sources with memory.

Unit IV: Mathematical transformations, rate control in transform coding system

Unit V: Set partition coding, subband/wavelet coding system

.

References:

1.Digital Signal Compression Principles and Practice by William A. Pearlman,First Edition,2011,Cambridge University Press
2.Tools for Signal Compression: Applications to Speech and Audio Coding, Nicolas Moreau,Wiley sonxs,First Edition,2013.
3. Signal Compression: Coding of Speech, Audio, Text, Image and Video,World Scientific Publishing co.Pte.Ltd,First Edition,1997.

Course Outcomes: Skill development

- Analyze and implement step-by-step descriptions of algorithms.
- Analyze and implement mathematical transformations including the KLT, DCT and wavelet transforms.
- Design compression techniques for image processing Applications.

Specialization Elective
Machine Learning
L P U: 4 0 4

Course Objective:

- To introduce the field of Machine Learning, its history and Research scope
- To introduce the concept of Linear and Logistic Regression
- To gain knowledge about Decision trees
- To introduce Probability and Bayes Learning
- To introduce Support Vector Machine and Neural Networks

Contents:

Unit I: Introduction, Different types of Learning, Supervised Learning, Machine Learning Process.
Testing Machine Learning Algorithms- Overfitting, Training, Testing, and Validation Sets, Confusion Matrix, Accuracy Metrics, Receiver Operator Characteristic (ROC) Curve, Unbalanced Datasets, Measurement Precision
Turning Data into Probabilities- Minimizing Risk, Naïve Bayes' Classifier, Basic Statistics

Unit II: Neurons, Neural Networks, and Linear Discriminants- Brain and the Neuron, Neural Networks, Perceptron, Linear Separability, Linear Regression
Multi-Layer Perceptron- Going Forwards, Going Backwards: Back-Propagation of Error, Multi-Layer Perceptron in Practice, MLP, Deriving Back-Propagation.

Unit III: Radial Basis Functions and Splines- Receptive Fields, Radial Basis Function (RBF) Network, Interpolation and Basis Functions
Dimensionality Reduction-Linear Discriminant Analysis (LDA), Principal Components Analysis (PCA), Factor Analysis, Independent Components Analysis (ICA), Locally Linear Embedding, ISOMAP

Unit IV: Probabilistic Learning- Gaussian Mixture Models, Nearest Neighbour Methods
Support Vector Machines- Optimal Separation, Kernels, Support Vector Machine Algorithm, Extensions to the SVM

Unit V: Optimization and Search- Going Downhill, Least-Squares Optimization, Conjugate Gradients, Search: Three Basic Approaches Simulated Annealing, Using Genetic Algorithms, Genetic Programming, Combining Sampling with Evolutionary Learning

References:

1. http://nptel.ac.in/courses/106105152/
2. Machine Learning, An Algorithmic Perspective, Stephen Mars Land, II Edition-, CRC Press, 2009.

Course Outcomes: Skill development

- To explain the basics of Machine Learning Algorithms.
- To explain/apply Linear/ Logistic Regression techniques to problems depending on requirement.
- To explain SVM and Neural Networks.
- To be familiar with various Machine Learning tools.

Inter Disciplinary Course
Internet of Things
L P U: 4 0 4

Pre-requisites: Basic programming knowledge

Can be offered to: CE, ECE, EEE and ME

Course Objective:

- To understand the application areas of IOT
- To realize the revolution of Internet in Mobile Devices, Cloud & Sensor Networks
- To understand building blocks of Internet of Things and characteristics
- To understand IoT principles, design and abstraction of developing IoT systems

Contents:

UNIT I: Introduction to Internet of Things: Introduction-Definition & Characteristics of IoT , Physical Design of IoT- Things in IoT , IoT Protocols, Logical Design of IoT- IoT Functional Blocks, IoT Communication Models, IoT Communication APIs , IoT Enabling Technologies-Wireless Sensor Networks , Cloud Computing, Big Data Analytics, Communication Protocols , Embedded Systems, IoT Levels & Deployment Templates.

UNIT II: Domain Specific IoTs and Home Automation: Smart Lighting, Smart Appliances, Intrusion Detection, Smoke/Gas Detectors. Cities-Smart Parking, Smart Lighting, Smart Roads, Structural Health Monitoring, Surveillance, Emergency Response. Environment-Weather Monitoring, Air Pollution Monitoring, Noise Pollution Monitoring, Forest Fire Detection, River Floods Detection .Energy- Smart Grids , Renewable Energy Systems , Prognostics. Retail-Inventory Management, Smart Payments, Smart Vending Machines. Logistics-Route Generation & Scheduling, Fleet Tracking, Shipment Monitoring, Remote Vehicle Diagnostics. Agriculture-Smart Irrigation, Green House Control. Industry –Machine Diagnosis & Prognosis Indoor Air Quality Monitoring. Health & Lifestyle –Health & Fitness Monitoring, Wearable Electronics

UNIT III: IoT and M2M: Introduction, M2M-Difference between IoT and M2M, SDN and NFV for IoT-Software Defined Networking, Network Function Virtualization.

UNIT IV: IoT Platforms Design Methodology: IoT Design Methodology-Purpose & Requirements Specification, Process Specification, Domain Model Specification, Information Model Specification , Service Specifications , IoT Level Specification, Functional View Specification , Operational View Specification , Device & Component Integration , Application Development, Case Study on IoT System for Weather Monitoring, Motivation for Using Python IoT Physical Devices & Endpoints

What is an IoT Device-Basic building blocks of an IoT Device, Exemplary Device: Raspberry Pi, About the Board, Linux on Raspberry Pi , Raspberry Pi Interfaces – Serial, SPI , I2C ,

Programming Raspberry Pi with Python-Controlling LED with Raspberry Pi , Interfacing an LED and Switch with Raspberry Pi ,Interfacing a Light Sensor (LDR) with Raspberry Pi , Other IoT Devices- PCDuino, Beagle Bone Black , Cubieboard.

UNIT V: IoT & Beyond: Use of Big Data and Visualization in IoT, Industry 4.0 Concepts. Overview of RFID, Low-power design (Bluetooth Low Energy), range extension techniques (data mining and mesh networking), and data intensive IoT for continuous recognition applications. Overview of Android / IOS App Development tools & Internet of Everything.

References:

- Internet of Things, A Hands on Approach, Arshdeep Bahga, Vijay audisetti, Orient Blackswan Private Limited - New Delhi; First edition, 2015.
- The Internet of Things How Smart TVs, Smart Cars, Smart Homes, and Smart Cities Are Changing the World, Michael Millen, Pearson Education, Inc., 2015.

Course Outcomes: Skill development

- To design and develop IoT on a variety of open source devices and software services
- To integrate a variety of IoT devices, sensors and services to build complex applications

Inter Disciplinary Course
Robotics and Automation
L P U: 4 0 4

Pre-requisites: Electrical Science-I,Electrical Science-II.

Can be offered to: ECE, EEE and ME

Course Objective:

- To Describe Evolution of robotics, mobile and manipulator robots, coordinate systems
- To understand kinematic models of manipulators, position, velocity and force control, sensors and actuators
- To explain robotic vision, workspace modeling, task and path planning, industrial robots, manufacturing and autonomous systems, robot programming

Contents:

UNIT I:. Introduction, automation and robotics, Brief History, Types of Robots, Technology of Robots, Basic Principles in Robotics, Classification, Major components and applications. End effectors: Mechanical gripper, Magnetic, Vacuum cup and other types of grippers, General consideration on gripper selection and design, Robot actuator and sensors.

UNIT II: Elementary mechanical concepts, motion conversion, Modeling of mechanical systems, Kinematic chains, End Effectors, Resolution, Repeatability and accuracy of a manipulator. Stepper Motors, DC Motors, Hydraulic actuators, pneumatic systems and servo amplifiers.

UNIT III: Non-optical, optical sensory devices, velocity, proximity sensors, Touch and slip, force and torque sensors. Imaging components, image representation, hardware considerations

UNIT IV: Picture coding, object recognition vision and categorization, software considerations, review of existing systems. Architectural considerations, Hardware considerations, Robot Programming, Path planning and Robot's, computer system.

UNIT V:. Homogeneous coordinates, coordinate reference frames, Homogeneous transformations and the manipulator. Forward and Inverse solution, Motion generation, the Jacobian, controller Architecture, Methods, interpolation and capabilities

References:

1. Mikell P Groover Industrial Robotics: Technology, Programming, and Applications - McGraw-Hill,2nd Edition , 2012
2. Ashitava Ghosal, Robotics: Fundamental concepts & analysis, Oxford,First edition,2006.
3. K. S. Fu, Ralph C. Gonzalez, C.S.G. Lee, Robotics – Tata McGrawHill,First Edition,1988.

Course Outcomes: Skill development

- To Analyze and implement kinematic models of manipulators, position, velocity and force control, sensors and actuators.
- To Implement workspace modeling, task and path planning, industrial robots, manufacturing and autonomous systems, robot programming in real time Applications.

Research Methodology-II
L P U: 4 0 4

Course Objectives:

- To recognize the analogies that can be drawn between the fundamental elements of all four types of systems: electrical, mechanical, fluid and thermal.
- To perform frequency analysis and plot the frequency responses.
- To learn first order, second and higher order math models.
- To learn different optimization techniques and genetic algorithms

Contents:

Unit I- Basic building blocks for modeling engineering systems: Introduction, Electrical elements, Mechanical components, Fluid elements, Thermal elements, Importance of analogies.

Unit II- Constructing, analyzing and practical applications of first-order math models: Introduction to math models, Tools for developing math models, First –order math models, Response to a step input, Response to a sinusoidal input, Response to other input functions, power analysis, Applications through case study.

Unit III- Constructing, analyzing and practical applications of second-order math models: Constructing second order math models, Analyzing second order math models using numerical solution methods, Analyzing second order math models using exact solution methods, Applications through case study.

Constructing, analyzing higher order math models: Constructing and analyzing higher-order math models.

Unit IV- Optimization techniques and genetic algorithms: Overview of optimization techniques, Case study. Fundamentals of genetic algorithms, Single objective genetic algorithm, Multi objective evolutionary algorithm.

Unit V- Qualitative analysis: Nature and applications of qualitative research in social and organizational research, Conceptualization of qualitative research and formulation of problem statements and research questions, Qualitative research study design, Qualitative data collection procedures.

References:

13. Modeling Engineering Systems, Jack W. Lewis, High Text Publication, Inc, 1994.

14. Neural Networks, Fuzzy Logic, and Genetic Algorithms: Synthesis And Applications- S. Rajasekaran, G. A. Vijayalakshmi Pai, PHI Learning Pvt. Ltd , Kindle edition, 2003.
15. Nptel: Optimization Methods - Web course
16. Nptel: Design and Optimization of Energy Systems- Course syllabus.
17. Swayam: Modeling and Simulation of Dynamic Systems by Pushpa Raj Mani Pathak
18. Link: https://swayam.gov.in/courses/3557-modelling-and-simulation-of-dynamic-systems

Course Outcomes: Skill development

- To construct a math model of a real world engineering system
- To analyze power requirements for engineering systems
- To analyze and solve higher order math models using various techniques
- To solve real world problems using genetic algorithms
- To perform qualitative analysis

Advanced Discipline Course
Estimation for Wireless Communications , MIMO /OFDM Cellular and Sensor Networks
L P U: 4 0 4

Course Objective:

- To understand tools and techniques which form the basis for several key applications in modern wireless communications and signal processing
- To describe various signal processing procedures in communication systems such as channel estimation, equalization, synchronization etc.
- To understandMIMO (Multiple-Input Multiple-Output) and OFDM (Orthogonal Frequency Division Multiplexing) based 3G/ 4G wireless systems

Contents:

Unit I: Basics of Estimation, Maximum Likelihood (ML), Properties – Mean/ Variance of Estimate. Wireless Flat-Fading Channel Estimation, Pilot-based MLEstimate, Properties, Example of Channel Estimation.

Unit II: Cramer-Rao Bound (CRB),Vector Parameter Estimation, Multi-Antenna Downlink Mobile Channel Estimation, Least Squares (LS) Principle,Pseudo-Inverse,Properties of LS Estimate, Examples – Mullti-Antenna Downlink and MIMO Channel Estimation.

Unit III: Inter Symbol Interference (ISI), Channel Equalization, Zero-Forcing (ZF) Equalizer, ZF Example 6 Introduction to Orthogonal Frequency Division Multiplexing (OFDM) and Pilot Based OFDM Channel Estimation,Example

Unit IV: Comb Type Pilot (CTP) Transmission, Channel Estimation in Time/ Frequency Domain, CTP Example, Frequency Domain Equalization (FDE), Example-FDE Sequential Least Squares (SLS) Estimation – Scalar/ Vector Cases,Applications- Wireless Fading Channel Estimation,SLS Example.

References:

1.Andrea Goldsmith, ``Wireless Communications,'' Cambridge University Press,First Edition 2005.

2.Andreas F. Molisch, ``Wireless Communications,'' John Wiley and Sons, First Edition,2005.

3.E. G. Larsson and P. Stoica, Information Theory, Space-Time Block Coding for Wireless Communications, Cambridge University Press,First Edition, 2003

4. A. Paulraj, R. Nabar and D. Gore, Introduction to Space-Time WirelessCommunications, Cambridge Univ. Press,First Edition, 2003

Course Outcomes: Skill development

1.Estimate and Design Different Channels MIMO/OFDM Cellular Networks.
2. Analyze and Design Different Channels in sensor networks.

Specialization Elective
Statistical Signal Processing
L P U: 4 0 4

Course Objective:

- To Understand representing real-world signals by stochastic or random processes.
- To describe the tools for analyzing these random signals are developed in the Probability, Random Variables, and Estimation Theory.

Contents:

Unit I: Introduction and Review of Discrete-time Systems

Introduction and course overview. Role of deterministic and random signals, and the various interpretations of random processes in the different physical sciences. Brief review of Fourier transform theorem, transforms for continuous-time, discrete-time, periodic or aperiodic, signals, Parsevals Theorem.The DFT as a linear transformation. Review of discrete-time systems. Basic discrete-time signals. The z-transform and basic properties. Summary of frequently used transform pairs. Rational transfer functions; pole-zero models. Frequency response of LTI systems. Example of inverse bilateral z-transforms, and different approaches to get the same answer; partial fraction expansions using the cover-up rule.

Unit II: Stochastic Processes

Introduction to stochastic processes, predictable processes with an example of harmonic processes, description of stochastic processes using probability density functions (pdfs). Notion of stationary and nonstationary processes. Examples of some predictable processes through a MATLAB demonstration, second-order statistics including mean and autocorrelation sequences, with an example of calculating autocorrelation for a harmonic process. independent, independent and identically distributed random processes, and uncorrelated and orthogonal processes. Introduction to stationary processes, both order-N stationary, strict-sense stationary and wide-sense stationary; example of testing whether a Wiener process is stationary or not, wide sense periodic and wide-sense cyclo-stationary processes. Notion of ergodicity and the notion of time-averages being equal to ensemble averages in the mean-square sense. Second-order statistical descriptions, joint-signal statistics; types of joint stochastic processes, correlation matrices Markov processes.

Unit III: Linear signal models-I

The effect of linear systems on random processes, Discusses the case of LTI systems, and the fact that most real world applications will be a LTV system. System identification using cross-correlation. Frequency-domain analysis of LTI systems, including input-output CPSD and output PSD, LTV systems with non-stationary inputs. Introduction to the notion of parametric modeling. Nonparametric Vs parametric signal models, All-pole models: impulse response, autocorrelation functions, poles, minimum-phase conditions.

Unit IV: Linear signal models-II

Linear prediction, autoregressive (AR) processes, Yule-Walker equations, All-zero models: impulse response, autocorrelation functions, zeros, and moving average (MA) processes, Pole-Zero models: autocorrelation functions, autoregressive moving average (ARMA) processes, Overview of extension to time-varying processes,9. Applications and examples

Unit V: Estimation Theory for Random Processes

Sample autocorrelation and auto-covariance functions, Least-squares for AR modeling, Estimating signals in noise, using parametric signal models, Bayesian estimation of sinusoids in noise, and other applications of Bayesian estimation methods to time-series analysis. Applications of statistical signal processing Digital SAR image processing. Bayesian estimation theory. Case of study: Kalman filter for carrier synchronization.

References:

1.Therrien C. W. and M. Tummala, Probability and Random Processes for Electrical and Computer Engineers, Second edition, CRC Press, 2011.

2.Recommended course text book: Therrien C. W. and M. Tummala, Probability and Random Processes for Electrical and Computer Engineers, Second edition, CRC Press, 2011.

3. Manolakis D. G., V. K. Ingle, and S. M. Kogon, Statistical and Adaptive Signal Processing: Spectral Estimation, Signal Modeling, Adaptive Filtering and Array Processing, McGraw Hill, FirstEditionInc.,2000.

4. Kay S. M., Fundamentals of Statistical Signal Processing: Estimation Theory, Prentice-Hall, Inc.,First Edition,1993.

5. Papoulis A. and S. Pillai, Probability, Random Variables, and Stochastic Processes, Fourth edition,McGrawHill,Inc.,2002.

6.M. S. Grewal, A. P. Andrews, Kalman filtering: theory and practice using Matlab, John Wiley & Sons,First Edition, 2001.

7. H. L. Van Trees, K. L. Bell, Bayesian bounds for parameter estimation of nonlinear filtering/tracking, IEEE Press,First Edition 2007.

Course Outcomes: Skill development

1.Explain, describe, and understand the notion of a random process and statistical time series.

2. Characterize random processes in terms of its statistical properties, including the notion of stationary and ergodicity.

3. Define, describe, and Analyze the notion of the power spectral density of stationary random processes;analyse and manipulate power spectral densities.

4. Analyze in both time and frequency the affect of transformations and linear systems on random processes, both in terms of the density functions, and statistical moments.

5. Explain the notion of parametric signal models, and describe common regression-based signal models in terms of its statistical characteristics, and in terms of its affect on random signals.

Specialization Elective
CAD for VLSI
L P U: 4 0 4

Course Objective:

- To Describe Methods of Computer-Aided Design tools for the modeling.
- To Understand design, analysis, test, and verification of digital Very Large Scale Integration (VLSI) systems

Contents:

Unit I: VLSI DESIGN METHODOLOGIES Introduction, Review of Data structures and algorithms, Review of VLSI Design automation tools,Algorithmic Graph Theory and Computational Complexity, Tractable and Intractable problems, Different methods for combinatorial optimization

Unit II: DESIGN RULES- Layout Compaction, Design rules, problem formulation, algorithms for constraint graph compaction, placement and partitioning, Circuit Representation, Placement algorithms, partitioning.

Unit III: FLOOR PLANNING- Floor planning concepts,shape functions and floor plan sizing, Types of local routing problems, Area routing,channel routing ,global routing,algorithms for global routing.

Unit IV: SIMULATION-Gate-level modeling and simulation, Switch-level modeling and simulation, Combinational Logic Synthesis, Binary Decision Diagrams,Two Level Logic Synthesis. DRC etc. Parasitic extraction, delay and power estimation through post layout simulation

Unit V: MODELLING AND SYNTHESIS -High level Synthesis,Hardware models,Internal representation,Allocation assignment and scheduling, Simple scheduling algorithm, Assignment problem, High level transformations. CAD for analog and mixed signal designs, Memory synthesis. Clock and power routing. Testability, insertion of scan chain.

References:

1.S.H. Gerez, "Algorithms for VLSI Design Automation", John Wiley & Sons,First Edition,2002

2.N.A. Sherwani, "Algorithms for VLSI Physical Design Automation", Kluwer Academic Publishers, First Edition,2002.

3.Giovanni DeMicheli , Synthesis and Optimization of Digital Circuits, McGraw-Hill, Firsat Edition,1994

4.Stephen M. Trimberger (Editor) An Introduction to CAD for VLSI, Springer-Veril0g, First Edition,2002

5. Erik Brunvand, Digital VLSI Chip Design with Cadence and Synopsys CAD Tools, Addison-Wesley,First Edition,2010.

6.Sarrafzadeh, Majid and Wong, C. K., An Introduction to VLSI Physical Design, McGraw-Hill, First Edition,1996.

Course Outcomes: Skill development

1. Analyze CMOS VLSI and associated technologies.
2. Analyze and Design CMOS logic circuits, with particular reference to speed and power consumption.
3. Design the layout by using CAD tools in VLSI design.

Specialization Elective
Testing and verification for SOC Designs
L P U: 4 0 4

Course Objective:

- To understand testing and techniques of VLSI SOCs at higher level design flow.
- To understand Verification techniques of VLSI SOCs at higher level design flow.\
- To introduce functional and timing verification

Contents:

Unit I: Scope of testing and verification in VLSI design process. Issues in test and verification of complex chips, embedded cores and SOCs.

Unit II: Fundamentals of VLSI testing. Fault models. Automatic test pattern generation. Design for testability.

Unit III: Scan design. Test interface and boundary scan. System testing and test for SOCs. Iddq testing. Delay fault testing. BIST for testing of logic and memories. Test automation.

Unit IV: Design verification techniques based on simulation, analytical and formal approaches. Functional verification. Timing verification. Formal verification. Basics of equivalence checking and model checking. Hardware emulation.

References:

1.M. Bushnell and V. D. Agrawal, "Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits", Kluwer Academic Publishers,First Edition, 2000.
2. M. Abramovici, M. A. Breuer and A. D. Friedman, "Digital Systems Testing and Testable Design", IEEE Press,First Edition, 1990.
3. T.Kropf, "Introduction to Formal Hardware Verification", Springer Verilog,First Edition, 2000.
4.P. Rashinkar, Paterson and L. Singh, "System-on-a-Chip VerificationMethodology and Techniques", Kluwer Academic Publishers,First Edition, 2001

Course Outcomes: Skill development

1. Analyze Circuits by using tools related to testing and verification.
2. Design advanced algorithms, and can do Practical analysis of Testing and Verification from research articles.

Interdisciplinary Course
Wireless Sensor Networks
L P U: 4 0 4

Pre requisities: Computer Networks and basic C Programming Knowledge

Course Objective:

1.To introduce the field of Wireless Sensor Networks, its history and Research scope.
2.To understand the motivation and importance of various Wireless Sensor Networks in the context of limited storage, computation and communication capabilities.
3.To gain knowledge about Energy efficient MAC protocols for WSN.
4.To introduce Energy Efficient Routing protocols for WSN.
5.To introduce several TCP protocols for WSN.

Contents:

Unit I: Introduction and overview of wireless sensor networks, Applications of wireless sensor networks, Basic wireless technology- Sensor node technology, Sensor taxonomy, WN operating environment, WN Trends.
Wireless transmission technology and systems- Radio technology primer, Available wireless technologies.

Unit II: MAC for wireless sensor networks- Fundamentals of MAC protocols, MAC protocols for WSN, Sensor-MAC case study, IEEE 802.15.4 LR-WPANs standard case study.
Routing protocols for wireless sensor networks- Introduction, Background, Data dissemination and gathering, Routing challenges and design issues in wireless, Routing strategies in wireless sensor networks.

Unit III: Transport control protocols for wireless sensor networks- Traditional transport control protocols, Transport protocol design issues, Examples of existing transport control protocols, Performance of transport control protocol.
Middleware for Wireless Sensor Networks- WSN middleware principles, Middleware architecture, Existing middleware.

Unit IV: Network management for wireless sensor networks- Network management requirements, Traditional network management models, Network management design issues, Example of management architecture: MANNA, Other issues related to network management.
Operating systems for wireless sensor networks- Operating system design issues, Examples of operating systems.

Unit V: Performance and traffic management- Introduction, Background, WSN design issues, Performance modeling of WSNs, Case study: Simple computation of the system life span.

References:

4. Wireless Sensor Networks – Technology, Protocols and Applications, Kazem Sohraby, Daniel Minoli, TaiebZnati, Wiley India Pvt, Ltd., 2007.
5. Wireless Sensor Networks: A Networking Perspective, Jun Zheng, Abbas Jamalipour, Wiley, 2008.
6. Protocols and Architectures for Wireless Sensor Networks, Holger Karl, Andreas Willig, Wiley, 2006.

Course Outcome: Skill development

- To analyze several energy efficient MAC and routing protocols for WSN.
- To analyze different transport layer protocols for WSN
- To design solutions for challenges involved in WSN.

Advanced Discipline Course
Advanced Materials in Engineering
L P U: 4 0 4

Course Objectives:

The objective of the course is selection and classification of materials, applications of advanced materials like Nonferrous Metals, Alloys, Semiconductor Materials, Polymer Materials, Ceramic Materials, Composite Materials, etc. Nanomaterials, Smart materials, Functionally graded materials (FGMs), Left-handed materials, MAX phase materials, Nondestructive Testing Techniques: Visual Inspection, Ultrasonic Testing, Radiography Testing, Liquid Penetrant testing, Magnetic particle testing, etc.

Contents:

Unit I- Griffth"s Theory, stress intensity factor and fracture Toughness, Toughening Mechanisms, Ductile and Brittle transition in steel, High Temperature Fracture, Creep, Larson – Miller Parameter, Deformation and Fracture mechanism maps.

UNIT II- Fatigue, Low and High cycle fatigue test, Crack Initiation and Propagation mechanism and Paris Law, Effect of surface and metallurgical parameters on Fatigue, Fracture of non-metallic materials, fatigue analysis, Sources of failure, procedure of failure analysis.

UNIT- III - Selection for Surface durability, Corrosion and Wear resistance, Relationship between Materials Selection and Processing, Case studies in Materials Selection with relevance to Aero, Auto, Marine, Machinery and Nuclear Applications. Motivation for selection, cost basis and service requirements, Selection for Mechanical Properties, Strength, Toughness, Fatigue and Creep.

UNIT IV- Smart Materials, Shape Memory alloys, Metallic Glass, Quasi Crystal and Nano Crystalline Materials. Metal-Matrix composites.

UNIT V- MEMS and Microsystems, Evolution of Micro fabrication, Microsystems and Microelectronics, Microsystems and miniaturization, Applications of MEMs in Industries, Micro sensors, Micro actuation, MEMS with Micro actuators Micro accelerometers, Micro fluidics.

References:

1. Mechanical Behaviour of Materials, Thomas H. Courtney, 2nd Edition, McGraw Hill,2000.
2. Mechanical Metallurgy, George E. Dieter, McGraw Hill,1998.
3. Selection and use of Engineering Materials,Charles J.A, Butterworth Heiremann.

4. Foundation of MEMS, Chang Liu,Pearson, 2012

Course outcomes: Skill development

At the end of the course, the student shall be acquainted with the knowledge of Importance application of material in various engineering applications. Design and manufacturing of smart materials and MEMS.

Advanced Discipline Course
Failure Analysis in Engineering
L P U: 4 0 4

Course Objectives:

To understand importance of design and design process considerations, Creativity and creativity methods to solve problems, understand buckling phenomenon due to combined external pressure and axial loading, Failure analysis and determination of stress patterns from plastic Flow observations, Fatigue and Creep deformation.

Contents:

UNIT I- Importance of design- The design process-Considerations of Good Design – Morphology of Design – Organization for design– Computer Aided Engineering –Concurrent Engineering – Product and process cycles –Market Identification – Competition Bench marking. Identification of customer needs- customer requirements- Product Design Specifications- Human Factors in Design – Ergonomics and Aesthetics.

UNIT II- Creativity and Problem Solving –Creativity methods-Theory of Inventive Problem Solving(TRIZ)– Conceptual decomposition-Generating design concepts-Axiomatic Design – Evaluation methods-Embodiment Design- Product Architecture-Configuration Design-Parametric Design. Role of models in design-Mathematical Modeling– Simulation – Design for Reliability –Introduction to Robust Design-Failure mode Effect Analysis.

UNIT III-Buckling phenomenon – Elastic Buckling of circular ring and cylinders under external pressure – collapse of thick walled cylinders or tubes under external pressure – Effect of supports on Elastic Buckling of Cylinders – Buckling under combined External pressure and axial loading.

UNIT IV-Failure analysis and determination of stress patterns from plastic Flow observations – Dynamic loading– Fracture types in tension—Fatigue crack growth– Fatigue life prediction-Cumulative fatigue damage-Stress theory of failure vessels-Thermal stress fatigue.

UNIT V- Introduction –Through cracks emanating from holes – Corner cracks at holes – Cracks approaching holes-Combined loading-Fatigue crack growth binder- Mixed mode loading-Fracture toughness of weld metals-Service failure analysis.

References:

1. Dieter, George E., Engineering Design - A Materials and Processing Approach, McGraw Hill,International Editions, Singapore, 2000.

2. Pahl, G, and Beitz, W., Engineering Design, Springer – Verlag, NY. 1984.
3. David Broek, Elementary Engineering Fracture Mechanics, Fifthoff and Noerdhoff International Publisher, 1978.
4. Preshant Kumar, Elements of Fracture Mechanicsǁ, Wheeler Publishing, 1999.
5. John F. Harvey, Theory and Design of Pressure Vessels, CBS Publishers and Distributors, 1987.
6. Henry H. Bedner, Pressure Vessels, Design Hand Book, CBS publishers and Distributors, 1987.

Course Outcomes: Skill development

On completion of the course, students can:

- Design methodology and various aspects involved in design process
- Different creative and inventive problem solving techniques
- Different types of design process, concepts of reliable and safe design
- Concept of buckling of cylinders under various loading conditions
- The fundamentals of fracture, fracture types and concepts of fatigue crack growth, fatigue life prediction and various stress theories of failure vessels
- Basic crack propagation concept, concepts of crack propagation under combined loading, fracture toughness of weld metals.

Specialization Elective
Mechanical Vibrations
L P U: 4 0 4

Course Objectives:

The primary objective of this course is to understand the Single degree of Freedom systems, Multi degree freedom systems, Response to Non Periodic Excitations, Numerical Methods and Application of concepts.

Contents:

UNIT 1- Single degree of Freedom systems: Undamped and damped free vibrations: forced vibrations ; coulomb damping; Response to harmonic excitation; rotating unbalance and support excitation, Vibration isolation and transmissibility, Vibrometers, velocity meters & accelerometers.

Unit II- Response to Non Periodic Excitations: unit Impulse, unit step and unit Ramp functions; response to arbitrary excitations, The Convolution Integral; shock spectrum; System response by the Laplace Transformation method.

Unit III-Multi degree freedom systems: Principal modes – undamped and damped free and forced vibrations ; undamped vibration absorbers, Matrix formulation, stiffness and flexibility influence coefficients; Eigen value problem; normal modes and their properties; Free and forced vibration by Modal analysis; Method of matrix inversion; Torsional vibrations of multi – rotor systems and geared systems; Discrete-Time systems.

Unit IV-Numerical Methods: Rayliegh's, stodola's, Matrix iteration, Rayleigh-Ritz Method and Holzer's methods.

Unit V- Application of concepts: Free vibration of strings – longitudinal oscillations of bars-transverse vibrations of beams- Torsional vibrations of shafts. Critical speeds without and with damping, secondary critical speed.

References:

1. Elements of Vibration Analysis by Meirovitch.
2. Mechanical Vibrations by G.K. Groover.
3. Mechanical Vibrations by S S Rao
4. Vibrations by W.T. Thomson
5. Mechanical Vibrations – Schaum series.
6. Vibration problems in Engineering by S.P. Timoshenko.
7. Mechanical Viabrations – V.Ram Murthy.

Course outcomes: Skill development

On completion of the course, students can:

- Understand the Single degree of Freedom systems.
- Understand the Multi degree freedom systems
- Understand the Response to Non Periodic Excitations
- Analyze Numerical Methods and Application of concepts.

Specialization Elective
Experimental stress Analysis
L P U: 4 0 4

Course Objectives:

The primary objective of this course is to understand the Plane stress and plane strain conditions, Compatibility conditions, Strain Measurement and Recordings, Photo elasticity and Three dimensional Photo elasticity. Brittle coatings, Moire Methods and Birefringent Coatings.

Contents:

UNIT I- Introduction: Stress, strain, Plane stress and plane strain conditions, Compatibility conditions. Problems using plane stress and plane strain conditions, stress functions, mohrs circle for stress strain, Three-dimensional stress strain relations.

UNIT II- Strain Measurement and Recordings: Various types of strain gauges, Electrical Resistance strain gauges, semiconductor strain gauges, strain gauge circuits. Introduction, static recording and data logging, dynamic recording at very low frequencies, dynamic recording at intermediate frequencies, dynamic recording at high frequencies, dynamic recording at very high frequencies, telemetry systems.

UNIT III- Photo elasticity: Photo elasticity – Polariscope – Plane and circularly polarized light, Bright and dark field setups, Photo elastic materials – Isochromatic fringes – Isoclinics
Three dimensional Photo elasticity : Introduction, locking in model deformation, materials for three-dimensional photo elasticity, machining cementing and slicing three-dimensional models, slicing the model and interpretation of the resulting fringe patterns, effective stresses, the sheardifference method in three dimensions, applications of the Frozen-stress method, the scatteredlight method.

UNIT IV- Brittle coatings: Introduction, coating stresses, failure theories, brittle coating crack patterns, crack detection, ceramic based brittle coatings, resin based brittle coatings, test procedures for brittle coatings analysis, calibration procedures, analysis of brittle coating data.
Moire Methods: Introduction, mechanism of formation of Moire fringes, the geometrical approach to Moire-Fringe analysis, the displacement field approach to Moire-Fringe analysis, out of plane displacement measurements, out of plane slope measurements, sharpening and multiplication of Moire-Fringes, experimental procedure and techniques.

UNIT V- Birefringent Coatings: Introduction, Coating stresses and strains, coating sensitivity, coating materials, application of coatings, effects of coating thickness, Fringe-order determinations in coatings, stress separation methods.

References:

1. Theory of Elasticity by Timoshenke and Goodier Jr
2. Experimental stress analysis by Dally and Riley,Mc Graw-Hill
3. A treatise on Mathematical theory of Elasticity by LOVE .A.H
4. Photo Elasticity by Frocht
5. Experimental stress analysis, Video course by K.Ramesh / NPTEL

Course outcomes: Skill development

On completion of the course, students can:

- Understand the Plane stress and plane strain conditions and Compatibility conditions.
- Measure and record the strain.
- Understand the Photo elasticity and Three dimensional Photo elasticity.
- Analyze Moire Methods and apply Birefringent Coatings.

Specialization Elective
Theory of Plates and Shells
L P U: 4 0 4

Course Objective:

- Introduce students to the classical structural mechanics approximations of Membrane, Plate and Shell theories.
- Use energy formulations to demonstrate the consistent derivation of approximate boundary conditions and edge effects.
- Demonstrate the analysis tools necessary to describe static, dynamic and non-linear motions.
- Demonstrate the approximation of the classical formulations using numerical approximation techniques.

Contents

UNIT I- Introduction: Assumptions in the theory of thin plates, Pure bending of Plates, Relations between bending moments and curvature, Particular cases of pure bending of rectangular plates, Cylindrical bending, Strain energy in pure bending of plates in Cartesian and polar co-ordinates, Limitations.

Unit II- Laterally Loaded Rectangular Plates: Differential equation of plates, Boundary conditions, Navier solution for simply supported plates subjected to uniformly distributed load and point load, Levy's method of solution for plates, Simply supported plates with moments distributed along the edges, Approximate Methods.

Unit III- Effect of transverse shear deformation: plates of variable thickness, An-isotropic plates, thick plates, Orthotropic plates and grids, Large Deflection theory.

Unit IV-Deformation of Shells without Bending: Definitions and notation, shells in the form of a surface of revolution, displacements, membrane theory of cylindrical shells, and the use of stress function in calculating membrane forces of shells.

Unit V-General Theory of Cylindrical Shells: A circular cylindrical shell loaded symmetrically with respect to its axis, symmetrical deformation, pressure vessels, cylindrical tanks, general case of deformation, and the use of a strain and stress function, stress analysis of cylindrical roof shells.

References:

1. Theory of Plates and Shells by Stephen P. Timoshenko, Sergius Woinowsky-Krieger (McGraw-Hill).
2. Thin Plates and Shells: Theory: Analysis, and Applications by Eduard Ventsel, Theodor Krauthammer (CRC).
3. Mechanics of Laminated Composite Plates and Shells: Theory and Analysis by J. N. Reddy (CRC).

Course Outcomes: Skill development

On completion of the course, students can:

- Apply the structural mechanics approximations of membrane, plates and shells.
- Derive simple modifications to the membrane plate and shell theories.
- Use analysis to determine the static, dynamic, and non-linear motion of membrane, plate and shell Structures.
- Compute numerical approximations.

Specialization Elective
Additive Manufacturing
L P U: 4 0 4

Course Objectives:

The objective of the course is to impart fundamentals of additive manufacturing processes along with the various file formats, software tools, processes, techniques and applications.

Contents:

UNIT I- Introduction: Introduction to Additive Manufacturing (AM), Distinction between AM and CNC, other related technologies, AM Software: Need for AM software, MIMICS, Magics, Surgi Guide, 3-matic, 3D-Doctor, Simplant, Velocity2, VoXim, SolidView, 3DView, etc., software, Preparation of CAD models, Problems with STL files, STL file manipulation, AM data formats: SLC, CLI, RPI, LEAF, IGES, HP/GL, CT, STEP.

UNIT II- Design/Fabrication Processes: Data Sources, Software Tools, File Formats, Model Repair and Validation, Pre & Post processing, Reverse engineering: digitizing, laser scanning, CT-scanning, point cloud manipulation, data segmentation, surface reconstruction, model further processing.

UNIT III- Materials Science for AM: Materials Science for Additive Manufacturing- Polymer and Photo-polymerization, Process & Material Selection, Direct Digital Manufacturing and AM; parts and their uses. Process Monitoring and Control for AM-Defects, Geometry, Composition, Temperature, Phase Transformation.

UNIT IV- Design for Additive Manufacturing: Multiple Materials, Hybrids, Functionally Graded Materials, Composite Materials, current and future directions; Process Modeling of AM process- Design optimization through finite-element modeling of AM- Simulation of phase transformations- heating, melting, forming, solidification and finishing and rheological studies of various AM materials.

UNIT V- Applications and Future Directions of AM: Rapid Tooling and Manufacturing, The Express Tool Process- Conformal Cooling Channels, The Express tool Process, Finite Element Analysis of Express Tool, limitations - Applications of AM: Aerospace, Automotive, Biomedical Applications of AM, Product Development, Commercialization, Trends and Future Directions in Additive Manufacturing.

References:

3. Ian Gibson, David Rosen, Brent Stucker, Additive Manufacturing Technologies, Springer Publications, 2015.
4. Dongdong Gu, Laser Additive Manufacturing of High-Performance Materials, Springer Publication, 2014.
5. Andreas Gebhardt, Understanding Additive Manufacturing, Hanser Publishers, 2011.
6. Hopkinson, Hague, Dickens, Rapid Manufacturing: An Industrial Revolution for the Digital Age. Wiley, 2005.

Course outcomes: Skill development

- To decide between the various trades-offs when selecting AM processes, devices and materials. To suit particular engineering requirements.
- To develop latest trends and opportunities in AM.
- To commercialize ideas.

Specialization Elective
Geometric Modeling
L P U: 4 0 4

Course Objectives:

- Making the student understand how graphics created in computer world is the main goal of this course.
- Using colors in different places and for different objects is also one of the goals of the course.
- Animating some simple graphics is the last aim of the course.

Contents:

UNIT I-Geometrical Modeling: Introduction, History, Geometrical representation, Linear Algebra Boolean Algebra, Vectors, Matrices, Equations for curves- Intrinsic and Explicit ,parametric equations of curves ,conic curves and points on curves, Problems.

UNIT II-Transformations: 2-D and 3D Transformations, translation, Rotation, Homogeneous space, Scaling, stretching, Mirror reflection, Composite Transformations and problems.

Cubic splines: Algebraic and geometric force of cubic spline, parametric space of a curve, blending functions, Problems.

UNIT III-Bezier curves: Berustein's polynomials, equations, control points, convex hull property, truncating and subdividing composite and Rational Bezier curves, Problems.

B-Spline curves: Uniform and non-uniform B-Spline basis functions, quadratic and cubic Bspline basis functions, NURBS, Problems.

UNIT IV-Surfaces: Explicit and Implicit equations of surfaces, quadratic surfaces, parametric equation of surfaces, Curve Nets and Embedded Curves, Generation, Mathematical Analysis, Applications of Bezier and B-Spline Surfaces, Surface patches. Problems.

UNIT V-Solids: Parametric and Tricubic solids, sweep solids, Topology of models, graph and boolean based models. Constructive solid Geometry (CSG), B-rep models. Problems.

References:

1. Geometric Modeling by Micheal E. Mortenson, Third Edition, McGraw Hill Publishers
2. CAD/CAM concepts and Applications, Alavala, PHI
3. Curves and surfaces for CAGD, Fifth Edition by Gerald Farin, Elsevier, India
4. Computer Graphics, Alavala, PHI, New Delhi
5. CAD/CAM by Ibrahim Zeid, Tata McGraw Hill.
6. Elements of Computer Graphics by Roger & Adams, Tata McGraw Hill.

Course outcomes: Skill development

Upon successful completion of the course students will be able to draw various curves and surfaces. Learning how to rescale, transmit (shift), shear (skew), and rotate different graphical objects is another goal. To construct various solid (3D) models by computer.

Specialization Elective
Advanced Manufacturing
L P U: 4 0 4

Course Objectives:

- To learn the concepts of traditional manufacturing processes in casting, welding, forming. To give information various Non-Traditional machining processes.
- To Understanding of various fundamental mechanisms of machining processes, high speed machining, micro-machining and nanofabrication techniques.

Contents:

UNIT I- Advances in casting: Stir casting process: working principle, variables in stir casting process, advantages and application, composite preparation, analysis of composite. High pressure molding, metal injection molding, Graphite mold process.
Advances in welding: Friction stir welding process, parameters, tool geometry, applications, Friction stir welding similar and dissimilar materials, Ultrasonic welding, Electron beam welding process, Laser beam welding processes, Hybrid welding process. Defective analysis of friction welded components.

UNIT II- Advanced Metal forming processes: High Energy Rate Forming (HERF), Explosive Forming, Electrohydraulic Forming, Electromagnetic forming and computer applications in metal forming.
Advances in metal cutting: Mechanics of metal cutting, tool geometry and their design of single point and multi point cutting tools. Theories of tool life and wear. Laws of friction and nature of frictional force in metal cutting, cutting tool materials and cutting fluids. Chip morphology, surface integrity and machinability index.

UNIT III- Introduction of Non-Traditional machining, need and applications. Principle of working equipment, Material removal rate, Mechanics of cutting and Process parameters of Abrasive Jet Machining (AJM), Water Jet Machining (WJM), Ultra Sonic Machining (USM), Electric Discharge Machining (EDM), Wire-cut Electric Discharge Machining (WEDM), Electro Chemical Machining (ECM), Electro Chemical Grinding (ECG), Plasma Arc Machining (PAM), Laser Beam Machining (LBM), Ion Beam Machining (IBM) Electron Beam Machining (EBM).

UNIT IV- Introduction of micro and high speed machining. Working principles of micro and high speed machining. Hybrid machining methods and applications. Fabrication of Microelectronic devices: Crystal growth and wafer preparation, Film Deposition oxidation, lithography, bonding and packaging, reliability and yield, Printed Circuit boards, computer aided design in micro-electronics and surface mount technology.

UNIT V- Rapid Manufacturing Processes: Introduction to Rapid Prototyping, Traditional Prototyping Vs. Rapid Prototyping (RP), Need for time compression in product development, Usage of RP parts, Generic RP process. Working principles and applications of various RP Processes like VAT Photopolymerization, Powder Bed Fusion, Binder Jetting (3D Printing), Material Jetting, Sheet Lamination, Material Extrusion and Directed Energy Deposition.

References:

1. Manufacturing Engineering and Technology, Kalpakijian, Adisson Wesley, 1995.
2. Foundation of MEMS, Chang Liu,Pearson, 2012.
3. Advanced Machining Processes, V.K.Jain, Allied Publications.
4. R. S. Mishra, Friction Stir Welding and Processing, ASM International, 2007.
5. Heine, Loper and Rosenthal, "Principles of Metal Casting", Tata McGraw-Hill, New Delhi, 2008.
6. Ian Gibson., David W Rosen., Brent Stucker., Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, Springer, 2010.
7. Fundamentals of Metal cutting and Machine tools , B.L.Juneja, G. S. Sekhom and Nitin Seth, New Age International publishers
8. Tool Engineering, G.R.Nagpal, Khanna Publishers

Course outcomes: Skill development

- To understand various advanced manufacturing process in casting, welding, forming, metal cutting.
- To learn various Non-Traditional machining composite materials and rapid prototyping.

Specialization Elective
Advanced IC Engine Technology
L P U: 4 0 4

Course Objectives:

- To study engine exhaust emission control and alternate fuels.
- To understand recent developments in IC Engines, SI and CI Engines.

Contents:

UNIT I- SI Engine-introduction-carburetion- mixture requirements-Fuel supply - Ignition - Stages of combustion-Normal and abnormal combustion-factors affecting knock -Combustion chambers. CI engine- Injection systems-Mechanical and electronic-Combustion in CI engines-stages of combustion-Factors affecting combustion.

UNIT II- Direct and indirect injection systems –Combustion chambers – Fuel spray behaviour – spray structure, spray penetration-and evaporation – air motion – Introduction to Turbo charging and supercharging.

UNIT III- Basic concepts of engine simulation, governing equations, simulation of various engine processes for SI and CI Engines. Thermodynamic and fluid mechanic based models. Different types of combustion chamber.

UNIT IV- Engine instrumentation-Types of pollutants-Euro and Bharat norms-Emission control methods in SI and CI engines catalytic converters-EGR-Modern evaporative emission control system.

UNIT V- Lean Burn Engines – Stratified charge Engines – homogeneous charge compression ignition engines – Plasma Ignition – Zero Emission Vehicles, Engines for special applications – Mining, Defence, Off-highway -Tractor, Bulldozer etc. Submarines, Race car Engine systems, Flexible fuel systems. Surface ignition.

References:

1. V. Ganesan, Int. Combustion Engines, II Edition, TMH, 2002.
2. V. Ganesan, Computer simulation of spark ignition process: University process, Hyderabad, 1993.
3. M.L. Mathur and R.P.Sharma, A course in internal Combustion Engines, Dhanapat Rai Publications, New Delhi, 2014.
4. K.K. Ramalingam, Internal Combustion Engine Fundamentals, Scitech Publications, 2011.

Course outcomes: Skill development

- To analyze performance of SI and CI engines.
- To recognize emission control norms and use alternate fuels in IC engines.

Specialization Elective
Refrigeration and Cryogenic Systems
L P U: 4 0 4

Course Objectives:

- To understand the refrigeration systems and vapour compression refrigeration and vapour absorption system and applications of refrigeration system.
- To estimate performance of various refrigeration systems.
- To lean various cryogenic Systems

Contents:

Unit I-Review of Thermodynamic Principles of Refrigeration: Vapour compression cycle, actual vapour compression cycle, multistage, multi evaporator system, cascade system, gas cycle refrigeration, aircraft refrigeration.

Unit II- Refrigeration Systems: Estimation of thermal load, selection and matching of components compressors, evaporators, condensers, expansion devices, cyclic controls requirements of refrigerants, lubricants in refrigeration, Secondary refrigerants, mixed refrigerants. Theory of mixtures ; enthalpy composition diagrams, absorption system calculation, aqua ammonia systems, LiBr water system, Three fluid absorption systems, solar refrigeration system.

Unit III-Cryogenic Systems: Introduction: Insight on Cryogenics, Properties of Cryogenic fluids, Material properties at Cryogenic Temperatures. Carnot Liquefaction Cycle, F.O.M. and Yield of Liquefaction ; Cycles. Inversion Curve - Joule Thomson Effect. Liquefaction Cycles: Linde Hampson Cycle, Precooled Linde Hampson Cycle, Claudes Cycle, Dual Cycle, Helium Regrigerated Hydrogen Liquefaction Systems. Crtical components in Liquefaction Systems.

Unit IV-Cryogenic Refrigerators: J.T.Cryocoolers, Stirling Cycle Refrigerators, G.M.Cryocoolers, Pulse Tube Refrigerators, Regenerators used in Cryogenic Refrigerators.

Unit V-Magnetic Refrigerators Applications: Applications of Cryogenic in Space Programmes, Superconductivity, Cryo Metallurgy, Medical applications.

References:

1. W.F. Stoecker, and J.W. Jones, Refrigeration and Air Conditioning, 2nd Edition, Tata McGraw Hill, New Delhi, 1982.
2. M. Prasad., 'Refrigeration and Air Conditioning', Willey Eastern Ltd., 1990.
3. Jordan and Priester, 'Refrigeration and Air conditioning', Prentice Hall of India, 1974.
4. R. F. Barron, Cryogenic Systems, McGraw Hill, 1985.
5. R.B.Scott, Cryogenic Engineering, Van Nostrand and Co., 1962.

Course outcomes: Skill development

- To understand various refrigeration systems,
- To develop and working of refrigeration equipment's and explain the refrigeration system equipment.
- To calibrate refrigerants

Specialization Elective
Advanced Fluid Mechanics
L P U: 4 0 4

Course Objectives:

The objective of the course is to Derive continuity, momentum and energy equations of fluid flow, learn concept of irrotational flows, flow past cylinders and rankine body and concepts of boundary layer, prandtl mixing length, turbulent theory, universal velocity profile.

Contents:

Unit I- Concept of continuum and definition of a fluid. Body and surface forces, stress tensor, principle of local stress equilibrium. Scalar and vector fields, Eulerian and Lagrangian description of flow.

Unit II-Motion of fluid element: translation, rotation and deformation; vorticity and strain-rate tensors. Continuity equation, Cauchy's equations of motion, Transport theorems. Constitutive equations Stokes law of viscosity. Derivation of N-S equations for compressible flow.

Unit III-Exact solutions of Navier-Stokes equations: plane Poiseuille flow and Couette flow, HagenPoiseuille flow, flow between twoconcentric rotating cylinders, Stokes first and second problems, Hiemenz stagnation-point flow, flow near a rotating disk, flow in convergent-divergent channels. Slow viscous flow: Stokes and Oseens approximation, theory of hydrodynamic lubrication.

Unit IV-Boundary layer: Derivation, exact solutions, Blasius, Falkner Skan series solution and numerical solutions. Approximate methods. Momentum integral method. Introduction to hydrodynamic stability, Orr-Sommerfeld equation, neutral curve of linear stability for plane Poiseuille flow.

Unit V-Description of turbulent flow, velocity correlations, Reynolds stresses. Equations for turbulence kinetic energy and kinetic energy of mean flow. Eddy viscosity models of turbulence: zero equation, one-equation and two-equation models. Prandtls Mixing Length Theory. Empirical laws: law of the wall, velocity defect law, universal velocity distribution.

References:

1. R.N. Fox and A.T McDonald., 'Fluid Mechanics', John Wiley & Sons, 1994.
2. A.H. Shapin, 'The dynamics and thermodynamics of compressible fluid flow', Vol. I and II, The Ronald Press Co., 1955.
3. S.W. Yuan, 'Foundations of Fluid Mechanics', Prentice Hall of India, 1976.
4. Dr. J.K Goyal I K.P. Gupta., 'Fluid Dynamics', 3rd revised Ed., Pragathi Prakasan, Meerut, 1989.
5. Robertson. 'Hydrodynamics Theory and Application', Prentice Hall of India, 1965.

Course outcomes: Skill development

After going through this course the students will be able to apply continuity equation to solve numerical flow problems, apply momentum equation to determine velocity distribution in the fluid flow and analyze flow using boundary layer theory.

Specialization Elective
Mechanics of Composite Materials
L P U: 4 0 4

Course Objectives:

The primary objective of this course is to understand the Composites, matrix materials, reinforced matrix of composites, Hooke's Law for a Two-Dimensional Angle Lamina, Failure Theories of an Angle Lamina, Macromechanical Analysis of a Lamina and Design of Laminates.

Contents:

UNIT I- Introduction to Composites: Introduction, Classification, matrix materials, reinforced matrix of composites

UNIT II-Hooke's Law for a Two-Dimensional Angle Lamina, Engineering Constants of an Angle Lamina, Invariant Form of Stiffness and Compliance Matrices for an Angle Lamina Strength Failure Theories of an Angle Lamina : Maximum Stress Failure Theory Strength Ratio, Failure Envelopes,Maximum Strain Failure Theory ,Tsai–Hill Failure Theory, Tsai–Wu Failure Theory, Comparison of Experimental Results with Failure Theories. Hygrothermal Stresses and Strains in a Lamina: Hygrothermal Stress–Strain Relationships for a Unidirectional Lamina, Hygrothermal Stress–Strain Relationships for an Angle Lamina

UNIT III-Macromechanical Analysis of a Lamina :Introduction ,Definitions: Stress, Strain ,Elastic Moduli, Strain Energy. Hooke's Law for Different Types of Materials, Hooke's Law for a Two- Dimensional Unidirectional Lamina, Plane Stress Assumption, Reduction of Hooke's Law in Three Dimensions to Two Dimensions, Relationship of Compliance and Stiffness Matrix to Engineering Elastic Constants of a Lamina.

UNIT IV-Micromechanical Analysis of a Lamina :Introduction, Volume and Mass Fractions, Density, and Void Content, Evaluation of the Four Elastic Moduli, Strength of Materials Approach, Semi- Empirical Models ,Elasticity Approach, Elastic Moduli of Lamina with Transversely Isotropic Fibers, Ultimate Strengths of a Unidirectional Lamina, Coefficients of Thermal Expansion, Coefficients of Moisture Expansion Macromechanical Analysis of Laminates: Introduction, Laminate Code , Stress–Strain Relations for a Laminate, In-Plane and Flexural Modulus of a Laminate, Hygrothermal Effects in a Laminate, Warpage of Laminates, hybrid laminates

UNIT V-Design of Laminates : Introduction , thin plate theory, specially orthotropic plate, cross and angle ply laminated plates, problems using thin plate theory, Failure Criterion for a Laminate, Design of a Laminated Composites.

References:

1.Engineering Mechanics of Composite Materials by Isaac and M Daniel, Oxford University Press, 1994.
2.B. D. Agarwal and L. J. Broutman, Analysis and performance of fibre Composites, Wiley-Interscience, New York, 1980.
3. Mechanics of Composite Materials, Second Edition (Mechanical Engineering), By Autar K. Kaw ,Publisher: CRC.
4. R. M. Jones, Mechanics of Composite Materials, Mc Graw Hill Company, New York, 1975.
5. L. R. Calcote, Analysis of Laminated Composite Structures, Van Nostrand Rainfold, New York, 1969.

Course Outcomes: Skill development

Upon successful completion of the course students will be able to understand the Composites, matrix materials, reinforced matrix of composites, Two-Dimensional Angle Lamina, Failure Theories of an Angle Lamina, Macromechanical Analysis of a Lamina and Design of Laminates.

Specialization Elective
Vibration control
L P U: 4 0 4

Course Objectives:

The objective of the course is to learn the concepts of the basic vibration control, vibration generation mechanism, passive vibration control and active vibration control with vibration measurement with data acquisition and FFT analysis.

Contents:

UNIT I-Basic Concepts: Review of free and forced vibrations with and without damping; Free and forced vibration of single, two and multi-degree of freedom systems with and without viscous damping
Basic Vibration Control: reduction at source, Active feedback control, vibration isolation

UNIT II-Vibration Generation Mechanism: Vibration generation mechanisms: Source classification, self excited vibration, flow induced vibration, field balancing of rigid rotors/flexible rotors and damping models and measures, Design consideration of material selection.

UNIT III-Passive Vibration Control: Basics, design of absorber, absorber with ideal spring, shock absorber, isolators with stiffness and damping.

UNIT IV
Active Vibration Control: Basics, Piezoelectric materials, electro rheological fluids, magneto rheological fluids, Magneto- and Electrostrictive Materials in Vibration Control, shape memory alloys and electro-magnetic materials.

UNIT V-Vibration Measurement: Basics, data acquisition, FFT analysis and filters vibration.

References:

1. D. J. Inman R(2002), Vibration and Control, John Willey & Sons Inc.
2. J. S. Rao R(2006) Vibration Condition Monitoring of Machines, Tata Mc-Graw Hill.
3. S S Rao (2016). Mechanical Vibrations, 6th edition, Pearson.
4. S.P. Timoshenko (2007), Vibration problems in Engineering. Reprint Edition. Wolfenden Press Eduction.
5. Meirovitch. Elements of Vibration Analysis, 2nd Revised edition McGraw-Hill.

Course outcomes: Skill development

Upon successful completion of the course students will be able to control the vibrations issues in the different mechanical systems using active and passive vibration techniques using FFT analysis..

Specialization Elective

Signal Analysis and Condition Monitoring
L P U: 4 0 4

Course Objectives:

The primary objective of this course is to understand the Basic concepts of fourier analysis. Bandwidth and Signal types and signal analysis. Practical analysis of stationary signals, Practical analysis of continuous non-stationary signals. practical analysis of transients and Condition monitoring in real systems.

Contents:

UNIT I-Introduction, Basic concepts. Fourier analysis. Bandwidth. Signal types. Convolution. **Signal analysis:** Filter response time. Detectors. Recorders. Analog analyzer types.

UNIT II-Practical Analysis of Stationary Signals: Stepped filter analysis. Swept filter analysis. High speed analysis. Real-time analysis.

UNIT III-Practical Analysis of Continuous Non-Stationary Signals: Choice of window type. Choice of window length. Choice of incremental step. Practical details. Scaling of the results.

UNIT IV-Practical Analysis of Transients: Analysis as a periodic signal. Analysis by repeated playback (constant bandwidth). Analysis by repeated playback (variable bandwidth).

UNIT V- Condition Monitoring in Real Systems: Diagnostic tools. Condition monitoring of two stage compressor. Cement mill foundation. I.D. fan. Sugar centrifugal. Cooling tower fan. Air separator. Preheater fan. Field balancing of rotors. ISO standards on vibrations, active, passive hybrid methods of condition monitoring.

References:

1. Condition Monitoring of Mechanical Systems / Kolacat.
2. Frequency Analysis /R.B.Randall.
3. Mechanical Vibrations Practice with Basic Theory / V. Ramamurti/ Narosa Publishing House.
4. Theory of Machines and Mechanisms/ Amitabh Ghosh & AK Malik/ EWP.

Course Outcomes: Skill development

Upon successful completion of the course students will be able to understand the Basic concepts of fourier analysis. Bandwidth and Signal types and signal analysis. Practical analysis of stationary signals, Practical analysis of continuous non-stationary signals. practical analysis of transients and Condition monitoring in real systems.

Specialization Elective
Reverse Engineering
L P U: 4 0 4

Course Objectives:

The objective of the course is to obtain knowledge about reverse engineering. The detail information about the structure and function of the equipment that is used in reverse engineering. Also recognize and compare the technology in this field and use them in practice. And obtain the knowledge about control and maintenance of devices used for reverse engineering and work with these devices independently.

Contents:

UNIT I- Introduction to reverse engineering, Reverse Engineering–The Generic Process, The Potential for Automation with 3-D Laser Scanners, What Is Not Reverse Engineering.

UNIT II- System Reverse engineering, Reverse engineering Methodology, Reverse engineering Steps, System level design and Examples.

UNIT III- Computer-aided (Forward) Engineering, Computer-aided Reverse Engineering, Computer Vision and Reverse Engineering, contact Methods and Noncontact Methods, Destructive Method, and the Selection Process, Some Additional Complexities.

UNIT IV- Point Capture Devices, Triangulation Approaches, Time-of-flight" or Ranging Systems, Structured-light and Stereoscopic Imaging Systems, issues with Light-based Approaches, Tracking Systems, Internal Measurement Systems, X-ray Tomography, Destructive Systems.

UNIT V-Some Comments on Accuracy, Positioning the Probe, Post processing the Captured Data, Handling Data Points, Curve and Surface Creation, Inspection Applications, Manufacturing Approaches.

References:

1. Raja, V. and Fernandes, K. J. (2008). Reverse Engineering: An Industrial Perspective. Springer-Verlag.
2. Kevin, O. Kristin W. (2001). Product Design: Techniques in Reverse Engineering and New Product Development, 1st ed. Pearson.
3. Eldad, E. (2005). Reversing: Secrets of Reverse Engineering. Wiley.

Course outcomes: Skill development

After the completion of the course, students should be able to:

- Understand basics in Reverse engineering systems.
- Understand the terminologies related to re-engineering, forward engineering, and reverse engineering.
- Disassemble products and specify the interactions between its subsystems and their functionality.
- Understand Reverse Engineering methodologies.
- Understand Mechanical Reverse engineering.

Specialization Elective
Modeling and Simulation of Manufacturing Systems
L P U: 4 0 4

Course Objectives:

- To learn the concepts of principles and methods of statistical analysis of experimental designs.
- To gain the knowledge on process/product optimization through statistical concepts.

Contents:

UNIT I- Introduction to System and simulation: Concept of system and elements of system, Discrete and continuous system, Models of system and Principles of modeling and simulation, Monte carlo simulation, Types of simulation, Steps in simulation model, Advantages, limitations and applications of simulation, Applications of simulation in manufacturing system.

UNIT II- Review of statistics and probability: Types of discrete and continuous probability distributions such as Geometric, Poisson, Uniform, Geometric distribution with examples, Normal, Exponential distribution with examples

Random numbers: Need for RNs, Technique for Random number generation such as Mid product method, Mid square method, and Linear congruential method with examples.

UNIT II- Test for Random numbers: Uniformity - Chi square test or Kolmogorov Smirnov test, Independency- Auto correlation test.
Random Variate generation: Technique for Random variate generation such as Inverse transforms technique or Rejection method.

UNIT III- Analysis of simulation data: Input data analysis, Verification and validation of simulation models, Output data analysis.
Simulation languages: History of simulation languages, Comparison and selection of simulation languages.

UNIT IV- Design and evaluation of simulation experiments: Development and analysis of simulation models using simulation language with different manufacturing systems
Queueing models: An introduction, M/M/1 and M/M/m Models with examples, Open Queueing and Closed queueing network with examples

UNIT V- Markov chain models and others: Discrete time markov chain with examples, Continues time markov chain with examples, stochastic process in manufacturing, Game theory.

References:

1. Jerry Banks, John S. Carson, Barry L. Nelson, David M. Nicol, and P. Shahabudeen, Discrete Event System Simulation, PHI, New Delhi, 2008.
2. Averill M. Law and W. David Kelton, Simulation Modeling and Analysis, Tata McGraw Hill, New Delhi, 2006.
3. N. Viswanadham and Y. Narahari, "Performance Modeling of Automated Manufacturing Systems", PHI, New Delhi, 2007.

Course outcomes: Skill development

- To to classify simulation and analytical models used in manufacturing system environment.
- To learn simulation languages, design and evaluate a given manufacturing system using simulation.
- To generate random numbers and variants to execute a simulation model, evaluate queuing networks and markov chains in the context of manufacturing.

Specialization Elective
Micro manufacturing and precession engineering
L P U: 4 0 4

Course Objectives:

- To have the knowledge of different micro machining methods.
- To understand the working principles of various Non-traditional methods in machining and forming.
- To understand the basic concepts and advances measurement methods

Contents:

UNIT I-Mechanical Micro machining – Ultra Sonic Micro Machining – Abrasive Jet Micro Machining – Water Jet Micro Machining – Abrasive Water Jet Micro Machining – Micro turning – Chemical and Electro Chemical Micro Machining – Electric discharge micro machining. Beam Energy based micro machining – Electron Beam Micro Machining – Laser Beam Micro Machining – Electric Discharge Micro Machining – Ion Beam Micro Machining –Plasma Beam Micro Machining – Hybrid Micro machining – Electro Discharge Grinding – Electro Chemical spark micro machining – Electrolytic in process Dressing.

UNIT II-Abrasive Flow finishing – Magnetic Abrasive Finishing – Magneto rheological finishing – Magneto Rheological abrasive flow finishing - Magnetic Float polishing – Elastic Emission Machining – chemmechanical Polishining.

UNIT III-Micro extrusion – Micro and Nano structured surface development by Nano plastic forming and Roller Imprinting – Micro bending with LASER – LASER micro welding – Electron beam for micro welding. Metrology for micro machined components – Ductile regime machining– AE based tool wear compensation– Machining of Micro gear, micro nozzle, micro pins – Applications.

UNIT IV-Concept of accuracy, accuracy of numerical control systems, tolerance and fits, acceptance tests for machine tools, static stiffness and its influence on machining accuracy, inaccuracies due to thermal effects, influence of forced vibration on accuracy, dimensional wear of cutting tools and its influences on accuracy.

UNIT V-clamping and setting errors, location principles and errors due to location, surface roughness and micro finishing processes, dimensioning and dimensional chains, methods of improving accuracy and surface finish, thread and gear measuring instruments, coordinate measuring machines, introduction to computer aided tolerance.

References:

1. Kluwer, "A new direction in manufacturing", Academic Publishers, London, 1997
2. Kalpakjian, "Manufacturing engineering & technology", Addison – Wesley, 4nd Edition
3. J. A. McGeough, "Advanced methods of machining", Chapman and Hall, London, 1988
4. Jain V. K., "Introduction to micromachining", Narosa Publishers
5. Momber A. W. and Kovacevic R., "Principles of water jet machining", Springer –Verlag
6. R. L. Murthy., "Precision engineering manufacturing", New Age International

Course outcomes: Skill development

Upon successful completion of the course students will be able to decide between the various micro manufacturing methods. To understand the various hybrid manufacturing methods and measurement machines.

Specialization Elective
Thermal System Simulation and Design
L P U: 4 0 4

Course Objectives:

- To impart knowledge on thermal system simulation and optimization methods.
- To design and study of optimization methods.
- To learn integer programming and linear programming.

Contents:

Unit I- Formulation of the design problem: design variables, constraints and limitations, requirements and specifications; Conceptual design, Steps in the design process (examples from thermal systems), Material selection.

Unit II- Modeling of thermal systems: types of models, mathematical modeling, physical modeling and dimensional analysis, curve fitting. Acceptable design of a thermal system: initial design, design strategies, some application illustrations (cooling of electronic equipment, heat transfer equipment, fluid flow systems etc.).

Unit III- Problem formulation for optimization: optimization in design, final optimized design, objective function, constraints, operating conditions, types of thermal systems, practical aspects in optimal design (choice of variables for optimization, sensitivity analysis, dependence on objective function and change of concept or model), Knowledge-based design and additional considerations, professional ethics.

Unit IV- Optimization of unconstrained problems, optimization of constrained problems, applicability to thermal systems, search methods (single variable problem, unconstrained search with multiple variables and multivariable constrained optimization).

Unit V- Integer programming - penalty function method. Use of artificial intelligence techniques (neural network, fuzzy logic and genetic algorithm) in thermal systems design and optimization (simple examples).

References:

1. Y. Jaluria, Design and Optimization of Thermal Systems, CRC Press, 2007.
2. S. S. Rao, Optimization methods, PHI, 1998.
3. W.F. Stoecker, Design of Thermal Systems - McGraw-Hill, 1971.
4. Bejan, G. Tsatsaronis, M.J. Moran, Thermal Design and Optimization - Wiley, 1996.
5. R. F. Boehm, Developments in the Design of Thermal Systems - Cambridge University.

Course outcomes: Skill development

To create alternative designs of thermal systems that are able to fulfill the desired functionality in an optimal manner for given objectives.

Specialization Elective
Air-Conditioning and Ventilating System
L P U: 4 0 4

Course Objectives:

To impart knowledge on air-conditioning systems, psychrometry concepts and applications of air-conditioning systems and study of air distribution systems.

Contents:

Unit I: Psychometry: Definition, Psychometric terms, Degree of saturation, Humidity, Absolute Humidity, Relative humidity, dry bulb temperature, wet bulb temperature, wet bulb depression, Dew point temperature, Dew point depression, Dalton's law of Partial pressure, Psychometric Relations, Humidity ratio, Psychometer, Psychometric chart, Psychometric Processes, Sensible heating, Sensible cooling, By-pass factor of heating and cooling coils, Dehumidification and humidification , Methods of humidification and dehumidification.

Unit II: Air-conditioning systems: Introduction, Air conditioning system and equipments used in air-conditioning system, various types of air-conditioning systems, Comfort Air-conditioning, Factors affecting effective optimum temperature, Factors affecting comfort air-conditioning, Room Sensible heat factor and Grand sensible heat factor.

Unit III: Cooling Load estimation: Air-conditioning calculations, Comfort scales and measures concepts of effective temperatures, Solar heat gains through gains through glass, buildings, heat storage, diversity and stratification.

Unit IV: Internal heat gains: Sensible heat, Latent heat, Cooling towers, spray chambers, Cooling and humidifying coils, Design of air-duct system, Room air distribution principles, Temperature, pressure and humidity controls, Various types of system controls, Building automation systems.

Unit V: Ducts: Introduction, Classification, Material of duct, construction, shape, pressure in ducts, Continuity equation and Bernoulli's equation for ducts, Pressure losses inducts: Frictional losses & Dynamic losses, Duct design, pressure loss due to enlargement in area and static regain.

Reference Books

1. W.F. Stoecker, and J.W. Jones, Refrigeration and Air Conditioning, 2nd Edition, Tata McGraw Hill, New Delhi, 1982.
2. Jordan and Priester, 'Refrigeration and Air conditioning', Prentice Hall of India, 1974.
3. M. Prasad., 'Refrigeration and Air Conditioning', Willey Eastern Ltd., 1990.
4. R.C Legg, Air Conditioning Systems - Design, Commissioning and maintenance, Batsford Ltd, London 1991.

Course outcomes: Skill development

To apply thermodynamic principles to various air-conditioning system, design of air-conditioning systems and analyze fan and duct system.

Specialization Elective
Two-Phase Flow and Heat Transfer
L P U: 4 0 4

Course Objectives:

To impart knowledge two phase flow regime mappings, modeling of two phase flow with different models and study of measurement technique for multiphase flow.

Contents:

Unit I: Introduction, different terminologies, flow regimes for single and two component vertical and horizontal flow, flow regime mappings.

Unit II: Conservation equations based on homogeneous flow, drift flux model, separated flow model (multi-fluid model), flooding, fluidization, two phase transportation. Brief discussion on critical flow condition. Introduction to Lockhart-Martinelli and other important correlations for pressure drop, correlations for void fraction.

Unit III: Hydrodynamics of solid-liquid and gas-solid flow, Principles of hydraulic and pneumatic transportation.
Measurement techniques for multiphase flow: Flow regime identification, pressure drop, void fraction and flow rate measurement.

Unit IV: Heat Transfer with Change of Phase: Film wise condensation of pure vapours – Drop wise condensation in plated surfaces – condensation in presence of non condensable gas – pool boiling – Boiling in forced flow inside tubing.

Unit V: Gas – Liquid Fluidization: Gas liquid particle process, Gas liquid particle operation – Gas liquid fluidization. Flow of Gas – Bubble formation, bubble growth gas hold up – Gas mixing liquid hold up – liquid mixing – flow of liquid mixing – Gas liquid mass transfer.

References:

1. J.N. Ginou, 'Two Phase Flow & Heat Transfer', McGraw Hill, New York, 1978.
2. S.C. Kutateladeze, 'Problems of Heat Transfer and Hydraulics of Two Phase Media', Pergamon Press, 1982.
3. J.F Davidson and D.Harrison, 'Fluidization', Prentice Hall, 1976.
4. L.S. Tong., 'Boiling Heat Transfer and Two Phase Flow', Wiley, New York, 1965.

Course outcomes: Skill development

- To analyze two phase flow patterns for thermal systems and apply analytical tools for design and performance assessment of two-phase devices.
- To generate conservation equations based on homogeneous flow
- To apply heat transfer for various phase

Interdisciplinary Course
Computational Methods in Engineering
L P U: 4 0 4

Course Objectives:

The primary objective of this course is to understand the numerical methods applied to engineering problems, Boundry value problems and charecteristic value problems, Transformation Techniques, Numerical solutions of partial differential equations, Partial differential equations: Explicit method.

Contents:

UNIT I-Introduction to numerical methods applied to engineering problems: Examples, solving sets of equations – Matrix notation – Determinants and inversion – Iterative methods – Relaxation methods – System of non-linear equations. Least square approximation fitting of non-linear curves by least squares –regression analysis- multiple linear regression, non linear regression - computer programs.

UNIT II-Boundry value problems and charecteristic value problems: Shooting method – Solution through a set of equations – Derivative boundary conditions – Rayleigh – Ritz method –Characteristic value problems.

UNIT III-Transformation Techniques: Continuous fourier series, frequency and time domains, laplace transform, fourier integral and transform, discrete fourier transform (DFT), Fast fourier transform (FFT).

UNIT IV-Numerical solutions of partial differential equations: Laplace's equations – Representations as a difference equation – Iterative methods for Laplace's equations – poisson equation – Examples – Derivative boundary conditions – Irregular and non – rectangular grids – Matrix patterns, sparseness – ADI method – Finite element method.

UNIT V-Partial differential equations: Explicit method – Crank-Nickelson method – Derivative boundary condition – Stability and convergence criteria. Solving wave equation by finite differences-stability of numerical method –method of characteristics-wave equation in two space dimensions-computer programs.

References:

1. Steven C.Chapra, Raymond P.Canale "Numerical Methods for Engineers" Tata Mc-Graw Hill
2. Curtis F.Gerald, Partick.O.Wheatly,"Applied numerical analysis"Addison-Wesley,1989.
3. Douglas J.Faires,Riched Burden"Numerical methods", Brooks/Cole publishing company,1998.Second edition.
4. Ward Cheney and David Kincaid "Numerical mathematics and computing" Brooks/Cole
5. publishing company1999, Fourth edition.
6. Riley K.F,. M.P.Hobson and Bence S.J,"Mathematical methods for physics and engineering", Cambridge University press,1999.
7. Kreysis, Advanced Mathematics.

Course Outcomes: Skill development

Upon successful completion of the course students will be able to understand the numerical methods applied to engineering problems, Boundry value problems and charecteristic value problems, Transformation Techniques, Numerical solutions of partial differential equations, Partial differential equations: Explicit method.

Interdisciplinary Course
Design and Analysis of Experiments
L P U: 4 0 4

Course Objectives:

- To learn the concepts of principles and methods of statistical analysis of experimental designs.
- To gain the knowledge on process/product optimization through statistical concepts.
- To introduce the concepts of influence and contribution factors etc.

Contents:

UNIT I: Fundamentals of Experimentation: Role of experimentation in rapid scientific progress, Historical perspective of experimental approaches, Steps in experimentation, Principles of experimentation.

UNIT II: Experiments with a Single Factor: Basic Principles and Guidelines of Design of Experiments - Single Factor Experiments – ANOVA - Model Adequacy Checking - Determining Sample Size - Comparing Pairs of Treatment Means - Introduction to DOAE software.

UNIT III: Factorial Designs: Two levels - 2k factorial designs - Confounding and Blocking in factorial designs. Fractional Factorial Designs: The One-Half and One-Quarter Fraction of the 2k Design - General 2k–p Fractional Factorial, Design – Resolution.

UNIT IV: Taguchi's Parameter Design: Concept of robustness, noise factors, objective function & S/N ratios, inner-array and outer-array design, data analysis. Regression Analysis: Introduction - Simple Linear Regression Analysis - Multiple Linear Regression Model – Model Adequacy Checking.

UNIT V: Response Surface Methodology: Response surface methodology, parameter – optimization - robust parameter design and its application to control of processes with high variability.

References:

3. Douglas C. Montgomery, Design and Analysis of Experiments, John Wiley & Sons, Inc., 9th edition, 2017.
4. Philip J. Rose, Taguchi Techniques for quality Engineering, Prentice Hall, 2000.
5. Charles R. Hicks, Kenneth V. Turner, Fundamental concepts in the Design of Experiments, Oxford University Press, 5th edition 1999.
6. K. Krishnaiah, P. Shahabuddeen, Applied Design of Experiments and Taguchi Methods, PHI Publications, 2012.

Course outcomes: Skill development

- To select an appropriate design,
- To conduct the experiment and interpret the result using appropriate statistical techniques.
- To solve the problem by optimizing the product/process parameters.
- To predict the outcomes through statistical concepts.

Interdisciplinary Course
Advanced Finite Element Analysis
L P U: 4 0 4

Course Objectives:

The primary objective of this course is to understand the Formulation Techniques, One-dimensional elements, Two dimensional problems. Isoparametric formulation, Static and dynamic analysis, eigen value problems.

Contents:

UNIT I-Formulation Techniques: Methodology, Engineering problems and governing differential equations , finite elements, Variational methods-potential energy method, Raleigh Ritz method, strong and weak forms, Galerkin and weighted residual methods, calculus of variations, Essential and natural boundary conditions.

UNIT II-One-dimensional elements: Bar, trusses, beams and frames, displacements, stresses and temperature effects.

UNIT III-Two dimensional problems: CST, LST, four noded and eight nodded rectangular elements, Lagrange basis for triangles and rectangles, serendipity interpolation functions. Axisymmetric Problems: Axisymmetric formulations, Element matrices, boundary conditions. Heat Transfer problems: Conduction and convection, examples: - two-dimensional fin.

UNIT IV- Isoparametric formulation: Concepts, sub parametric, super parametric elements, numerical integration, Requirements for convergence, h-refinement and p-refinement, complete and incomplete interpolation functions, pascal's triangle, Patch test.

UNIT V-Finite elements in Structural Analysis: Static and dynamic analysis, eigen value problems, and their solution methods, case studies using commercial finite element packages.

References:

1. J.N. Reddy, Finite element method in Heat transfer and fluid dynamics, CRC press, 1994
2. Zienckiwicz O.C. & R. L. Taylor, Finite Element Method, McGraw-Hill,1983.
3. K. J. Bathe, Finite element procedures, Prentice-Hall, 1996.
4. Finite element methods by Chandrubatla & Belagondu.
5. Finite element methods by Logan.

Course Outcomes: Skill development

Upon successful completion of the course students will be able to understand the Formulation Techniques, One-dimensional elements, Two dimensional problems. Isoparametric formulation, Static and dynamic analysis, eigen value problems.

Interdisciplinary Course
Advanced Computational Fluid Dynamics
L P U: 4 0 4

Course Objectives:

The primary objective of this course is to understand the difference method, finite volume method, finite element method, Solution methods and Standard variational methods. Hyperbolic equations, Formulations of incompressible viscous flows, Treatment of compressible flows, Finite volume method.

UNIT I- Introduction: Finite difference method, finite volume method, finite element method, governing equations and boundary conditions. Derivation of finite difference equations. Treatment of compressible flows.
Solution methods: Solution methods of elliptical equations – finite difference formulations, interactive solution methods, direct method with Gaussian elimination. Parabolic equations-explicit schemes and Von Neumann stability analysis, implicit schemes, alternating direction implicit schemes, approximate factorization, fractional step methods, direct
method with tridiagonal matrix algorithm.

UNIT II-Hyperbolic equations: explicit schemes and Von Neumann stability analysis, implicit schemes, multi step methods, nonlinear problems, second order one-dimensional wave equations. Burgers equations: Explicit and implicit schemes, Runge-Kutta method.

UNIT III- Formulations of incompressible viscous flows: Formulations of incompressible viscous flows by finite difference methods, pressure correction methods, vortex methods.
Treatment of compressible flows: potential equation, Eluer equations, Navier-stokes system of equations, flow field-dependent variation methods, boundary conditions, example problems.

UNIT IV-Finite volume method: Finite volume method via finite difference method, formulations for two and three-dimensional problems.

UNIT V-Standard variational methods: Linear fluid flow problems, steady state problems, Transient problems.

References:

1. Text book of fluid dynamics, Frank Chorlton, CBS Publishers &distributors, 1985
2. Computational fluid dynamics, T. J.Chung, Cambridge University press, 2002.

Course Outcomes: Skill development

Upon successful completion of the course students will be able to understand the difference method, finite volume method, finite element method, Solution methods and Standard variational methods. Hyperbolic equations, Formulations of incompressible viscous flows, Treatment of compressible flows, Finite volume method.

Course No	Course Title	L	P	U
EC501	Pattern Recognition	3	0	5

Learning Outcomes

After successful completion of the course student will be able to

1. Understand the need for image transforms ,different types of image transforms and their properties.
2. Learn different techniques employed for the enhancement of images.
3. Learn different causes for image degradation and overview of image restoration techniques.
4. Implement simple pattern classifiers, classifier combinations, and structural pattern recognizers.

Unit 1

Introduction, Image acquisition process, Sampling & quantization, Pixel neighborhood properties, Geometric Transformations, Frequency Transformations, Multi-resolution Expansions

UNIT 2

Edge Detection, Multiresolution Expansions, Wavelet Transforms, Image Segmentation, Thresholding, Edge-based Segmentation, Region-based Segmentation, Matching, Evaluation Issues in Segmentation, Mathematical concepts, Operators based on first order derivative (Roberts, Prewitt and Sobel),

UNIT 3

Image Data Compression, Image Data Properties, Discrete Image Transforms in Image Data Compression, Laplacian (Second order derivative based edge detection), LOG

UNIT 4

Morphological Image Processing, Dilation and Erosion, Opening and Closing, Basic Morphological Algorithms, Supervised algorithm.

UNIT 5

Unsupervised Clustering Algorithm, K-NN, Support Vector Machine, Neural Networks, Deep learning Overview

Text Book

1. Digital Image Processing, Rafael C. Gonzalez and Richard E. Woods, Pearson Education, Second Edition.
2. Image Processing, Analysis and Machine Vision, Sonka, Hlavac, Boyle 3rd edition

Reference book

1. Fundamentals of Digital Image Processing, Anil K. Jain, PHI.
2. Pattern Recognition and Image Analysis, Earl Gose and Richard Johnsonbaugh Steve Jost, PHI.

Learning Outcomes: Skill development

Upon successful completion of the course, student will be able to:

1. Define and describe pattern Recognition and its main constituents.
2. Distinguish class of problems suitable for solving with expert systems.
3. Assemble various parts of knowledge and skills in order to devise the approach to solution.
4. Application of Pattern recognition to solve various problem in real life situation.

Course No: EC502	Course Title: **Design for Testability Yield and Reliability**	L	P	U
		3	0	5

Course Objectives

1. To study techniques in testing of VLSI chips.
2. To understand fault models and their use in testing of VLSI Circuits.
3. To learn fault modelling and testing for memory.

Syllabus:

Chapter 1: Scope of testing and verification in VLSI design process. Issues in test and verification of complex chips, embedded cores and SOCs.

Chapter 2: Basics of Testing: Introduction, Fault models, Combinational logic and fault simulation, Test generation for Combinational Circuits. Current sensing based testing.

Chapter 3: Classification of sequential ATPG methods. Fault collapsing and simulation. Testing of static and dynamic circuits

Chapter 4: Fault models for diagnosis, Cause- effect diagnosis, Effect-cause diagnosis. Scan design, Partial scan, use of scan chains, boundary scan. DFT for other test objectives, Memory Testing.

Chapter 5: Pattern Generators, Estimation of test length, Test points to improve testability, Analysis of aliasing in linear compression, BIST methodologies, BIST for delay fault testing

Text Book:

1. N. Jha & S.D. Gupta, "Testing of Digital Systems", Cambridge, 2003.

References:

2. W. W. Wen, "VLSI Test Principles and Architectures Design for Testability", Morgan Kaufmann Publishers. 2006
3. Michael L. Bushnell &Vishwani D. Agrawal," Essentials of Electronic Testing for Digital, memory & Mixed signal VLSI Circuits", Kluwar Academic Publishers. 2000.

Learning Outcomes: Skill development

Upon successful completion of the course, student will be able to:

1. Apply the concepts in testing which can help them design a better yield in IC design.
2. Tackle the problems associated with testing of semiconductor circuits at earlier design levels so as to significantly reduce the testing costs.
3. Ability to use Fault models for testing various VLSI circuits.
4. Design Circuits for Testability.
5. Recognize the BIST techniques for improving testability.

Course No: EC503	Course Title: **Advanced Real Time Systems**	L	P	U
		3	0	5

Course Objectives

1. develop an understanding of various Real Time systems Application
2. obtain a broad understanding of the technologies and applications for the emerging and exciting domain of real-time systems
3. get in-depth hands-on experience in designing and developing a real operational system.

Syllabus:

Chapter 1: Introduction: Real- Time Systems, Hard versus soft Real- Time Systems: Jobs and Processes, Release Times, Deadlines and Timing Constraints, Hard and Soft Timing Constraints, Hard Real Time Systems, Soft Real Time Systems

Chapter 2: A Reference Model of Real – Time Systems: Processors and Resources, Temporal Parameters of Real Time Workload, Periodic Task Model, Precedence Constraints and Data Dependency, Functional Parameters- preemptivity of jobs, criticality of jobs, Resource Parameters of Jobs and Parameters of Resources, Scheduling Hierarchy- Scheduler and Schedules, Feasibility, Optimality and Performance Measures.

Chapter 3: Classification of Real Time Scheduling Approaches: Clock- Driven Approach, Weighted Round- Robin Approach, Priority- Driven Approach, Dynamic versus Static Systems, Effective Release Times and Deadlines, optimality of the EDF and LST algorithms, Non optimality of the EDF and LST algorithms, Challenges in validating timing constraints in priority –driven systems Off-line versus On-line Scheduling

Chapter 4: Clock-Driven Scheduling : Notations and Assumptions, Static, Timer -Driven Scheduler, General Structure of Cyclic Schedules, Cyclic Executives, Improving the Average Response Time of Aperiodic Jobs, Scheduling Sporadic Jobs-Acceptance test ,EDF Scheduling of accepted jobs and implementation, Pros and Cons of Clock Driven Scheduling.

Chapter 5: Priority-Driven Scheduling of Periodic Tasks: Static Assumption, Fixed Priority v/s Dynamic Priority Algorithms, schedulability test for the EDF algorithm, sufficient schedulability conditions for RM & DM algorithms: schedulable utilization of the RM algorithm for tasks with Di=pi, schedulable utilization of fixed priority tasks with arbitrary relative deadlines. Scheduling Aperiodic and Sporadic Jobs in Priority-Driven Systems: Assumptions and Approaches, Deferrable Servers- Operations of Deferrable Servers, Constant utilization server Scheduling of sporadic jobs-a simple acceptance test in deadline driven systems, a simple acceptance test in fixed- priority driven systems.

Text Book:

1. Real - Time Systems, Jane W S Liu, Pearson Education, ISBN 81 – 7808 – 463 - 5.

References:

4. Real-Time Systems and Software, John Wiley& Sons Inc., 2001. ISBN 0-471- 35490-2
5. Real Time Systems : C.M. Krishna & Kang G. Shin : McGraw Hill.
6. C.Sivamurthy, G. Manimaran, Resource Management in Real-Time Systems and Networks, PHI, New Delhi,2005.

Learning Outcomes: Skill development

Upon successful completion of the course, student will be able to:

6. Enumerate the need and the challenges in the design of hard and soft real time systems.
7. Compare different scheduling algorithms and the schedulability criteria.
8. Determine schedulability of a set of periodic tasks given a scheduling algorithm.
9. Develop algorithms to decide the admission criterion of sporadic jobs and the schedule of aperiodic jobs.
10. Integrate resource access mechanisms with the scheduling techniques and develop integrated schedulability criteria.

Course No: CS501	Course Title: Applied Machine Learning	L	P	U
		2	2	5

Course Objectives:

- The course objective is to study the theory and practice of constructing algorithms that learn (functions) and make optimal decisions from data and experience.
- Machine learning is a field with goals overlapping with other disciplines, in particular, statistics, algorithms, engineering, or optimization theory.
- It also has wide applications to a number of scientific areas such as finance, life sciences, social sciences, or medicine.

Course Contents

UNIT-I

Mathematical foundations of machine learning:

Random variables and probabilities, probability distributions, high-dimensional spaces, overview of machine learning, supervised, semi-supervised, unsupervised learning, inductive and transductive frameworks, Basics of parameter estimation, maximum likelihood and maximum a posteriori, Bayesian formulation.

UNIT-II

Classification algorithms:

Linear and non-linear algorithms, perceptron, logistic regression, naive Bayes, decision trees, neural networks, support vector machines, regression algorithms, least squares linear regression, neural networks.

UNIT-III

Kernel Methods:

Kernels with classification and regression)**:** Representation learning and matrix factorization (nonlinear), dimensionality reduction, sparse coding, and basics of graphical models, Bayesian networks, e.g., hidden Markov model, inference and estimation.

UNIT-IV

Ensemble Methods:

Bagging, boosting, random forests, practical aspects in machine learning, data preprocessing, over fitting, accuracy estimation, and parameter and model selection.

UNIT-V

Special Topics: Introduction to PCA learning, sample selection bias, learning from graph data, learning from sequential data.

Reference Books:

4. Pattern Recognition and Machine Learning,- by C. M. Bishop, Springer 2006.
5. Machine Learning - by Tom M. Mitchell, McGraw-Hill, 1997
6. The Elements of Statistical Learning - by T. Hastie, R. Tibshirani, and J. Friedman, 2009.

Learning Outcomes: Skill Development

Upon successful completion of the course, student will be able to

- Understand the Mathematical Models which are applicable for Machine Learning.
- Demonstrate ability to manipulate with maximum likelihood and maximum a posteriori, Bayesian formulation.
- Apply the concept of Correlation and Regression to the engineering problems.
- Apply various kernel methods to the complex problems in Machine Learning.

Course No: CS502	Course Title: Communication Protocols in IoT	L	P	U
		3	0	5

Course Objectives

7. Understand the basic building blocks of IoT Technology
8. Explore the vast communication technologies in IoT
9. Develop IoT Application
10. Explain to analyze the performance of various communication protocols of IoT
11. Describe to choose the appropriate communication protocol for the given requirements
12. Describe to Customize the communication technologies for the given applications

UNIT-I

Intoduction :Cellular systems- Frequency Management and Channel Assignment- types of handoff and their characteristics, dropped call rates & their evaluation -MAC – SDMA – FDMA – TDMA – CDMA – Cellular Wireless Network. Introduction to IoT-Definition & Characteristics of IoT , Physical Design of IoT- Things in IoT , IoT Protocols, Logical Design of IoT- IoT Functional Blocks.IoT Levels. 3 Layer and 5 Layer Architecture of IoT

UNIT -II

MAC Layer Protocols : IEEE 802.15.4, Blue Tooth, Bluetooth Low Energy, Blue Tooth 5, IEEE 802.11 AH, LoRAWAN Technology, Sigfox, NB IOT.

UNIT -III

Network layer and Service Layer Protocols : IPV4, Mobile Ad Hoc Routing Protocols: AODV, DSR, DSDV Zigbee, - WSN routing – OLSR- data aggregation, IPV6, 6LowPAN, RPL

Transport Layer Protocols : Indirect TCP – Snooping TCP – Mobile TCP – Fast Retransmit / Fast Recovery – Transmission/Timeout Freezing-Selective Retransmission – Transaction Oriented TCP-, UDP over wireless Networks

UNIT -IV

Application Layer : CoAP, MQTT, XMPP, AMQP & WebSockets, Application Development: Interfacing LoRAWAN end module with Gateway, Raspberry PI Programming :Interfacing with Bluetooth and database, Clent server communication with Wi-Fi, IoT with cloud via Thinsspeak, MQTT Client server Communication,CoAP Client server communication

UNIT -V

M2M communications--Difference between IoT and M2M, SDN for IoT-Software Defined Networking, NFV for IoT-Software Defined Networking, Network Function Virtualization.

References:

11. Jochen Schiller, "Mobile Communications", Second Edition, Pearson Education,200
12. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), —Architecting the Internet of Things‖, Springer, 2011.
13. Olivier Hersent, David Boswarthick, Omar Elloumi , —The Internet of Things – Key applications and Protocols‖, Wiley, 2012
14. Robert Davidson, Akiba, Carles Cufi, Kevin Townsend ,- Getting Started with Bluetooth Low Energy, O'Reilly Media, Inc.May 2014
15. Sethi and Smruti R. Sarangi- Internet of Things: Architectures, Protocols, and Applications, Hindawi Journal of Electrical and Computer EngineeringVolume 2017
16. C. Siva Ram Murthy, and B. S. Manoj, "Ad Hoc Wireless Networks: Architectures and Protocols ", Prentice Hall Professional Technical Reference, 2008.
17. ArshadeepBagha, Vijay Madisetti, "Internet of Things-A hands-on Approach", Universal Press 2018.Introduction to Expert Systems, Jackson P., 3rd edition, Addison Wesley, ISBN 0-201-87686-8

Learning Outcomes: Skill Development

Upon successful completion of the course, student will be able to:

7. Understand the basic building blocks of IoT Technology
8. Understand and differetiate the vast communication technologies in IoT
9. Develop IoT Application
10. Analyze the performance of various communication protocols of IoT
11. Choose the appropriate communication protocol for the given requirements
12. Customize the communication technologies for the given applications

Research Methodology-I
L P U: 4 0 4

Course Objectives:

- To develop research orientation among the scholars with the fundamentals of research methods
- To introduce the basic concepts in research, research methods and their approach
- To include literature survey, research design, techniques, collection and analysis of data
- To develop an understanding of the ethical dimensions of conducting applied research

Contents:

Unit I - Introduction to research and research process overview: Research: Meaning of Research, research motivation and objectives, research and scientific method. Research Approaches: Descriptive vs. analytical research, applied vs. fundamental research, quantitative vs. qualitative research, conceptual vs. empirical research. Significance of research. Research methodology: An introduction. Research Process: Basic overview, Criteria of Good research, Formulating the research problem, Defining the research problem. Research questions, research methods vs. research methodology.

Unit II - Essence of research methodology: Stages of research problem: Selecting the research topic, defining the research problem, importance of literature survey and reference collection in defining a problem. Literature review: Primary and secondary sources, journals, patents, web as a source. Development of working methodology.

Unit III - Designing and planning of experiments, time management: Research design: Meaning of research design, need for research design, different research designs, Observation of Laws and theories, predictions and explanation. Experimental design: Basic principles of experimental designs, planning of experiments for achieving aims and objectives, Importance of reproducibility of research work.

Unit IV – Methods of data collection and analysis: Collection of data: Collection of primary data, secondary data, sampling merits and demerits of experiments, procedure and observation methods, sampling errors. Statistical data analysis: Introduction to statistics: Probability theories, Conditional probability, Poisson distribution, binomial distribution and normal distributions, estimates of means and proportions, Chi-Square Test, Association of attributes: T-test, standard deviation, coefficient of variations. Types of analysis: Correlation and regression analysis. Introduction to statistical packages, plotting of graphs.

Unit V – Interpretation, report and thesis writing: Meaning of interpretation and its precautions, significance of report writing, different steps in writing report- layout and structure, layout of research report. Types of report writing: research papers, thesis, research project reports, pictures and graphs, citation styles and oral presentation. Application of results and ethics: Research ethics, copy right, intellectual property right and patent law, reproduction of published material, plagiarism, citation and acknowledgement, reproducibility and accountability.

References

16. Research Methodology: Methods and techniques, C. R. Kothari, 2nd revised edition, New Age International Publishers (2004).
17. The preparation of reports, R. P. Baker, A. C. Howell, New York: Ronald Press (1938).
18. Statistical methods, Edwards, L. Allen, 2nd edition, New York: Holt, Rinehart and Winston (1967).
19. Statistical methods for research workers, R. A. Fisher, 13th edition, New York: Hafner Publishing Co., (1960).
20. The design of experiments, R. A. Fisher, 7th revised edition, New York: Hafner Publishing Co., (1960).
21. Introductory statistical analysis, Harnett, L. Donald and Murphy, L. James, Philippines: Addison Wesley Publishing Co., Inc., (1975).
22. The research report: A guide for the beginner, Johnson, Ellen, New York: Ronald Press (1951).
23. Elementary Statistics, Ullman, R. Neil, New York: John Wiley and Sons, Inc., (1978).
24. Statistics: An Introductory Analysis, T. Yamane, 3rd edition, New York: Prentice-Hall (1960).
25. Research design: Qualitative, Quantitative and Mixed methods approaches, John W. Creswell, 2nd edition, Sage publications (2003).
26. Practical Research: Planning and Design, P. D. Leedy and J. E. Ormrod, Prentice Hall (2004).
27. Conducting research literature reviews: From the internet to paper, A. Fink, Sage Publications (2009).
28. Research Methodology: Concepts and cases, Chawla, Deepak and Sondhi, Neena, Vikas Publishing House Pvt. Ltd. Delhi (2011).
29. Data collection and analysis, 2nd edition, Edited by Roger Sapsford and Victor Jupp, Sage publications (2006).
30. Fundamental of Research methodology and statistics, Yogesh Kumar Singh, New Age International Publishers (2006).

Course Outcomes: Skill Development

- To establish a common basis for the PhD research education as well as to provide insight into the history and theory of science, qualitative and quantitative research methodology and research ethics
- To apply the knowledge and skills for the interpretation of data analysis and presentation in user friendly formats
- To provide insight into the theory of science, research methodology and research ethics

Research Methodology-II
L P U: 4 0 4

Course Objectives:

- To recognize the analogies that can be drawn between the fundamental elements of all four types of systems: electrical, mechanical, fluid and thermal.
- To perform frequency analysis and plot the frequency responses.
- To learn first order, second and higher order math models.
- To learn different optimization techniques and genetic algorithms

Contents:

Unit I- Basic building blocks for modeling engineering systems: Introduction, Electrical elements, Mechanical components, Fluid elements, Thermal elements, Importance of analogies.

Unit II- Constructing, analyzing and practical applications of first-order math models: Introduction to math models, Tools for developing math models, First –order math models, Response to a step input, Response to a sinusoidal input, Response to other input functions, power analysis, Applications through case study.

Unit III- Constructing, analyzing and practical applications of second-order math models: Constructing second order math models, Analyzing second order math models using numerical solution methods, Analyzing second order math models using exact solution methods, Applications through case study.

Constructing, analyzing higher order math models: Constructing and analyzing higher-order math models.

Unit IV- Optimization techniques and genetic algorithms: Overview of optimization techniques, Case study. Fundamentals of genetic algorithms, Single objective genetic algorithm, Multi objective evolutionary algorithm.

Unit V- Qualitative analysis: Nature and applications of qualitative research in social and organizational research, Conceptualization of qualitative research and formulation of problem statements and research questions, Qualitative research study design, Qualitative data collection procedures.

References:

19. Modeling Engineering Systems, Jack W. Lewis, High Text Publication, Inc, 1994.
20. Neural Networks, Fuzzy Logic, and Genetic Algorithms: Synthesis And Applications- S. Rajasekaran, G. A. Vijayalakshmi Pai, PHI Learning Pvt. Ltd , Kindle edition, 2003.
21. Nptel: Optimization Methods - Web course
22. Nptel: Design and Optimization of Energy Systems- Course syllabus.
23. Swayam: Modeling and Simulation of Dynamic Systems by Pushpa Raj Mani Pathak
24. Link: https://swayam.gov.in/courses/3557-modelling-and-simulation-of-dynamic-systems

Course Outcomes: Skill Development

- To construct a math model of a real world engineering system
- To analyze power requirements for engineering systems
- To analyze and solve higher order math models using various techniques
- To solve real world problems using genetic algorithms
- To perform qualitative analysis

Advanced Discipline Course
Computational Intelligence
L P U: 4 0 4

Course Objectives:

- To introduce the fundamental theory and concepts of computational intelligence methods, in particular neural networks, fuzzy systems, genetic algorithms and their applications in the area of machine intelligence
- To gain comprehensive theoretical knowledge as well as practical skills related to the CI approaches, algorithms and methods

Contents:

Unit I: Introduction to soft computing: Soft computing constituents and conventional artificial intelligence, Neuro-fuzzy, Soft computing characteristics.

Unit II: Fuzzy sets: Introduction, Basic definitions and terminology, Set-theoretic operations, MF formulation and parameterization, More on fuzzy union, Intersections, Complement.
Fuzzy rules and fuzzy reasonings: Extension principles and fuzzy relations, Fuzzy If-Than rules and Fuzzy reasoning. Fuzzy inference systems: Mamdani fuzzy models, Sugeno fuzzy models, Tsukamoto fuzzy models, Other considerations.

Unit III: Derivative free optimization: Genetic algorithm, simulated annealing, Random search, Downhill simplex search.

Unit IV: Adaptive networks: Architecture, Back propagation for feed forward networks, Extended back propagation for recurrent networks, hybrid Learning rule.
Supervised learning neural networks: Perceptions, Adaline, Back propagation multi layer perceptions, Radial basis function networks, modular Networks. Learning from reinforcement: Introduction. Unsupervised learning and other neural networks: Competitive learning networks, Kohonen self organizing networks, Learning vector quantization, Hebbian learning, Principal component networks, and The Hopfield networks.

Unit V: Adaptive Neuro-Fuzzy inference systems: ANFIS architecture, Hybrid learning Algorithms, Learning methods that cross fertilize ANFIS and RBNF, Simulation examples.

References:

7. Neuro Fuzzy and Soft Computing, S. R. Jang, C. T. Sun, E. Mizutani, Pearson Education 2009.
8. Neuro - Fuzzy & Soft Computing : A Computational Approach to Learning and Machine Inttelligence, J. S. R. Jang, C. T. Sun, E. Mizutani, Pearson Education, First Edition, 2015

Course Outcomes: Skill Development

- To design and build CI algorithms and approaches to real-life problems
- To analyze and solve major challenges and risks in computational intelligence
- To implement solutions for various problems in computational intelligence

Advanced Discipline Course
Next Generation Computing
L P U: 4 0 4

Course Objective:

18. To get knowledge on Systems on chips (SoCs) systems.
19. To study how the process information and execute critical tasks at higher speed and lower power on a tiny chip.
20. To study evolution of multicore system from fairly simple unicore single memory designs to complex homogeneous/heterogeneous multicore SoC.

Contents:

Unit I: Introduction to multicore systems on-chip: The Multicore revolution, Multicore SoC basics, Multicore SoCs design challenges. Multicore SoCs design methods: Design space exploration, Parallel software development phase, Generic architecture template (GAT) for Real multicore SoC design.

Unit II: Multicore SoC organization: MCSoC building blocks, MCSoC memory hierarchy, Memory consistency in multicore systems. Multicore SoC on-chip interconnection networks, Network-on-chip architecture, Hardware design of on-chip network.

Unit III: Advanced multicore SoC interconnects: Three-dimensional on-chip interconnect, Photonic on-chip interconnect for high-bandwidth multicore SoCs. 3D Integration technology for multicore systems on-chip: 3D integration technology, Fault-tolerant TSV cluster for 3D integration, Adaptive Online TSV Sharing Algorithm.

Unit IV: Parallelizing compiler for single and multicore computing: Parallel queue compiler, Parallelizing compiler framework, Parallelizing compiler development results.

Unit V: Power optimization techniques for multicore SoCs: Power-Aware technological-level design optimizations, Power-aware logic-level design optimizations, Power-aware system level design optimizations.

References:

6. Advanced Multicore Systems-On-Chip Architecture, On-Chip Network, Design, Abderazek Ben Abdallah, Springer, 2017.
7. Multicore Technology Architecture, Reconfiguration, and Modeling and Modeling, Muhammad Yasir Qadri, Stephen J. Sangwine, CRC Press Taylor & Francis Group, 2014.
8. Fundamentals of Multicore Software Development, Victor Pankratius, Ali-Reza Adl-Tabatabai, Walter Tichy, CRC Press Taylor & Francis Group, 2012.
9. High Performance Computing, Kevin Dowd, Charles R. Severance, Second Edition, O'REILLY, 1993.
10. Multicore Systems On-Chip: Practical Software/Hardware Design, Abderazek Ben Abdallah, Atlantis Press, 2010.

Course Outcomes: Skill Development

13. To expertise in the areas of SoCs, Multicore system Architectural design and many core systems.
14. To analyze basic network topology, design with multicore chip network design and communication.

Interdisciplinary Course
Internet of Things
L P U: 4 0 4

Pre-requisites: Basic Programming Knowledge

Can be offered to: CE, ECE, EEE and ME

Course Objective:

- To understand the application areas of IOT
- To realize the revolution of Internet in Mobile Devices, Cloud & Sensor Networks
- To understand building blocks of Internet of Things and characteristics
- To understand IoT principles, design and abstraction of developing IoT systems

Contents:

UNIT I: Introduction to Internet of things: Introduction-definition & characteristics of IoT , Physical design of IoT- things in IoT , IoT protocols, Logical design of IoT- IoT functional blocks, IoT communication models, IoT communication APIs , IoT enabling technologies-Wireless sensor networks , Cloud computing, Big data analytics, Communication protocols , Embedded systems, IoT levels & deployment templates.

UNIT II: Domain specific IoTs and home automation: Smart lighting, Smart appliances, Intrusion detection, smoke/gas detectors. Cities-smart parking, Smart lighting, Smart roads, Structural health monitoring, Surveillance, Emergency response. Environment-weather monitoring, Air pollution monitoring, Noise pollution monitoring, Forest fire detection, River floods detection .Energy- smart grids , Renewable energy systems , Prognostics. Retail-inventory management, Smart payments, Smart vending machines. Logistics-Route generation & scheduling, Fleet tracking, Shipment monitoring, Remote vehicle diagnostics. Agriculture-smart irrigation, Green house control. Industry –Machine diagnosis & prognosis indoor air quality monitoring. Health & lifestyle –Health & fitness monitoring, Wearable electronics.

UNIT III: IoT and M2M: Introduction, M2M-Difference between IoT and M2M, SDN and NFV for IoT-Software defined networking, Network function virtualization.

UNIT IV: IoT platforms design methodology: IoT design methodology-purpose & requirements specification, Process specification, Domain model specification, Information model specification, Service specifications, IoT level specification, Functional view specification , Operational view specification , Device & component integration , Application development, Case study on IoT System for weather monitoring, Motivation for using python IoT physical devices & endpoints.

What is an IoT Device-Basic building blocks of an IoT Device, Exemplary device: Raspberry Pi, About the board, Linux on Raspberry Pi , Raspberry Pi interfaces – Serial, SPI , I2C ,

programming Raspberry Pi with Python-Controlling LED with Raspberry Pi , Interfacing an LED and switch with Raspberry Pi ,Interfacing a light sensor (LDR) with Raspberry Pi , Other IoT Devices- PCDuino, Beagle bone black , Cubieboard.

UNIT V: IoT & beyond: Use of big data and visualization in IoT, Industry 4.0 concepts. Overview of RFID, Low-power design (Bluetooth Low Energy), Range extension and data intensive IoT for continuous recognition applications. Overview of Android / IOS App Development tools & Internet of Everything.

References:

- Internet of Things, A Hands on Approach, Arshdeep Bahga, Vijay audisetti, Orient Blackswan Private Limited - New Delhi; First edition, 2015.
- The Internet of Things How Smart TVs, Smart Cars, Smart Homes, and Smart Cities Are Changing the World, Michael Millen, Pearson Education, Inc., 2015.

Course Outcomes: Skill Development

- To design and develop IoT on a variety of open source devices and software services
- To integrate a variety of IoT devices, sensors and services to build complex applications

Interdisciplinary Course
Modern Computer Architecture
L P U: 4 0 4

Pre-requisites: Computer Organization and Architecture

Can be offered to: ECE, EEE

Course Objective:

- Able to describe the operation of modern and high performance computers.
- To undertake performance comparisons of modern and high performance computers.

Contents:

Unit I: Introduction- Review of basic computer architecture, Quantitative technique in computer design measuring and reporting performance, Amdahl's law, Flynn's classification, CISC and RISC processors.

Unit II: Pipelining- Basic concepts, Instructions and arithmetic pipelines, Structural hazards, data hazards and control hazards, Techniques for handling hazards, Exception handling, Pipeline optimization technique.

Unit III: Hierarchical memory technology- Multi cache problem, Inclusion, Coherence and locality properties, Cache memory organizations, Technique for reducing cache misses, Virtual memory organization techniques and management techniques, Memory replacement policies.

Unit IV: Instruction level parallelism- Basic concepts, technique for increasing ILP, Super-scalar, Super-pipelined VLIW processor architectures, Array and vector processors, SMT, Hyper threading.
Multiprocessor architectures: Taxonomy of parallel architecture.

Unit V: Centralized shared Memory Architecture- Synchronization, memory consistency inter connection networks, Distributed shared memory architecture, Cluster computing, Cloud Computing, Grid technology.

References

5. Computer Architecture: A Quantitative Approach, John Hennessy, David Patterson; Imprint: Morgan Kaufmann, November 2017.
6. Computer Architecture and Parallel Processing, K. Hwang and F.A. Briggs, Mc-Graw Hill, 1984.
7. Advanced Computer Architecture: Parallelism, Scalability and Programmability, Kai Hwang, Mc-Graw Hill. 2008
8. Advanced Concepts of Operating System, M. Singhal and N.G.Sivaratri, Tata-Mc-Graw Hill Publication, 2005

Course outcomes: Skill Development

- To solve computationally intensive problems
- To improve the performance of applications on modern and high performance computers.
- To develop procedures to improve the performance of modern and high performance computers.

Specialization Elective
Machine Learning
L P U: 4 0 4

Course Objective:

- To introduce well defined learning problems.
- To summarize classification and regression.
- To gain knowledge in Artificial Neural Networks.
- To understand dimensionality reduction, clustering and association analysis.
- To introduce reinforcement learning.

Contents:

Unit I: Introduction- Well defined learning problems, Designing a learning system, Issues in machine learning; The concept learning task - General-to-specific ordering of hypotheses, Find-S, List then eliminate algorithm, Candidate elimination algorithm, Inductive bias.

Unit II: Classification- Linear classification, Logistic regression, Linear discriminant analysis, Quadratic discriminant analysis, Support vector machines, Decision Trees, Baye's optimal classifier, Naive Baye's, Regression- Linear regression, Ridge regression, Lasso.

Unit III: Artificial neural networks: Perceptron, Gradient descent and the Delta rule, Adaline, Multilayer networks, Derivation of back-propagation, rule-Back-propagation Algorithm-Convergence, Generalization.

Unit IV: Dimensionality reduction: Principal component analysis, Partial least squares clustering: K-means, K-medoids, Fuzzy C- Means ,Hierarchal, Gaussian mixture, Association analysis: Apriori, FP –Growth, Hidden Markov model, SVD.

Unit V: The learning task, Q Learning, Nondeterministic rewards and actions, Temporal difference learning, Generalizing from examples, Relationship to dynamic programming.

References:

6. Machine Learning, Tom M .Mitchell, McGraw Hill, 1997.
7. Pattern Recognition and Machine Learning Christopher Bishop, Springer, 2006.
8. Data mining : practical machine learning tools and techniques, I. H.; Frank, Eibe.; Hall, Mark A. 3rd ed. : Burlington, MA : Morgan Kaufmann, cop. 2011.
9. Neural Networks - A Class Room Approach, Satish Kumar, Second Edition, Tata McGraw-Hill, 2013.
10. Neural networks Fuzzy logics and Genetic algorithms, S. Rajasekaran and G.A. Vijayalakshmi Pai, Prentice Hall of India, 2004

Course Outcome: Skill Development

- To understand real word learning problems.
- To develop supervised learning application.
- To design unsupervised learning application

Specialization Elective
Natural Language Processing
L P U: 4 0 4

Course Objective:

- To introduce the fundamental concepts and techniques of natural language processing (NLP)
- To gain an in-depth understanding of the computational properties of natural languages and the commonly used algorithms for processing linguistic information
- To examine NLP models and algorithms using both the traditional symbolic and the more recent statistical approaches

Contents:

Unit I: Language processing and python- Computing with language, Back to Python, Automatic natural language understanding.
Processing raw text- Accessing text from the web and from disk, Strings, Text processing with unicode, Regular expressions for detecting word patterns, Useful applications of regular expressions, Normalizing text, Regular expressions for tokenizing text.

Unit II: Categorizing and tagging words- Using a tagger, Tagged corpora, Mapping words to properties using python dictionaries, Automatic tagging, N-Gram tagging, Transformation-Based tagging.
Learning to classify text- Supervised classification, Further examples of supervised classification, Evaluation, Decision trees, Naive Bayes classifier, Maximum entropy classifiers, Modeling linguistic patterns.

Unit III: Extracting information from text- Information extraction, Table of contents, Chunking, Developing and evaluating chunkers, Recursion in linguistic structure, Named entity recognition, Relation extraction.
Analyzing sentence structure: Some grammatical dilemmas, Context-Free grammar, Parsing with context-free grammar, Dependencies and dependency grammar, Grammar development.

Unit IV: Building feature based grammars- Grammatical features, Processing feature structures, Extending a feature-based grammar.
Analyzing the meaning of sentences: Natural language understanding, propositional logic, First-order logic, Semantics of english sentences, Discourse semantics.

Unit V: Information extraction- Named entity recognition, Relation extraction, Extracting times, Extracting events and their times, Template filling.

References:

3. http://nptel.ac.in/courses/106105152/
4. Machine Learning, An Algorithmic Perspective, Stephen Mars Land, II Edition-, CRC Press, 2009.

Course Outcomes: Skill Development

- To develop language processing with the Natural Language Tool Kit (NLTK)
- To Compare and contrast the approaches of natural language processing
- To build applications using Python to work on natural language processing
- To analyze different classification and extraction techniques

Specialization Elective
Mobile Computing
L P U: 4 0 4

Course Objective:

- To introduce the field of Mobile and Wireless Technology, its history and Research scope.
- To understand the motivation and importance of various wireless MAC schemes.
- To gain knowledge about GSM (Global System for Mobile Communication), UMTS (Universal Mobile Telecommunication Systems) etc.
- To introduce Mobile IP and Mobile Transport Layer for Mobile Computing.
- To have knowledge on MANETs and WAP.

Contents:

Unit I: Introduction- A short history of wireless communication, A market for mobile communications, Open research topics, Simplified reference model. Wireless transmission-frequencies, Signals, Antennas and Signal propagation.

Unit II: MAC: Motivation for a specialized MAC, SDMA, FDMA, TDMA and CDMA, Comparisons.

Unit III: Telecommunication systems: GSM, DECT, TERA, UMTS and IMT-2000.
Satellite systems: History, Applications, Basics, Routing, Localization and handover. Broadcast systems- Overview, Cyclical repetition of data, Digital audio broadcasting, Digital video broadcasting, Convergence of broadcasting and mobile communications.

Unit IV: Wireless LAN: Infrared Vs Radio transmission, Infrastructure and Adhoc networks, IEEE 802.11, HIPERLAN, Bluetooth.

Unit V: Mobile network layer- Mobile IP, Mobile IP, DHCP, MANETs. Mobile transport layer: Traditional TCP, Classical TCP improvements and WAP, TCP over 2.5/3G wireless networks, Performance enhancing proxies. Support for mobility- File systems, WWW, Wireless application protocol, I-mode, SyncML, WAP 2.0.

References:

1. Mobile Communications, JochenSchiller, Second Edition, Pearson publication, 2003.
2. Hansmann, Merk, Nicklous, Stober, "Principles of Mobile Computing", Springer, second edition, 2003.
3. Martyn Mallick, "Mobile and Wireless Design Essentials", Wiley DreamTech, 2003.

Course Outcome:

- To analyze Compare 3G Cellular telephone data transfer rates with those over Wireless LAN
- To analyze different variations of Mobile IP and Mobile Transport Layer.
- To formulate various challenges involved in MANETs

Specialization Elective
Distributed Systems
L P U: 4 0 4

Course Objective:

- To learn the characteristics of a distributed OS
- To study issues related to the principles and paradigms of distributed system environment
- To study the various shared memory approaches and issues related to it
- To get knowledge about various cache concurrency control protocols

Contents:

Unit I: Introduction: Definition, Relation to computer system components, Relation to parallel multiprocessor/multicomputer systems, Message passing systems versus shared memory systems, Primitives for distributed communication, Synchronous versus asynchronous executions, Design issues and challenges. Model of distributed computations, Model of distributed executions, Models of communication network, Global state of a distributed system, Cuts of a distributed computation, Models of process communications.

Unit II: Architectures: System architectures, Centralized architectures, Decentralized architectures, Hybrid architectures, Architectures versus middle ware, Self-management in distributed systems. Process: Threads, Visualization, Clients, Servers, Code migration.

Unit III: Communication: Fundamentals, Remote procedure call, Message-oriented communication, Stream-oriented communication, Multi-cast communication.
Synchronization: Clock synchronization, Logical clock, Mutual exclusion, Global positioning of nodes, Election algorithms.

Unit IV: Deadlock detection in distributed systems: System model, Preliminaries, Preliminaries, Knapp's classification of distributed deadlock detection algorithms, Mitchell and Merritt's algorithm for the single-resource model, Chandy-Misra-Haas algorithm for the AND model, Chandy-Misra-Haas algorithm for the OR Model, Kshemkalyani-Singhal algorithm for P-out-of-Q Model.
Global predicate detection: Stable and unstable predicates, Modalities on predicates, Centralized algorithm for relational predicates, Conjunctive predicates, Distributed algorithms for conjunctive predicates, Further classification of predicates.

Unit V: Distributed shared memory: Abstraction and advantages, Memory consistency models, Shared memory mutual exclusion, Wait-freedom, Register hierarchy and wait-free simulations, Wait-free atomic snapshots of shared objects.
Check pointing and rollback recovery: Background and definitions, Issues in failure recovery, Checkpoint based recovery, Log-based rollback recovery, Koo-Toueg coordinated check pointing algorithm, Manivannan-Singhal Quasi-Synchronous check pointing algorithm, Peterson-Kearns algorithm based on vector time.

References:

1. Distributed Systems Principles and paradigms, Andrew S.Tanenbaum, Maarten Van Steen, Second Edition, International Edition, Pearson Education, 2007.
2. Distributed Systems Principles and paradigms, Ajay D. Kshemkalyani, Mukesh Singhal, Cambridge Press, 2007.
3. Distributed Systems Concepts and Design, George Coulouris, Jean Dollimore, Tim Kindberg, Gordon Blair, Fifth Edition, Addison-Wesley, 2012.
4. Design and Analysis of Distributed Algorithms, Nicola Santoro, john wiley & sons, inc., publication, 2007.
5. Distributed Operating Systems Theory and Practice, Yakup Paker, Jean-Pierre Banatre, Muslim Bozyigit, NATO Advanced Science Institutes Series, Springer - Verlag, 1986.

Course Outcomes: Skill Development

1. To analyze distributed platforms
2. Expertizing about standard distributed algorithms and approaches
3. Ability to develop distributed mutual exclusion algorithms

Specialization Elective
Parallel computing
L P U: 4 0 4

Course Objective:

- To introduce the foundations of parallel computing, including parallel architectures, parallel programming methods and techniques
- To know about parallel algorithm designs, and parallel performance analysis

Contents:

Unit I: Introduction to parallel computing, Motivating parallelism, Scope of parallel computing, Parallel programming platform, Principles of parallel algorithm design, Preliminaries, Decomposition techniques, Characteristics of tasks and interactions, Mapping techniques for load balancing, Methods for containing interaction overheads, Parallel algorithm model.

Unit II: Basic communication operations- One-to-All broadcast and All-to-One reduction, All-to-All broadcast and reduction, All-Reduce and Prefix-Sum operations, Scatter and Gather, All-to-All personalized communication, Circular shift, Improving the speed of some communication operations.

Unit-III: Analytical modeling of parallel programs- Sources of overhead in parallel programs, Performance metrics for parallel systems, Effect of granularity on performance, Scalability of parallel systems, Minimum execution time and minimum cost-optimal execution time, Asymptotic analysis of parallel programs.

Unit-IV: Programming using the message-passing paradigm- Principles of message, Passing programming, Building blocks: Send and receive operations, MPI: the message passing interface, Topologies and embedding, Overlapping communication with computation, Collective communication and computation operations, Groups and communicators.

Programming shared address space platforms- Thread basics, POSIX Thread API, Synchronization primitives, Controlling thread and synchronization attributes, Thread cancellation, Composite synchronization constructs.

Unit V: Dense matrix algorithms, Sorting, Graph algorithms, Search algorithms for discrete optimization problems, Dynamic programming- Overview of dynamic programming, Serial monadic DP formulations, Nonserial monadic DP formulations, Serial polyadic DP formulations, Nonserial polyadic DP formulations

References:

3. Introduction to Parallel Computing, Ananth Grama, Anshul Gupta, George Karypis, Vipin Kuma,r Addison Wesley, 2nd edition, 2003.
4. https://onlinecourses.nptel.ac.in/noc18_cs55/preview

Course Outcomes: Skill Development

- To analyze how large scale parallel systems are architectured and how massive parallelism are implemented in accelerator architectures
- To write parallel programs for large scale parallel systems, shared address space platforms, and heterogeneous platforms
- To design efficient parallel algorithms and applications

Specialization Elective
Software Project Management
L P U 4 0 4

Course Objectives

- To deliver successful software projects that support organization's strategic goals
- To match organizational needs to the most effective software development model
- To plan and manage projects at each stage of the software development life cycle (SDLC)
- To create project plans that address real-world management challenges
- To develop the skills for tracking and controlling software deliverables

Contents

Unit I: Activities in software project management, Overview of project planning, Stepwise planning, Contract management, Software processes and process models, Cost benefit analysis, Cash flow forecasting, Cost-benefit evaluation techniques, Risk evaluation. Project costing.

Unit II: COCOMO 2, Staffing pattern, Effect of schedule compression, Putnam's equation, Capers Jones estimating rules of thumb, Project sequencing and scheduling activities, Scheduling resources, Critical path analysis, Network planning, Risk management, Nature and types of risks, Managing risks.

Unit III: Hazard identification, Hazard analysis, Risk Planning and control, PERT and monte carlo simulation techniques, Monitoring and control, Collecting data, Visualizing progress, Cost monitoring, Review techniques, Project termination review, Earned value analysis, Change control.

Unit IV: Software configuration management (SCM), Managing contracts, Types of contracts, Stages in contract placement, Typical terms of a contract, Contract management and acceptance, Quality management and people management.

Unit V: Introduction, Understanding behavior, Organizational behaviour, Selecting the right person for the job, Motivation, Oldman – Hackman Job characteristics model, Working in groups, Organization and team structures, Decision making, Leadership, Organizational structures, Stress, Health and safety, ISO and CMMI models, Testing, Software reliability, Test automation.

References:

1. Software Project Management, Bob Hughes, Mike Cotterell, , Fifth Edition, Tata McGraw Hill, 2011.
2. http://nptel.ac.in/courses/106101061/29
3. Effective Software Project Management, Robert K. Wysocki, Wiley desktop editions, 2009.

Course Outcomes: Skill Development

- To analyze issues and challenges faced while doing the software project management.
- To explore how the failure probability can be reduced effectively in software project management
- To implement project scheduling, tracking, Risk analysis, Quality management and Project Cost estimation using different techniques.

Specialization Elective
Information Security Management (Security Analyst – I)
LPU 4 0 4

Course Objective:

- To introduce the information security terminology, technology and its applications
- To introduce the concept of security analyst
- To introduce the tools, technologies & programming languages which is used by security analyst

Contents:

Unit I: Information security management- Information security overview, Threats and attack vectors, Types of attacks, Common vulnerabilities and exposures (CVE), Security attacks, Fundamentals of information security, Computer security concerns, Information security measures etc.

Unit II: Fundamentals of information security- Key elements of networks, Logical elements of network, Critical information characteristics, Information states etc.

Unit III: Data leakage- What is data leakage and statistics, Data leakage threats, Reducing the risk of data loss, Key performance indicators (KPI), Database security etc.

Unit IV: Information security policies, Procedures and audits- Information security policies-Necessity-key elements & characteristics, Security policy implementation, Configuration, Security standards-guidelines & frameworks etc.

Unit V: Information security management roles and responsibilities- Security roles & responsibilities, Accountability, Roles and responsibilities of information security management, Team-responding to emergency situation-risk analysis process etc.

References:

1. Management of Information Security, Michael E.Whitman ,Herbert J.Mattord Cengage Learning, third edition, 2010.
2. http://www.iso.org/iso/home/standards/management-standards/iso27001.htm
3. http://csrc.nist.gov/publications/nistpubs/800-55-Rev1/SP800-55-rev1.pdf

Course Outcomes: Skill Development

- To explore the policies, guideline and framework of information security
- To analyze the Roles and Responsibilities of ISM
- To analyze data leakage statistics, threats, security issues measures and mitigation.

- To design key elements and logical elements of networks.

Specialization Elective
Deep Learning
L P U: 4 0 4

Course Objective:

- To introduce the field of Deep Learning, its history and Research scope.
- To understand the motivation and importance of various Deep Learning/ Deep Neural Networks in the context of Visual Recognition.
- To gain knowledge about Image Classification, Loss Function and Optimization.
- To introduce CNN and RNN.

Contents:

Unit I: Modern practical deep networks- Deep Feedforward Networks, regularization for deep learning, optimization for training deep models, Introduction to CNN, Convolutional networks, Image Classification, Sequence modeling, Recurrent and recursive nets, Practical methodology, Applications.

Unit II: Loss function and optimization, Back propagation in neural networks. Training neural networks, deep learning softwares.

Unit III: CNN architectures, Recurrent neural networks. Detection and segmentation, Visualizing and understanding, Deep reinforcement learning.

Unit IV: Deep learning research-Linear factor models, Autoencoders, Representation learning, Structured probabilistic models for deep learning, Monte Carlo methods, Confronting the partition function, Approximate inference, Deep generative models.

References:

1. Deep Learning- An MIT Press book, Ian Goodfellow and Yoshua Bengio and Aaron Courville, The MIT Press, 2016.
2. http://cs231n.stanford.edu/
3. http://cs231n.stanford.edu/slides/2017/
4. http://cs231n.stanford.edu/slides/2018/

Course Outcome: Skill Development

- To analyze deep Learning in the Context of Image/Video Classification/Recognition
- To work on loss function and optimization in deep learning
- To solve the problems using deep learning softwares

Specialization Elective
Information Retrieval System
LPU 4 0 4

Course Objective:

- To define various retrieval strategies
- To explain various utilities of the retrieval system and cross language information retrieval
- To measure the efficiency of retrieval and query processing and explain various retrieval techniques

Contents:

Unit I: Retrieval strategies- Vector space model, Probabilistic retrieval strategies, Language models, Inference networks, Extended boolean retrieval, Latent semantic indexing, Neural networks, Genetic algorithms, Fuzzy set retrieval.

Unit II: Retrieval utilities- Relevance feedback, Clustering, Passage-based retrieval, N-grams, Regression analysis, Thesauri, Semantic networks, Parsing.

Unit III: Cross-Language information retrieval- Introduction, Crossing the language barrier, Cross-language retrieval strategies, Cross language utilities. Efficiency- inverted index, Query processing, Signature files, Duplicate document detection.

Unit IV: Integrating structured data and text- Review of the relational model, Historical progression, Information retrieval as a relational application, Semi-structured search using a relational schema, Multi-dimensional data model.
Parallel information retrieval- Parallel text scanning, Parallel indexing, Clustering and classification, Large parallel systems.

Unit V: Scalability challenges in web search engines: Components, Objectives, Parameters, Scalability issues and open problems

References:

1. Information Storage and Retrieval Systems: Theory and Implementation, Kowalski, Gerald, Mark T Maybury, Springer US, second edition, 2002.
2. Mining the Web: Discovering knowledge from hypertext data, Chakrabarti, Soumen, Morgan Kaufmann, 1st edition, 2002.
3. Information retrieval: Algorithms and heuristics, Grossman, David A, Ophir Frieder, Vol. 15, Springer Science & Business Media, 2012.

Course Outcomes: Skill Development

- To compute the similarity measure between collections of documents using different approaches and represent any problem as a state space search.
- To apply various retrieval techniques to improve the efficiency.
- To compute the similarity coefficient for retrieval of relevant documents of cross language in nature.
- To implement various optimization techniques to improve the efficiency of information retrieval.
- To perform information retrieval from various distributed sources in different forms.
- To design and build the working model of information retrieval system.

Specialization Elective
Energy Efficiency in Wireless Sensor Networks
L P U 4 0 4

Course Objective:

- To introduce the field of Wireless Sensor Networks, its history and Research scope.
- To understand the motivation and importance of various Wireless Sensor Networks in the context of limited storage, computation and communication capabilities.
- To gain knowledge about Energy efficient MAC protocols for WSN.
- To introduce Energy Efficient Routing protocols for WSN.
- To introduce several TCP protocols for WSN.

Contents:

Unit I: Introduction and overview of wireless sensor networks, Applications of wireless sensor networks, Basic wireless technology- Sensor node technology, Sensor taxonomy, WN operating environment, WN Trends.
Wireless transmission technology and systems- Radio technology primer, Available wireless technologies.

Unit II: MAC for wireless sensor networks- Fundamentals of MAC protocols, MAC protocols for WSN, Sensor-MAC case study, IEEE 802.15.4 LR-WPANs standard case study.
Routing protocols for wireless sensor networks- Introduction, Background, Data dissemination and gathering, Routing challenges and design issues in wireless, Routing strategies in wireless sensor networks.

Unit III: Transport control protocols for wireless sensor networks- Traditional transport control protocols, Transport protocol design issues, Examples of existing transport control protocols, Performance of transport control protocol.
Middleware for Wireless Sensor Networks- WSN middleware principles, Middleware architecture, Existing middleware.

Unit IV: Network management for wireless sensor networks- Network management requirements, Traditional network management models, Network management design issues, Example of management architecture: MANNA, Other issues related to network management.
Operating systems for wireless sensor networks- Operating system design issues, Examples of operating systems.

Unit V: Performance and traffic management- Introduction, Background, WSN design issues, Performance modeling of WSNs, Case study: Simple computation of the system life span.

References:

1. Wireless Sensor Networks – Technology, Protocols and Applications, Kazem Sohraby, Daniel Minoli, TaiebZnati, Wiley India Pvt, Ltd., 2007.
2. Wireless Sensor Networks: A Networking Perspective, Jun Zheng, Abbas Jamalipour, Wiley, 2008.
3. Protocols and Architectures for Wireless Sensor Networks, Holger Karl, Andreas Willig, Wiley, 2006.

Course Outcome: Skill Development

- To analyze several energy efficient MAC and routing protocols for WSN.
- To analyze different transport layer protocols for WSN
- To design solutions for challenges involved in WSN.

Specialization Elective
Real Time Systems
L P U 4 0 4

Course Objective:

1. To learn the **characteristics** of real time OS.
2. To study issues related to the methods and analysis of systems with real-time restraints.
3. To study the various uniprocessor and multiprocessor scheduling approaches.
4. To get knowledge about various real time communication protocols.
5. To become master in differentiating traditional and real time databases.

Contents:

Unit I: Introduction to real time computing – Concepts, Example of real-time applications, Structure of a real time system, Characterization of real time systems and tasks, Hard and soft timing constraints, Design challenges, Performance metrics, Prediction of execution time - source code analysis, Micro-architecture level analysis, Cache and pipeline issues, Programming languages for real time systems.

Unit II: Real time OS, Threads and tasks, Structure of microkernel, Time services, Scheduling mechanisms communication and synchronization, Event notification and software interrupt.

Unit III: Task assignment and scheduling, Task allocation algorithms, Single-processor and multiprocessor task scheduling, Clock-driven and priority-based scheduling algorithms, Fault tolerant scheduling

Unit IV: Real time communication, Network topologies and architecture issues, Protocols, contention based, Token based, Polled bus, Deadline based protocol, Fault tolerant routing. RTP and RTCP.

Unit V: Real time databases, Transaction priorities, Concurrency control issues, Disk scheduling algorithms, Two phase approach to improve predictability.

References:

1. Real Time Systems, C.M. Krishna, Kang G. Shin, International Edition, McGraw Hill Companies, Inc., New York, 1997
2. Real-Time Systems, Jane W.S. Liu, Pearson Education India, 2000.
3. Real-Time Systems Design and Analysis: Tools for the Practitioner, Philip A. Laplante and Seppo J. Ovaska, IV Edition IEEE Press, Wiley. 2011.
4. Real-time Simulation Technologies Principles, Methodologies, and Applications, Katalin Popovici, Pieter J. Mosterman, CRC Press is an imprint of Taylor & Francis Group, 2013.
5. Real-Time Systems Development, Rob Williams, Elsevier, 2006.

Course Outcome: Skill Development

1. To design communication protocols using real-time programming platforms.
2. To analyze real-time tasks schedulability.
3. To analyze real time communication protocols and databases.
4. To develop real time system tasks.

Specialization Elective
High Performance Computing
L P U 4 0 4

Course Objective:

1. To get knowledge on developments and applications field of computational science.
2. To study basics of modern processor architecture and serial optimization techniques.
3. To study the various uniprocessor and multiprocessor scheduling approaches.
4. To discuss critical issues in data movement.

Contents:

Unit I: Modern processors- Stored program computer architecture, General-purpose cache based microprocessor architecture, Memory hierarchies, Multicore processors, Multithreaded processors, Vector processors. Basic optimization techniques for serial code, Scalar profiling, Common sense optimizations, Simple measures, Large impact, The role of compilers, C++ optimization.

Unit II: Data access optimization- Balance analysis and light speed estimates, Storage order, Algorithm classification and access optimizations. Parallel computers, Taxonomy of parallel computing paradigms, Shared-memory computers, Distributed-memory computers, Hierarchical (Hybrid) systems, Networks, Case Study, Sparse matrix, Vector multiply.

Unit III: Basics of parallelization- Parallelism, Parallel scalability. Shared-memory parallel programming with Openmp- Short introduction to Openmp, Advanced Openmp- wavefront parallelization, Case study- Openmp-parallel Jacobi algorithm.

Unit IV: Efficient Openmp programming- Profiling Openmp programs, Performance pitfalls. Locality optimizations on Ccnuma architectures- Locality of access on Ccnuma, Placement pitfalls, Ccnuma issues with C++, Case study- Parallel sparse matrix-Vector multiply.

Unit V: Distributed-memory parallel programming with MPI: Message passing, Short introduction to MPI, Example: MPI parallelization of a Jacobi solver. Efficient MPI programming: MPI performance tools, Communication parameters, Synchronization, Serialization, Contention, Reducing communication overhead. Hybrid parallelization with MPI and Openmp: Basic MPI/Openmp programming models, MPI taxonomy of thread interoperability, Hybrid decomposition and mapping.

References:

1. Introduction to High Performance Computing for Scientists and Engineers, Georg Hager, Gerhard Wellein, CRC Press Taylor & Francis Group, 2011.
2. Advances in Computers High Performance Computing, Marvin v. zelkowitz, Elsevier, 2008.
3. High Performance Computing, Kevin Dowd, Charles R. Severance, Second Edition, O'REILLY, 1993.

Course Outcomes: Skill Development

1. To analyze real-time programming platforms.
2. To expertise in the areas of parallel processing in shared, non-uniform access, and distributed memories.
3. To develop parallel programs in OpenMP and MPI.

Specialization Elective
Software Testing
L P U 4 0 4

Course Objectives:

- To use various test tools
- To know about test processes
- To know about errors, fault models and software testing techniques

Contents:

Unit I: Introduction: Introduction to software testing, software testing terminology and methodology, Verification and validation, Evolution of testing, Software testing life cycle, V-model for software testing, Testing and debugging, Levels of testing, Software defect management, flow graphs, Code-based testing, Logic based testing, Configuration management, Risk analysis, Model based testing, Statistical testing, Formal testing.

Unit II: Testing techniques: Dynamic testing: White-box testing.
Static testing: Sliced based testing, mutation testing, Coverage analysis, Defect seeding.
Regression testing: Regression test process, Test case selection, Test case prioritization, Code based and model based regression testing.

Unit III: Testing process: Test Planning: Test policy, Test strategy, Quality plan and test plan, Test estimation, Test scenario, Test scripts, Test log document, Generation of test data, Test progress monitoring.

Test metrics and test reports: Testing data, Categories of product test metrics, Resource consumed in testing, Defect density, Test reports, Project test status reports, Integration, System and acceptance test report, Test process improvement, Benchmarking.

Unit IV: Testing Strategies: Integration and system testing- Top down and bottom up integration, Bi-directional integration, System integration, Scenario testing, Defect bash, Functional vs non-functional testing, Design/architecture verification, Deployment testing, Scalability testing, Reliability testing, Stress testing.
Acceptance testing: Acceptance testing criteria, Alpha, Beta and Gamma testing, Acceptance testing during each phase of SDLC Criticality of requirements, Software acceptance plan, User's responsibility.

Unit V: Test management and automation: Software test automation, Scope of automation, Design and architecture for automation, FSM based testing, generic requirements for test tool framework, Testing tool selections, Testing in object oriented systems, Testing web based system. Current research and emerging trends in software testing.

References:

1. Software Testing: Principles and Practices, S. Desikan and G. Ramesh, Pearson, first edition, 2005.
2. http://nptel.ac.in/courses/106105150/

Course Outcomes: Skill Development

- To analyze different testing techniques
- To implement different testing techniques to explore the testing process easier

Specialization Elective

Information Security Assessments & Audits (Security Analyst – II)

L P U 4 0 4

Course Objective:

- To introduce the terminology, technology and its applications
- To understand and knowledge of Security Analyst foundations
- To introduce tools, technologies and programming languages which is used by security analyst

Contents:

Unit I: Information security performance metrics and audit- Security metrics and reporting, Common issues and variances of performance metrics, Introduction to security audit, Servers and storage devices, Infrastructure and networks, Communication routes, Information security Methodologies (Black-box, White-box, Grey-box), Phases of information security audit and strategies, Ethics of an information security auditor etc.

Unit II: Information security audit tasks, Reports and post auditing actions- Pre-audit checklist, Information gathering, Vulnerability analysis, External security audit, Internal network security audit, Firewall security audit, IDS security auditing, Social engineering security auditing, Web application security auditing, Information security audit deliverables & writing report, Result analysis, Post auditing actions, Report retention etc.

Unit III: Vulnerability management-information security vulnerabilities, Threats and vulnerabilities, Human-based social engineering, Computer-based social engineering, Social media countermeasures, Vulnerability management, Vulnerability scanning, Testing, Threat management, Remediation etc.

Unit IV: Information security assessments- Vulnerability assessment, Classification, Types of vulnerability assessment, Vulnerability assessment phases, Vulnerability analysis stages, Characteristics of a good vulnerability assessment solutions &considerations, Vulnerability assessment reports – tools and choosing a right tool, Information security risk assessment, Risk treatment, Residual risk, Risk acceptance, Risk management feedback loops etc.

Unit V: Configuration reviews- Introduction to configuration management, Configuration management requirements, Plan, Control, Development of configuration control policies, Testing configuration management etc

References:

1. Assessing Information Security strategies, tactics, logic and framework, A Vladimirov, K.Gavrilenko, and A.Michajlowski, IT Governance Publishing, 2010
2. The Art of Computer Virus Research and Defense by Peter Szor, Addison-Wesley Professional, 2005.
3. https://www.sans.org/reading-room/whitepapers/threats/implementing-vulnerability-management-process-34180
4. http://csrc.nist.gov/publications/nistpubs/800-40-Ver2/SP800-40v2.pdf

Course Outcome: Skill Development

- To analyze the difference between Security Metrics and Audits
- To analyze Information Security Audit Tasks, Reports and Post Auditing Actions
- To understand Information Security Assessments

Specialization Elective
Social Network Analysis
L P U 4 0 4

Course Objective:

- To understand the concept graph essentials and related applications.
- To learn Graph Algorithms and Network Measures.
- To understand Network Models and Community Analysis.
- To learn Data Mining Algorithms.

Contents:

Unit I: Social media mining, Challenges for mining, Graph essentials, Graph basics, Nodes edges, Degree and degree distribution, Graph representation, Types of graphs, Connectivity in graphs, Special graphs, Trees and forests, Special sub-graphs, Complete graphs, Planar graphs, Bipartite graphs, Regular graphs, Bridges, Application.

Unit II: Graph algorithms- Graph/Tree traversal, Shortest path algorithms, Minimum spanning trees, Network flow algorithms, Maximum bipartite matching, Bridge detection. Network measures, Centrality, Degree centrality, Eigenvector centrality, Katz centrality, Page rank, Betweenness centrality, Group centrality, Transitivity and reciprocity: Transitivity, Reciprocity, Balance and status, Similarity- structural equivalence, Regular equivalence

Unit III: Network models- Properties of real-world networks: Degree distribution, Clustering coefficient, Average path length, Random graphs- Evolution of random graphs, Properties of random graphs, Modeling real-world networks with random graphs, Small-World model- Properties of the small-world model, Modeling real-world networks with the small-world model, Preferential attachment model: properties of the preferential attachment model, Modeling real-world networks with the preferential, Attachment model.

Unit IV: Community analysis- Community detection, Community detection algorithms, Member-based community detection, Group-based community detection, Community evolution, How networks evolve, Community detection in evolving networks, Community evaluation: evaluation with ground truth, Evaluation without ground truth.

Unit V: Data mining essentials- Data, Data quality, Data preprocessing, Data mining algorithms- Supervised learning: Decision tree learning, Naive Bayes classifier, Nearest Neighbor classifier. Classification with network information, Regression, Supervised learning evaluation, Unsupervised learning- Clustering algorithms, Unsupervised learning evaluation.

References:

1. Social Media Mining: An Introduction, Reza Zafarani, Mohammad Ali Abbasi, Huan Liu, Cambridge University Press; first edition, 2014.
2. Mastering Social Media Mining with Python, Marco Bonzanini, Packt Publishing. 2016

Course Outcome: Skill Development

- To develop social network related applications.
- To implement the graph algorithms and network measures in social network.
- To predict social network behavior and related communities.
- To implement the data mining algorithms in real world network.

Advanced Discipline Course
Wavelets in Signal Processing and Image Processing
L P U: 4 0 4

Course Objectives:

- To implement wavelets and related constructions.
- A particular emphasis will be put on constructions that are amenable to efficient algorithms.
- Establish the relationship between wavelets, multirate filter banks, and multi resolution analysis studied in the mathematics, signal processing, and computer vision communities respectively.

Contents:

Unit I: wavelets, subband coding and multiresolution signal processing. Hilbert spaces, orthonormal bases. Multirate signal processing: review Discrete-time bases.

Unit II: Analysis of Haar and Sinc Expansions of Discrete-Time Signals.Orthonormal and Linear Phase filter banks. onstruction of Daubechies filters.Lattice Factorization of Filter Banks.

Unit III: Construction by lifting: "next-generation" wavelets.Tree-structured filter banks and Wavelet-Packets. Multichannel Filter Banks / IIR filter banks.Discrete-Time Wavelet Series. Lapped Orthogonal Transforms.Series Expansions of Continuous-Time Signals.Haar and Sinc wavelets.

Unit IV: Adapted wavelet and wavelet packet representations.Best Bases algorithms.Arbitrary tilings of the time-frequency plane based on wavelets. Applications to signal compression. Review of Rate-Distortion, KLT, Optimal Bit Allocation principles.Basics of Quantization Theory. pplications to image and video compression.State-of-the-art wavelet image coders:Role of wavelets in next-generation image compression standard JPEG-2000. Applications of multiresolution concept to communications/networking:Joint source-channel coding, broadcast and multicast.Video over the Internet and Wireless Channels

References:

1. M. Vetterli and J. Kovacevic. Wavelets and Subband Coding. Prentice Hall, 1995.
2. S. Mallat. A Wavelet Tour of Signal Processing. Academic Press, 1998
3. G. Strang and T. Nguyen. Wavelets and Filter Banks. Wellesley-Cambridge Press, 1996.

Course Outcomes: Skill Development

- Apply wavelets, filter banks, and multiresolution techniques to a problem at hand, and justify why wavelets provide the right tool.
- Analyze and implement algorithms behind wavelets from an interdisciplinary perspective that unifies harmonic analysis (mathematics), filter banks (signal processing), and multiresolution analysis (computer vision).

Specialization Elective
Pattern Recognition and Neural Networks
L P U: 4 0 4

Course Objective:

- To understand Bayes Classification, Nearest Neighbor Rule, Neural Networks
- To explain classification techniques such as Support Vector Machines and Multi classifiers for solving Bio-Medical problems.

Contents:

Unit I: Introduction to pattern recognition, introduction to classifier design and supervised learning from data, classification and regression.

Unit II: Bayesian decision theory, Bayes and nearest neighbour classifiers, parametric and non-parametric estimation of density functions, linear discriminant functions, Perceptron, linear least-squares regression, LMS algorithm

Unit III: Fisher linear discriminant, introduction to statistical learning theory and empirical risk minimization, non-linear methods for classification and regression

Unit IV: Artificial neural networks for pattern classification and regression, multilayer feed forward networks, back propagation, RBF networks, Optimal separating hyperplanes. Applications.

Unit V: Support Vector Machines and some variants, Assessing generalization abilities of a classifier, Bias-variance trade-off, cross validation, bagging and boosting, AdaBoost algorithm, brief discussion of feature selection and dimensionality reduction methods.

References:

1.Neural networks for pattern recognition by Omid Omidvar, Judith Dayhoff,Academic Press,USA,First Edition,1995.
2.R.O.Duda,P.E.Hart and D.G.Stork,Pattern Classification, John Wiley,First Edition 2002.
3.C.M.Bishop, Neural Networks and Pattern Recognition, Oxford University Press (Indian Edition),First Edition 2003

Course Outcomes: Skill Development

1.The students would analyze different algorithms for learning pattern classifiers
2.The students would explore different datasets to get a Design for machine learning algorithms.
3.The statistical and optimization principles underlying different algorithms would be emphasized and designed machine learning Applications.

Specialization Elective
Digital Signal Compression
L P U: 4 0 4

Course Objective:

- To understand the fundamental concepts and coding methods of signal compression.
- To understand the Principles of lossless compression.
- To develop the various entropy coding techniques, including Huffman coding, arithmetic coding and Lempel-Ziv coding.

Contents:

Unit I: Data types, Basic compression process,applications, methods, Entropy and lossless coding, Source transformations, set portioning coding, coding systems

Unit II: Lossless source coding and entropy, variable length codes, entropy coding techniques, Huffman codes, Shannon FanoElias, Arithmetic, Run length, modified Huffman, Golomb and Dictionary codes.

Unit III: Lossy compression of scalar sources, coding of sources with memory.

Unit IV: Mathematical transformations, rate control in transform coding system

Unit V: Set partition coding, subband/wavelet coding system

.

References:

1.Digital Signal Compression Principles and Practice by William A. Pearlman,First Edition,2011,Cambridge University Press

2.Tools for Signal Compression: Applications to Speech and Audio Coding, Nicolas Moreau,Wiley sonxs,First Edition,2013.

3. Signal Compression: Coding of Speech, Audio, Text, Image and Video,World Scientific Publishing co.Pte.Ltd,First Edition,1997.

Course Outcomes: Skill Development

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- Analyze and implement step-by-step descriptions of algorithms.
- Analyze and implement mathematical transformations including the KLT, DCT and wavelet transforms.
- Design compression techniques for image processing Applications.

Specialization Elective
Machine Learning
L P U: 4 0 4

Course Objective:

- To introduce the field of Machine Learning, its history and Research scope
- To introduce the concept of Linear and Logistic Regression
- To gain knowledge about Decision trees
- To introduce Probability and Bayes Learning
- To introduce Support Vector Machine and Neural Networks

Contents:

Unit I: Introduction, Different types of Learning, Supervised Learning, Machine Learning Process.
Testing Machine Learning Algorithms- Overfitting, Training, Testing, and Validation Sets, Confusion Matrix, Accuracy Metrics, Receiver Operator Characteristic (ROC) Curve, Unbalanced Datasets, Measurement Precision
Turning Data into Probabilities- Minimizing Risk, Naïve Bayes' Classifier, Basic Statistics

Unit II: Neurons, Neural Networks, and Linear Discriminants- Brain and the Neuron, Neural Networks, Perceptron, Linear Separability, Linear Regression
Multi-Layer Perceptron- Going Forwards, Going Backwards: Back-Propagation of Error, Multi-Layer Perceptron in Practice, MLP, Deriving Back-Propagation.

Unit III: Radial Basis Functions and Splines- Receptive Fields, Radial Basis Function (RBF) Network, Interpolation and Basis Functions
Dimensionality Reduction-Linear Discriminant Analysis (LDA), Principal Components Analysis (PCA), Factor Analysis, Independent Components Analysis (ICA), Locally Linear Embedding, ISOMAP

Unit IV: Probabilistic Learning- Gaussian Mixture Models, Nearest Neighbour Methods
Support Vector Machines- Optimal Separation, Kernels, Support Vector Machine Algorithm, Extensions to the SVM

Unit V: Optimization and Search- Going Downhill, Least-Squares Optimization, Conjugate Gradients, Search: Three Basic Approaches Simulated Annealing, Using Genetic Algorithms, Genetic Programming, Combining Sampling with Evolutionary Learning

References:

1. http://nptel.ac.in/courses/106105152/
2. Machine Learning, An Algorithmic Perspective, Stephen Mars Land, II Edition-, CRC Press, 2009.

Course Outcomes: Skill Development

- To explain the basics of Machine Learning Algorithms.
- To explain/apply Linear/ Logistic Regression techniques to problems depending on requirement.
- To explain SVM and Neural Networks.
- To be familiar with various Machine Learning tools.

Inter Disciplinary Course

Internet of Things
L P U: 4 0 4

Pre-requisites: Basic programming knowledge

Can be offered to: CE, ECE, EEE and ME

Course Objective:

- To understand the application areas of IOT
- To realize the revolution of Internet in Mobile Devices, Cloud & Sensor Networks
- To understand building blocks of Internet of Things and characteristics
- To understand IoT principles, design and abstraction of developing IoT systems

Contents:

UNIT I: Introduction to Internet of Things: Introduction-Definition & Characteristics of IoT , Physical Design of IoT- Things in IoT , IoT Protocols, Logical Design of IoT- IoT Functional Blocks, IoT Communication Models, IoT Communication APIs , IoT Enabling Technologies-Wireless Sensor Networks , Cloud Computing, Big Data Analytics, Communication Protocols , Embedded Systems, IoT Levels & Deployment Templates.

UNIT II: Domain Specific IoTs and Home Automation: Smart Lighting, Smart Appliances, Intrusion Detection, Smoke/Gas Detectors. Cities-Smart Parking, Smart Lighting, Smart Roads, Structural Health Monitoring, Surveillance, Emergency Response. Environment-Weather Monitoring, Air Pollution Monitoring, Noise Pollution Monitoring, Forest Fire Detection, River Floods Detection .Energy- Smart Grids , Renewable Energy Systems , Prognostics. Retail-Inventory Management, Smart Payments, Smart Vending Machines. Logistics-Route Generation & Scheduling, Fleet Tracking, Shipment Monitoring, Remote Vehicle Diagnostics. Agriculture-Smart Irrigation, Green House Control. Industry –Machine Diagnosis & Prognosis Indoor Air Quality Monitoring. Health & Lifestyle –Health & Fitness Monitoring, Wearable Electronics

UNIT III: IoT and M2M: Introduction, M2M-Difference between IoT and M2M, SDN and NFV for IoT-Software Defined Networking, Network Function Virtualization.

UNIT IV: IoT Platforms Design Methodology: IoT Design Methodology-Purpose & Requirements Specification, Process Specification, Domain Model Specification, Information Model Specification , Service Specifications , IoT Level Specification, Functional View Specification , Operational View Specification , Device & Component Integration , Application Development, Case Study on IoT System for Weather Monitoring, Motivation for Using Python IoT Physical Devices & Endpoints

What is an IoT Device-Basic building blocks of an IoT Device, Exemplary Device: Raspberry Pi, About the Board, Linux on Raspberry Pi , Raspberry Pi Interfaces – Serial, SPI , I2C , Programming Raspberry Pi with Python-Controlling LED with Raspberry Pi , Interfacing an

LED and Switch with Raspberry Pi ,Interfacing a Light Sensor (LDR) with Raspberry Pi , Other IoT Devices- PCDuino, Beagle Bone Black , Cubieboard.

UNIT V: IoT & Beyond: Use of Big Data and Visualization in IoT, Industry 4.0 Concepts. Overview of RFID, Low-power design (Bluetooth Low Energy), range extension techniques (data mining and mesh networking), and data intensive IoT for continuous recognition applications. Overview of Android / IOS App Development tools & Internet of Everything.

References:

- Internet of Things, A Hands on Approach, Arshdeep Bahga, Vijay audisetti, Orient Blackswan Private Limited - New Delhi; First edition, 2015.
- The Internet of Things How Smart TVs, Smart Cars, Smart Homes, and Smart Cities Are Changing the World, Michael Millen, Pearson Education, Inc., 2015.

Course Outcomes: Skill Development

- To design and develop IoT on a variety of open source devices and software services
- To integrate a variety of IoT devices, sensors and services to build complex applications

Inter Disciplinary Course
Robotics and Automation
L P U: 4 0 4

Pre-requisites: Electrical Science-I,Electrical Science-II.

Can be offered to: ECE, EEE and ME

Course Objective:

- To Describe Evolution of robotics, mobile and manipulator robots, coordinate systems
- To understand kinematic models of manipulators, position, velocity and force control, sensors and actuators
- To explain robotic vision, workspace modeling, task and path planning, industrial robots, manufacturing and autonomous systems, robot programming

Contents:

UNIT I:. Introduction, automation and robotics, Brief History, Types of Robots, Technology of Robots, Basic Principles in Robotics, Classification, Major components and applications. End effectors: Mechanical gripper, Magnetic, Vacuum cup and other types of grippers, General consideration on gripper selection and design, Robot actuator and sensors.

UNIT II: Elementary mechanical concepts, motion conversion, Modeling of mechanical systems, Kinematic chains, End Effectors, Resolution, Repeatability and accuracy of a manipulator. Stepper Motors, DC Motors, Hydraulic actuators, pneumatic systems and servo amplifiers.

UNIT III: Non-optical, optical sensory devices, velocity, proximity sensors, Touch and slip, force and torque sensors. Imaging components, image representation, hardware considerations

UNIT IV: Picture coding, object recognition vision and categorization, software considerations, review of existing systems. Architectural considerations, Hardware considerations, Robot Programming, Path planning and Robot's, computer system.

UNIT V:. Homogeneous coordinates, coordinate reference frames, Homogeneous transformations and the manipulator. Forward and Inverse solution, Motion generation, the Jacobian, controller Architecture, Methods, interpolation and capabilities

References:

1. Mikell P Groover Industrial Robotics: Technology, Programming, and Applications - McGraw-Hill,2nd Edition , 2012
2. Ashitava Ghosal, Robotics: Fundamental concepts & analysis, Oxford,First edition,2006.
3. K. S. Fu, Ralph C. Gonzalez, C.S.G. Lee, Robotics – Tata McGrawHill,First Edition,1988.

Course Outcomes: Skill Development

- To Analyze and implement kinematic models of manipulators, position, velocity and force control, sensors and actuators.
- To Implement workspace modeling, task and path planning, industrial robots, manufacturing and autonomous systems, robot programming in real time Applications.

Research Methodology-II
L P U: 4 0 4

Course Objectives:

- To recognize the analogies that can be drawn between the fundamental elements of all four types of systems: electrical, mechanical, fluid and thermal.
- To perform frequency analysis and plot the frequency responses.
- To learn first order, second and higher order math models.
- To learn different optimization techniques and genetic algorithms

Contents:

Unit I- Basic building blocks for modeling engineering systems: Introduction, Electrical elements, Mechanical components, Fluid elements, Thermal elements, Importance of analogies.

Unit II- Constructing, analyzing and practical applications of first-order math models: Introduction to math models, Tools for developing math models, First –order math models, Response to a step input, Response to a sinusoidal input, Response to other input functions, power analysis, Applications through case study.

Unit III- Constructing, analyzing and practical applications of second-order math models: Constructing second order math models, Analyzing second order math models using numerical solution methods, Analyzing second order math models using exact solution methods, Applications through case study.

Constructing, analyzing higher order math models: Constructing and analyzing higher-order math models.

Unit IV- Optimization techniques and genetic algorithms: Overview of optimization techniques, Case study. Fundamentals of genetic algorithms, Single objective genetic algorithm, Multi objective evolutionary algorithm.

Unit V- Qualitative analysis: Nature and applications of qualitative research in social and organizational research, Conceptualization of qualitative research and formulation of problem statements and research questions, Qualitative research study design, Qualitative data collection procedures.

References:

1. Modeling Engineering Systems, Jack W. Lewis, High Text Publication, Inc, 1994.
2. Neural Networks, Fuzzy Logic, and Genetic Algorithms: Synthesis And Applications- S. Rajasekaran, G. A. Vijayalakshmi Pai, PHI Learning Pvt. Ltd , Kindle edition, 2003.
3. Nptel: Optimization Methods - Web course

4. Nptel: Design and Optimization of Energy Systems- Course syllabus.
5. Swayam: Modeling and Simulation of Dynamic Systems by Pushpa Raj Mani Pathak
6. Link: https://swayam.gov.in/courses/3557-modelling-and-simulation-of-dynamic-systems

Course Outcomes: Skill Development

- To construct a math model of a real world engineering system
- To analyze power requirements for engineering systems
- To analyze and solve higher order math models using various techniques
- To solve real world problems using genetic algorithms
- To perform qualitative analysis

Advanced Discipline Course
Estimation for Wireless Communications , MIMO /OFDM
Cellular and Sensor Networks
L P U: 4 0 4

Course Objective:

- To understand tools and techniques which form the basis for several key applications in modern wireless communications and signal processing
- To describe various signal processing procedures in communication systems such as channel estimation, equalization, synchronization etc.
- To understandMIMO (Multiple-Input Multiple-Output) and OFDM (Orthogonal Frequency Division Multiplexing) based 3G/ 4G wireless systems

Contents:

Unit I: Basics of Estimation, Maximum Likelihood (ML), Properties – Mean/ Variance of Estimate. Wireless Flat-Fading Channel Estimation, Pilot-based MLEstimate, Properties, Example of Channel Estimation.

Unit II: Cramer-Rao Bound (CRB),Vector Parameter Estimation, Multi-Antenna Downlink Mobile Channel Estimation, Least Squares (LS) Principle,Pseudo-Inverse,Properties of LS Estimate, Examples – Mullti-Antenna Downlink and MIMO Channel Estimation.

Unit III: Inter Symbol Interference (ISI), Channel Equalization, Zero-Forcing (ZF) Equalizer, ZF Example 6 Introduction to Orthogonal Frequency Division Multiplexing (OFDM) and Pilot Based OFDM Channel Estimation,Example

Unit IV: Comb Type Pilot (CTP) Transmission, Channel Estimation in Time/ Frequency Domain, CTP Example, Frequency Domain Equalization (FDE), Example-FDE Sequential Least Squares (SLS) Estimation – Scalar/ Vector Cases,Applications- Wireless Fading Channel Estimation,SLS Example.

References:

1.Andrea Goldsmith, ``Wireless Communications," Cambridge University Press,First Edition 2005.

2.Andreas F. Molisch, ``Wireless Communications," John Wiley and Sons, First Edition,2005.

3.E. G. Larsson and P. Stoica, Information Theory, Space-Time Block Coding for Wireless Communications, Cambridge University Press,First Edition, 2003

4. A. Paulraj, R. Nabar and D. Gore, Introduction to Space-Time WirelessCommunications, Cambridge Univ. Press,First Edition, 2003

Course Outcomes: Skill Development

1.Estimate and Design Different Channels MIMO/OFDM Cellular Networks.
2. Analyze and Design Different Channels in sensor networks.

Specialization Elective
Statistical Signal Processing
L P U: 4 0 4

Course Objective:

- To Understand representing real-world signals by stochastic or random processes.
- To describe the tools for analyzing these random signals are developed in the Probability, Random Variables, and Estimation Theory.

Contents:

Unit I: Introduction and Review of Discrete-time Systems

Introduction and course overview. Role of deterministic and random signals, and the various interpretations of random processes in the different physical sciences. Brief review of Fourier transform theorem, transforms for continuous-time, discrete-time, periodic or aperiodic, signals, Parsevals Theorem.The DFT as a linear transformation. Review of discrete-time systems. Basic discrete-time signals. The z-transform and basic properties. Summary of frequently used transform pairs. Rational transfer functions; pole-zero models. Frequency response of LTI systems. Example of inverse bilateral z-transforms, and different approaches to get the same answer; partial fraction expansions using the cover-up rule.

Unit II: Stochastic Processes

Introduction to stochastic processes, predictable processes with an example of harmonic processes, description of stochastic processes using probability density functions (pdfs). Notion of stationary and nonstationary processes. Examples of some predictable processes through a MATLAB demonstration, second-order statistics including mean and autocorrelation sequences, with an example of calculating autocorrelation for a harmonic process. independent, independent and identically distributed random processes, and uncorrelated and orthogonal processes. Introduction to stationary processes, both order-N stationary, strict-sense stationary and wide-sense stationary; example of testing whether a Wiener process is stationary or not, wide sense periodic and wide-sense cyclo-stationary processes. Notion of ergodicity and the notion of time-averages being equal to ensemble averages in the mean-square sense. Second-order statistical descriptions, joint-signal statistics; types of joint stochastic processes, correlation matrices Markov processes.

Unit III: Linear signal models-I

The effect of linear systems on random processes, Discusses the case of LTI systems, and the fact that most real world applications will be a LTV system. System identification using cross-correlation. Frequency-domain analysis of LTI systems, including input-output CPSD and output PSD, LTV systems with non-stationary inputs. Introduction to the notion of parametric modeling. Nonparametric Vs parametric signal models, All-pole models: impulse response, autocorrelation functions, poles, minimum-phase conditions.

Unit IV: Linear signal models-II

Linear prediction, autoregressive (AR) processes, Yule-Walker equations, All-zero models: impulse response, autocorrelation functions, zeros, and moving average (MA) processes, Pole-Zero models: autocorrelation functions, autoregressive moving average (ARMA) processes, Overview of extension to time-varying processes,9. Applications and examples

Unit V: Estimation Theory for Random Processes

Sample autocorrelation and auto-covariance functions, Least-squares for AR modeling, Estimating signals in noise, using parametric signal models, Bayesian estimation of sinusoids in noise, and other applications of Bayesian estimation methods to time-series analysis. Applications of statistical signal processing Digital SAR image processing. Bayesian estimation theory. Case of study: Kalman filter for carrier synchronization.

References:

1.Therrien C. W. and M. Tummala, Probability and Random Processes for Electrical and Computer Engineers, Second edition, CRC Press, 2011.

2.Recommended course text book: Therrien C. W. and M. Tummala, Probability and Random Processes for Electrical and Computer Engineers, Second edition, CRC Press, 2011.

3. Manolakis D. G., V. K. Ingle, and S. M. Kogon, Statistical and Adaptive Signal Processing: Spectral Estimation, Signal Modeling, Adaptive Filtering and Array Processing, McGraw Hill, FirstEditionInc.,2000.

4. Kay S. M., Fundamentals of Statistical Signal Processing: Estimation Theory, Prentice-Hall, Inc.,First Edition,1993.

5. Papoulis A. and S. Pillai, Probability, Random Variables, and Stochastic Processes, Fourth edition,McGrawHill,Inc.,2002.

6.M. S. Grewal, A. P. Andrews, Kalman filtering: theory and practice using Matlab, John Wiley & Sons,First Edition, 2001.

7. H. L. Van Trees, K. L. Bell, Bayesian bounds for parameter estimation of nonlinear filtering/tracking, IEEE Press,First Edition 2007.

Course Outcomes: Skill Development

1.Explain, describe, and understand the notion of a random process and statistical time series.

2. Characterize random processes in terms of its statistical properties, including the notion of stationary and ergodicity.

3. Define, describe, and Analyze the notion of the power spectral density of stationary random processes;analyse and manipulate power spectral densities.

4. Analyze in both time and frequency the affect of transformations and linear systems on random processes, both in terms of the density functions, and statistical moments.

5. Explain the notion of parametric signal models, and describe common regression-based signal models in terms of its statistical characteristics, and in terms of its affect on random signals.

Specialization Elective
CAD for VLSI
L P U: 4 0 4

Course Objective:

- To Describe Methods of Computer-Aided Design tools for the modeling.
- To Understand design, analysis, test, and verification of digital Very Large Scale Integration (VLSI) systems

Contents:

Unit I: VLSI DESIGN METHODOLOGIES Introduction, Review of Data structures and algorithms, Review of VLSI Design automation tools,Algorithmic Graph Theory and Computational Complexity, Tractable and Intractable problems, Different methods for combinatorial optimization

Unit II: DESIGN RULES- Layout Compaction, Design rules, problem formulation, algorithms for constraint graph compaction, placement and partitioning, Circuit Representation, Placement algorithms, partitioning.

Unit III: FLOOR PLANNING- Floor planning concepts,shape functions and floor plan sizing, Types of local routing problems, Area routing,channel routing ,global routing,algorithms for global routing.

Unit IV: SIMULATION-Gate-level modeling and simulation, Switch-level modeling and simulation, Combinational Logic Synthesis, Binary Decision Diagrams,Two Level Logic Synthesis. DRC etc. Parasitic extraction, delay and power estimation through post layout simulation

Unit V: MODELLING AND SYNTHESIS -High level Synthesis,Hardware models,Internal representation,Allocation assignment and scheduling, Simple scheduling algorithm, Assignment problem, High level transformations. CAD for analog and mixed signal designs, Memory synthesis. Clock and power routing. Testability, insertion of scan chain.

References:

1.S.H. Gerez, "Algorithms for VLSI Design Automation", John Wiley & Sons,First Edition,2002

2.N.A. Sherwani, "Algorithms for VLSI Physical Design Automation", Kluwer Academic Publishers, First Edition,2002.

3.Giovanni DeMicheli , Synthesis and Optimization of Digital Circuits, McGraw-Hill, Firsat Edition,1994

4.Stephen M. Trimberger (Editor) An Introduction to CAD for VLSI, Springer-Veril0g, First Edition,2002

5. Erik Brunvand, Digital VLSI Chip Design with Cadence and Synopsys CAD Tools, Addison-Wesley,First Edition,2010.

6.Sarrafzadeh, Majid and Wong, C. K., An Introduction to VLSI Physical Design, McGraw-Hill, First Edition,1996.

Course Outcomes: Skill Development

4. Analyze CMOS VLSI and associated technologies.
5. Analyze and Design CMOS logic circuits, with particular reference to speed and power consumption.
6. Design the layout by using CAD tools in VLSI design.

Specialization Elective
Testing and verification for SOC Designs
L P U: 4 0 4

Course Objective:

- To understand testing and techniques of VLSI SOCs at higher level design flow.
- To understand Verification techniques of VLSI SOCs at higher level design flow.\
- To introduce functional and timing verification

Contents:

Unit I: Scope of testing and verification in VLSI design process. Issues in test and verification of complex chips, embedded cores and SOCs.

Unit II: Fundamentals of VLSI testing. Fault models. Automatic test pattern generation. Design for testability.

Unit III: Scan design. Test interface and boundary scan. System testing and test for SOCs. Iddq testing. Delay fault testing. BIST for testing of logic and memories. Test automation.

Unit IV: Design verification techniques based on simulation, analytical and formal approaches. Functional verification. Timing verification. Formal verification. Basics of equivalence checking and model checking. Hardware emulation.

References:

1.M. Bushnell and V. D. Agrawal, "Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits", Kluwer Academic Publishers,First Edition, 2000.
2. M. Abramovici, M. A. Breuer and A. D. Friedman, "Digital Systems Testing and Testable Design", IEEE Press,First Edition, 1990.
3. T.Kropf, "Introduction to Formal Hardware Verification", Springer Verilog,First Edition, 2000.
4.P. Rashinkar, Paterson and L. Singh, "System-on-a-Chip VerificationMethodology and Techniques", Kluwer Academic Publishers,First Edition, 2001

Course Outcomes: Skill Development

1. Analyze Circuits by using tools related to testing and verification.
2. Design advanced algorithms, and can do Practical analysis of Testing and Verification from research articles.

Interdisciplinary Course
Wireless Sensor Networks
L P U: 4 0 4

Pre requisities: Computer Networks and basic C Programming Knowledge

Course Objective:
1.To introduce the field of Wireless Sensor Networks, its history and Research scope.
2.To understand the motivation and importance of various Wireless Sensor Networks in the context of limited storage, computation and communication capabilities.
3.To gain knowledge about Energy efficient MAC protocols for WSN.
4.To introduce Energy Efficient Routing protocols for WSN.
5.To introduce several TCP protocols for WSN.

Contents:

Unit I: Introduction and overview of wireless sensor networks, Applications of wireless sensor networks, Basic wireless technology- Sensor node technology, Sensor taxonomy, WN operating environment, WN Trends.
Wireless transmission technology and systems- Radio technology primer, Available wireless technologies.

Unit II: MAC for wireless sensor networks- Fundamentals of MAC protocols, MAC protocols for WSN, Sensor-MAC case study, IEEE 802.15.4 LR-WPANs standard case study.
Routing protocols for wireless sensor networks- Introduction, Background, Data dissemination and gathering, Routing challenges and design issues in wireless, Routing strategies in wireless sensor networks.

Unit III: Transport control protocols for wireless sensor networks- Traditional transport control protocols, Transport protocol design issues, Examples of existing transport control protocols, Performance of transport control protocol.
Middleware for Wireless Sensor Networks- WSN middleware principles, Middleware architecture, Existing middleware.

Unit IV: Network management for wireless sensor networks- Network management requirements, Traditional network management models, Network management design issues, Example of management architecture: MANNA, Other issues related to network management.
Operating systems for wireless sensor networks- Operating system design issues, Examples of operating systems.

Unit V: Performance and traffic management- Introduction, Background, WSN design issues, Performance modeling of WSNs, Case study: Simple computation of the system life span.

References:

1. Wireless Sensor Networks – Technology, Protocols and Applications, Kazem Sohraby, Daniel Minoli, TaiebZnati, Wiley India Pvt, Ltd., 2007.
2. Wireless Sensor Networks: A Networking Perspective, Jun Zheng, Abbas Jamalipour, Wiley, 2008.
3. Protocols and Architectures for Wireless Sensor Networks, Holger Karl, Andreas Willig, Wiley, 2006.

Course Outcome: Skill Development

- To analyze several energy efficient MAC and routing protocols for WSN.
- To analyze different transport layer protocols for WSN
- To design solutions for challenges involved in WSN.

Advanced Discipline Course
Advanced Materials in Engineering
L P U: 4 0 4

Course Objectives:

The objective of the course is selection and classification of materials, applications of advanced materials like Nonferrous Metals, Alloys, Semiconductor Materials, Polymer Materials, Ceramic Materials, Composite Materials, etc. Nanomaterials, Smart materials, Functionally graded materials (FGMs), Left-handed materials, MAX phase materials, Nondestructive Testing Techniques: Visual Inspection, Ultrasonic Testing, Radiography Testing, Liquid Penetrant testing, Magnetic particle testing, etc.

Contents:

Unit I- Griffth"s Theory, stress intensity factor and fracture Toughness, Toughening Mechanisms, Ductile and Brittle transition in steel, High Temperature Fracture, Creep, Larson – Miller Parameter, Deformation and Fracture mechanism maps.

UNIT II- Fatigue, Low and High cycle fatigue test, Crack Initiation and Propagation mechanism and Paris Law, Effect of surface and metallurgical parameters on Fatigue, Fracture of non-metallic materials, fatigue analysis, Sources of failure, procedure of failure analysis.

UNIT- III - Selection for Surface durability, Corrosion and Wear resistance, Relationship between Materials Selection and Processing, Case studies in Materials Selection with relevance to Aero, Auto, Marine, Machinery and Nuclear Applications. Motivation for selection, cost basis and service requirements, Selection for Mechanical Properties, Strength, Toughness, Fatigue and Creep.

UNIT IV- Smart Materials, Shape Memory alloys, Metallic Glass, Quasi Crystal and Nano Crystalline Materials. Metal-Matrix composites.

UNIT V- MEMS and Microsystems, Evolution of Micro fabrication, Microsystems and Microelectronics, Microsystems and miniaturization, Applications of MEMs in Industries, Micro sensors, Micro actuation, MEMS with Micro actuators Micro accelerometers, Micro fluidics.

References:

5. Mechanical Behaviour of Materials, Thomas H. Courtney, 2nd Edition, McGraw Hill,2000.
6. Mechanical Metallurgy, George E. Dieter, McGraw Hill,1998.
7. Selection and use of Engineering Materials,Charles J.A, Butterworth Heiremann.
8. Foundation of MEMS, Chang Liu,Pearson, 2012

Course outcomes: Skill Development

At the end of the course, the student shall be acquainted with the knowledge of Importance application of material in various engineering applications. Design and manufacturing of smart materials and MEMS.

Advanced Discipline Course
Failure Analysis in Engineering
L P U: 4 0 4

Course Objectives:

To understand importance of design and design process considerations, Creativity and creativity methods to solve problems, understand buckling phenomenon due to combined external pressure and axial loading, Failure analysis and determination of stress patterns from plastic Flow observations, Fatigue and Creep deformation.

Contents:

UNIT I- Importance of design- The design process-Considerations of Good Design – Morphology of Design – Organization for design– Computer Aided Engineering –Concurrent Engineering – Product and process cycles –Market Identification – Competition Bench marking. Identification of customer needs- customer requirements- Product Design Specifications- Human Factors in Design – Ergonomics and Aesthetics.

UNIT II- Creativity and Problem Solving –Creativity methods-Theory of Inventive Problem Solving(TRIZ)– Conceptual decomposition-Generating design concepts-Axiomatic Design – Evaluation methods-Embodiment Design- Product Architecture-Configuration Design-Parametric Design. Role of models in design-Mathematical Modeling– Simulation – Design for Reliability –Introduction to Robust Design-Failure mode Effect Analysis.

UNIT III-Buckling phenomenon – Elastic Buckling of circular ring and cylinders under external pressure – collapse of thick walled cylinders or tubes under external pressure – Effect of supports on Elastic Buckling of Cylinders – Buckling under combined External pressure and axial loading.

UNIT IV-Failure analysis and determination of stress patterns from plastic Flow observations – Dynamic loading– Fracture types in tension—Fatigue crack growth– Fatigue life prediction-Cumulative fatigue damage-Stress theory of failure vessels-Thermal stress fatigue.

UNIT V- Introduction –Through cracks emanating from holes – Corner cracks at holes – Cracks approaching holes-Combined loading-Fatigue crack growth binder- Mixed mode loading-Fracture toughness of weld metals-Service failure analysis.

References:

1. Dieter, George E., Engineering Design - A Materials and Processing Approach, McGraw Hill,International Editions, Singapore, 2000.
2. Pahl, G, and Beitz, W., Engineering Design, Springer – Verlag, NY. 1984.
3. David Broek, Elementary Engineering Fracture Mechanics, Fifthoff and Noerdhoff International Publisher, 1978.
4. Preshant Kumar, Elements of Fracture Mechanics‖, Wheeler Publishing, 1999.
5. John F. Harvey, Theory and Design of Pressure Vessels, CBS Publishers and Distributors, 1987.
6. Henry H. Bedner, Pressure Vessels, Design Hand Book, CBS publishers and Distributors, 1987.

Course Outcomes: Skill Development

On completion of the course, students can:

- Design methodology and various aspects involved in design process
- Different creative and inventive problem solving techniques
- Different types of design process, concepts of reliable and safe design
- Concept of buckling of cylinders under various loading conditions
- The fundamentals of fracture, fracture types and concepts of fatigue crack growth, fatigue life prediction and various stress theories of failure vessels
- Basic crack propagation concept, concepts of crack propagation under combined loading, fracture toughness of weld metals.

Specialization Elective
Mechanical Vibrations
L P U: 4 0 4

Course Objectives:

The primary objective of this course is to understand the Single degree of Freedom systems, Multi degree freedom systems, Response to Non Periodic Excitations, Numerical Methods and Application of concepts.

Contents:

UNIT 1- Single degree of Freedom systems: Undamped and damped free vibrations: forced vibrations ; coulomb damping; Response to harmonic excitation; rotating unbalance and support excitation, Vibration isolation and transmissibility, Vibrometers, velocity meters & accelerometers.

Unit II- Response to Non Periodic Excitations: unit Impulse, unit step and unit Ramp functions; response to arbitrary excitations, The Convolution Integral; shock spectrum; System response by the Laplace Transformation method.

Unit III-Multi degree freedom systems: Principal modes – undamped and damped free and forced vibrations ; undamped vibration absorbers, Matrix formulation, stiffness and flexibility influence coefficients; Eigen value problem; normal modes and their properties; Free and forced vibration by Modal analysis; Method of matrix inversion; Torsional vibrations of multi – rotor systems and geared systems; Discrete-Time systems.

Unit IV-Numerical Methods: Rayliegh's, stodola's, Matrix iteration, Rayleigh-Ritz Method and Holzer's methods.

Unit V- Application of concepts: Free vibration of strings – longitudinal oscillations of bars-transverse vibrations of beams- Torsional vibrations of shafts. Critical speeds without and with damping, secondary critical speed.

References:

1. Elements of Vibration Analysis by Meirovitch.
2. Mechanical Vibrations by G.K. Groover.
3. Mechanical Vibrations by S S Rao
4. Vibrations by W.T. Thomson
5. Mechanical Vibrations – Schaum series.
6. Vibration problems in Engineering by S.P. Timoshenko.
7. Mechanical Viabrations – V.Ram Murthy.

Course outcomes: Skill Development

On completion of the course, students can:

- Understand the Single degree of Freedom systems.
- Understand the Multi degree freedom systems
- Understand the Response to Non Periodic Excitations
- Analyze Numerical Methods and Application of concepts.

Specialization Elective
Experimental stress Analysis
L P U: 4 0 4

Course Objectives:

The primary objective of this course is to understand the Plane stress and plane strain conditions, Compatibility conditions, Strain Measurement and Recordings, Photo elasticity and Three dimensional Photo elasticity. Brittle coatings, Moire Methods and Birefringent Coatings.

Contents:

UNIT I- Introduction: Stress, strain, Plane stress and plane strain conditions, Compatibility conditions. Problems using plane stress and plane strain conditions, stress functions, mohrs circle for stress strain, Three-dimensional stress strain relations.

UNIT II- Strain Measurement and Recordings: Various types of strain gauges, Electrical Resistance strain gauges, semiconductor strain gauges, strain gauge circuits. Introduction, static recording and data logging, dynamic recording at very low frequencies, dynamic recording at intermediate frequencies, dynamic recording at high frequencies, dynamic recording at very high frequencies, telemetry systems.

UNIT III- Photo elasticity: Photo elasticity – Polariscope – Plane and circularly polarized light, Bright and dark field setups, Photo elastic materials – Isochromatic fringes – Isoclinics
Three dimensional Photo elasticity : Introduction, locking in model deformation, materials for three-dimensional photo elasticity, machining cementing and slicing three-dimensional models, slicing the model and interpretation of the resulting fringe patterns, effective stresses, the sheardifference method in three dimensions, applications of the Frozen-stress method, the scatteredlight method.

UNIT IV- Brittle coatings: Introduction, coating stresses, failure theories, brittle coating crack patterns, crack detection, ceramic based brittle coatings, resin based brittle coatings, test procedures for brittle coatings analysis, calibration procedures, analysis of brittle coating data.
Moire Methods: Introduction, mechanism of formation of Moire fringes, the geometrical approach to Moire-Fringe analysis, the displacement field approach to Moire-Fringe analysis, out of plane displacement measurements, out of plane slope measurements, sharpening and multiplication of Moire-Fringes, experimental procedure and techniques.

UNIT V- Birefringent Coatings: Introduction, Coating stresses and strains, coating sensitivity, coating materials, application of coatings, effects of coating thickness, Fringe-order determinations in coatings, stress separation methods.

References:

1. Theory of Elasticity by Timoshenke and Goodier Jr
2. Experimental stress analysis by Dally and Riley,Mc Graw-Hill
3. A treatise on Mathematical theory of Elasticity by LOVE .A.H
4. Photo Elasticity by Frocht
5. Experimental stress analysis, Video course by K.Ramesh / NPTEL

Course outcomes: Skill Development

On completion of the course, students can:

- Understand the Plane stress and plane strain conditions and Compatibility conditions.
- Measure and record the strain.
- Understand the Photo elasticity and Three dimensional Photo elasticity.
- Analyze Moire Methods and apply Birefringent Coatings.

Specialization Elective
Theory of Plates and Shells
L P U: 4 0 4

Course Objective:

- Introduce students to the classical structural mechanics approximations of Membrane, Plate and Shell theories.
- Use energy formulations to demonstrate the consistent derivation of approximate boundary conditions and edge effects.
- Demonstrate the analysis tools necessary to describe static, dynamic and non-linear motions.
- Demonstrate the approximation of the classical formulations using numerical approximation techniques.

Contents

UNIT I- Introduction: Assumptions in the theory of thin plates, Pure bending of Plates, Relations between bending moments and curvature, Particular cases of pure bending of rectangular plates, Cylindrical bending, Strain energy in pure bending of plates in Cartesian and polar co-ordinates, Limitations.

Unit II- Laterally Loaded Rectangular Plates: Differential equation of plates, Boundary conditions, Navier solution for simply supported plates subjected to uniformly distributed load and point load, Levy's method of solution for plates, Simply supported plates with moments distributed along the edges, Approximate Methods.

Unit III- Effect of transverse shear deformation: plates of variable thickness, An-isotropic plates, thick plates, Orthotropic plates and grids, Large Deflection theory.

Unit IV-Deformation of Shells without Bending: Definitions and notation, shells in the form of a surface of revolution, displacements, membrane theory of cylindrical shells, and the use of stress function in calculating membrane forces of shells.

Unit V-General Theory of Cylindrical Shells: A circular cylindrical shell loaded symmetrically with respect to its axis, symmetrical deformation, pressure vessels, cylindrical tanks, general case of deformation, and the use of a strain and stress function, stress analysis of cylindrical roof shells.

References:

4. Theory of Plates and Shells by Stephen P. Timoshenko, Sergius Woinowsky-Krieger (McGraw-Hill).
5. Thin Plates and Shells: Theory: Analysis, and Applications by Eduard Ventsel, Theodor Krauthammer (CRC).
6. Mechanics of Laminated Composite Plates and Shells: Theory and Analysis by J. N. Reddy (CRC).

Course Outcomes: Skill Development

On completion of the course, students can:

- Apply the structural mechanics approximations of membrane, plates and shells.
- Derive simple modifications to the membrane plate and shell theories.
- Use analysis to determine the static, dynamic, and non-linear motion of membrane, plate and shell Structures.
- Compute numerical approximations.

Specialization Elective
Additive Manufacturing
L P U: 4 0 4

Course Objectives:

The objective of the course is to impart fundamentals of additive manufacturing processes along with the various file formats, software tools, processes, techniques and applications.

Contents:

UNIT I- Introduction: Introduction to Additive Manufacturing (AM), Distinction between AM and CNC, other related technologies, AM Software: Need for AM software, MIMICS, Magics, Surgi Guide, 3-matic, 3D-Doctor, Simplant, Velocity2, VoXim, SolidView, 3DView, etc., software, Preparation of CAD models, Problems with STL files, STL file manipulation, AM data formats: SLC, CLI, RPI, LEAF, IGES, HP/GL, CT, STEP.

UNIT II- Design/Fabrication Processes: Data Sources, Software Tools, File Formats, Model Repair and Validation, Pre & Post processing, Reverse engineering: digitizing, laser scanning, CT-scanning, point cloud manipulation, data segmentation, surface reconstruction, model further processing.

UNIT III- Materials Science for AM: Materials Science for Additive Manufacturing- Polymer and Photo-polymerization, Process & Material Selection, Direct Digital Manufacturing and AM; parts and their uses. Process Monitoring and Control for AM-Defects, Geometry, Composition, Temperature, Phase Transformation.

UNIT IV- Design for Additive Manufacturing: Multiple Materials, Hybrids, Functionally Graded Materials, Composite Materials, current and future directions; Process Modeling of AM process- Design optimization through finite-element modeling of AM- Simulation of phase transformations- heating, melting, forming, solidification and finishing and rheological studies of various AM materials.

UNIT V- Applications and Future Directions of AM: Rapid Tooling and Manufacturing, The Express Tool Process- Conformal Cooling Channels, The Express tool Process, Finite Element Analysis of Express Tool, limitations - Applications of AM: Aerospace, Automotive, Biomedical Applications of AM, Product Development, Commercialization, Trends and Future Directions in Additive Manufacturing.

References:

1. Ian Gibson, David Rosen, Brent Stucker, Additive Manufacturing Technologies, Springer Publications, 2015.
2. Dongdong Gu, Laser Additive Manufacturing of High-Performance Materials, Springer Publication, 2014.
3. Andreas Gebhardt, Understanding Additive Manufacturing, Hanser Publishers, 2011.
4. Hopkinson, Hague, Dickens, Rapid Manufacturing: An Industrial Revolution for the Digital Age. Wiley, 2005.

Course outcomes: Skill Development

- To decide between the various trades-offs when selecting AM processes, devices and materials. To suit particular engineering requirements.
- To develop latest trends and opportunities in AM.
- To commercialize ideas.

Specialization Elective
Geometric Modeling
L P U: 4 0 4

Course Objectives:

- Making the student understand how graphics created in computer world is the main goal of this course.
- Using colors in different places and for different objects is also one of the goals of the course.
- Animating some simple graphics is the last aim of the course.

Contents:

UNIT I-Geometrical Modeling: Introduction, History, Geometrical representation, Linear Algebra Boolean Algebra, Vectors, Matrices, Equations for curves- Intrinsic and Explicit ,parametric equations of curves ,conic curves and points on curves, Problems.

UNIT II-Transformations: 2-D and 3D Transformations, translation, Rotation, Homogeneous space, Scaling, stretching, Mirror reflection, Composite Transformations and problems.

Cubic splines: Algebraic and geometric force of cubic spline, parametric space of a curve, blending functions, Problems.

UNIT III-Bezier curves: Berustein's polynomials, equations, control points, convex hull property, truncating and subdividing composite and Rational Bezier curves, Problems.

B-Spline curves: Uniform and non-uniform B-Spline basis functions, quadratic and cubic Bspline basis functions, NURBS, Problems.

UNIT IV-Surfaces: Explicit and Implicit equations of surfaces, quadratic surfaces, parametric equation of surfaces, Curve Nets and Embedded Curves, Generation, Mathematical Analysis, Applications of Bezier and B-Spline Surfaces, Surface patches. Problems.

UNIT V-Solids: Parametric and Tricubic solids, sweep solids, Topology of models, graph and boolean based models. Constructive solid Geometry (CSG), B-rep models. Problems.

References:

1. Geometric Modeling by Micheal E. Mortenson, Third Edition, McGraw Hill Publishers
2. CAD/CAM concepts and Applications, Alavala, PHI
3. Curves and surfaces for CAGD, Fifth Edition by Gerald Farin, Elsevier, India
4. Computer Graphics, Alavala, PHI, New Delhi
5. CAD/CAM by Ibrahim Zeid, Tata McGraw Hill.
6. Elements of Computer Graphics by Roger & Adams, Tata McGraw Hill.

Course outcomes: Skill Development

Upon successful completion of the course students will be able to draw various curves and surfaces. Learning how to rescale, transmit (shift), shear (skew), and rotate different graphical objects is another goal. To construct various solid (3D) models by computer.

Specialization Elective
Advanced Manufacturing
L P U: 4 0 4

Course Objectives:

- To learn the concepts of traditional manufacturing processes in casting, welding, forming. To give information various Non-Traditional machining processes.
- To Understanding of various fundamental mechanisms of machining processes, high speed machining, micro-machining and nanofabrication techniques.

Contents:

UNIT I- Advances in casting: Stir casting process: working principle, variables in stir casting process, advantages and application, composite preparation, analysis of composite. High pressure molding, metal injection molding, Graphite mold process.
Advances in welding: Friction stir welding process, parameters, tool geometry, applications, Friction stir welding similar and dissimilar materials, Ultrasonic welding, Electron beam welding process, Laser beam welding processes, Hybrid welding process. Defective analysis of friction welded components.

UNIT II- Advanced Metal forming processes: High Energy Rate Forming (HERF), Explosive Forming, Electrohydraulic Forming, Electromagnetic forming and computer applications in metal forming.
Advances in metal cutting: Mechanics of metal cutting, tool geometry and their design of single point and multi point cutting tools. Theories of tool life and wear. Laws of friction and nature of frictional force in metal cutting, cutting tool materials and cutting fluids. Chip morphology, surface integrity and machinability index.

UNIT III- Introduction of Non-Traditional machining, need and applications. Principle of working equipment, Material removal rate, Mechanics of cutting and Process parameters of Abrasive Jet Machining (AJM), Water Jet Machining (WJM), Ultra Sonic Machining (USM), Electric Discharge Machining (EDM), Wire-cut Electric Discharge Machining (WEDM), Electro Chemical Machining (ECM), Electro Chemical Grinding (ECG), Plasma Arc Machining (PAM), Laser Beam Machining (LBM), Ion Beam Machining (IBM) Electron Beam Machining (EBM).

UNIT IV- Introduction of micro and high speed machining. Working principles of micro and high speed machining. Hybrid machining methods and applications. Fabrication of Microelectronic devices: Crystal growth and wafer preparation, Film Deposition oxidation, lithography, bonding and packaging, reliability and yield, Printed Circuit boards, computer aided design in micro-electronics and surface mount technology.
UNIT V- Rapid Manufacturing Processes: Introduction to Rapid Prototyping, Traditional Prototyping Vs. Rapid Prototyping (RP), Need for time compression in product development, Usage of RP parts, Generic RP process. Working principles and applications of various RP

Processes like VAT Photopolymerization, Powder Bed Fusion, Binder Jetting (3D Printing), Material Jetting, Sheet Lamination, Material Extrusion and Directed Energy Deposition.

References:

1. Manufacturing Engineering and Technology, Kalpakijian, Adisson Wesley, 1995.
2. Foundation of MEMS, Chang Liu,Pearson, 2012.
3. Advanced Machining Processes, V.K.Jain, Allied Publications.
4. R. S. Mishra, Friction Stir Welding and Processing, ASM International, 2007.
5. Heine, Loper and Rosenthal, "Principles of Metal Casting", Tata McGraw-Hill, New Delhi, 2008.
6. Ian Gibson., David W Rosen., Brent Stucker., Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, Springer, 2010.
7. Fundamentals of Metal cutting and Machine tools , B.L.Juneja, G. S. Sekhom and Nitin Seth, New Age International publishers
8. Tool Engineering, G.R.Nagpal, Khanna Publishers

Course outcomes: Skill Development

- To understand various advanced manufacturing process in casting, welding, forming, metal cutting.
- To learn various Non-Traditional machining composite materials and rapid prototyping.

Specialization Elective
Advanced IC Engine Technology
L P U: 4 0 4

Course Objectives:

- To study engine exhaust emission control and alternate fuels.
- To understand recent developments in IC Engines, SI and CI Engines.

Contents:

UNIT I- SI Engine-introduction-carburetion- mixture requirements-Fuel supply - Ignition - Stages of combustion-Normal and abnormal combustion-factors affecting knock -Combustion chambers. CI engine- Injection systems-Mechanical and electronic-Combustion in CI engines-stages of combustion-Factors affecting combustion.

UNIT II- Direct and indirect injection systems –Combustion chambers – Fuel spray behaviour – spray structure, spray penetration-and evaporation – air motion – Introduction to Turbo charging and supercharging.

UNIT III- Basic concepts of engine simulation, governing equations, simulation of various engine processes for SI and CI Engines. Thermodynamic and fluid mechanic based models. Different types of combustion chamber.

UNIT IV- Engine instrumentation-Types of pollutants-Euro and Bharat norms-Emission control methods in SI and CI engines catalytic converters-EGR-Modern evaporative emission control system.

UNIT V- Lean Burn Engines – Stratified charge Engines – homogeneous charge compression ignition engines – Plasma Ignition – Zero Emission Vehicles, Engines for special applications – Mining, Defence, Off-highway -Tractor, Bulldozer etc. Submarines, Race car Engine systems, Flexible fuel systems. Surface ignition.

References:

1. V. Ganesan, Int. Combustion Engines, II Edition, TMH, 2002.
2. V. Ganesan, Computer simulation of spark ignition process: University process, Hyderabad, 1993.
3. M.L. Mathur and R.P.Sharma, A course in internal Combustion Engines, Dhanapat Rai Publications, New Delhi, 2014.
4. K.K. Ramalingam, Internal Combustion Engine Fundamentals, Scitech Publications, 2011.

Course outcomes:

- To analyze performance of SI and CI engines.
- To recognize emission control norms and use alternate fuels in IC engines.

Specialization Elective
Refrigeration and Cryogenic Systems
L P U: 4 0 4

Course Objectives:

- To understand the refrigeration systems and vapour compression refrigeration and vapour absorption system and applications of refrigeration system.
- To estimate performance of various refrigeration systems.
- To lean various cryogenic Systems

Contents:

Unit I-Review of Thermodynamic Principles of Refrigeration: Vapour compression cycle, actual vapour compression cycle, multistage, multi evaporator system, cascade system, gas cycle refrigeration, aircraft refrigeration.

Unit II- Refrigeration Systems: Estimation of thermal load, selection and matching of components compressors, evaporators, condensers, expansion devices, cyclic controls requirements of refrigerants, lubricants in refrigeration, Secondary refrigerants, mixed refrigerants. Theory of mixtures ; enthalpy composition diagrams, absorption system calculation, aqua ammonia systems, LiBr water system, Three fluid absorption systems, solar refrigeration system.

Unit III-Cryogenic Systems: Introduction: Insight on Cryogenics, Properties of Cryogenic fluids, Material properties at Cryogenic Temperatures. Carnot Liquefaction Cycle, F.O.M. and Yield of Liquefaction ; Cycles. Inversion Curve - Joule Thomson Effect. Liquefaction Cycles: Linde Hampson Cycle, Precooled Linde Hampson Cycle, Claudes Cycle, Dual Cycle, Helium Regrigerated Hydrogen Liquefaction Systems. Crtical components in Liquefaction Systems.

Unit IV-Cryogenic Refrigerators: J.T.Cryocoolers, Stirling Cycle Refrigerators, G.M.Cryocoolers, Pulse Tube Refrigerators, Regenerators used in Cryogenic Refrigerators.

Unit V-Magnetic Refrigerators Applications: Applications of Cryogenic in Space Programmes, Superconductivity, Cryo Metallurgy, Medical applications.

References:

1. W.F. Stoecker, and J.W. Jones, Refrigeration and Air Conditioning, 2nd Edition, Tata McGraw Hill, New Delhi, 1982.
2. M. Prasad., 'Refrigeration and Air Conditioning', Willey Eastern Ltd., 1990.
3. Jordan and Priester, 'Refrigeration and Air conditioning', Prentice Hall of India, 1974.
4. R. F. Barron, Cryogenic Systems, McGraw Hill, 1985.
5. R.B.Scott, Cryogenic Engineering, Van Nostrand and Co., 1962.

Course outcomes: Skill Development

- To understand various refrigeration systems,
- To develop and working of refrigeration equipment's and explain the refrigeration system equipment.
- To calibrate refrigerants

Specialization Elective
Advanced Fluid Mechanics
L P U: 4 0 4

Course Objectives:

The objective of the course is to Derive continuity, momentum and energy equations of fluid flow, learn concept of irrotational flows, flow past cylinders and rankine body and concepts of boundary layer, prandtl mixing length, turbulent theory, universal velocity profile.

Contents:

Unit I- Concept of continuum and definition of a fluid. Body and surface forces, stress tensor, principle of local stress equilibrium. Scalar and vector fields, Eulerian and Lagrangian description of flow.

Unit II-Motion of fluid element: translation, rotation and deformation; vorticity and strain-rate tensors. Continuity equation, Cauchy's equations of motion, Transport theorems. Constitutive equations Stokes law of viscosity. Derivation of N-S equations for compressible flow.

Unit III-Exact solutions of Navier-Stokes equations: plane Poiseuille flow and Couette flow, HagenPoiseuille flow, flow between twoconcentric rotating cylinders, Stokes first and second problems, Hiemenz stagnation-point flow, flow near a rotating disk, flow in convergent-divergent channels. Slow viscous flow: Stokes and Oseens approximation, theory of hydrodynamic lubrication.

Unit IV-Boundary layer: Derivation, exact solutions, Blasius, Falkner Skan series solution and numerical solutions. Approximate methods. Momentum integral method. Introduction to hydrodynamic stability, Orr-Sommerfeld equation, neutral curve of linear stability for plane Poiseuille flow.

Unit V-Description of turbulent flow, velocity correlations, Reynolds stresses. Equations for turbulence kinetic energy and kinetic energy of mean flow. Eddy viscosity models of turbulence: zero equation, one-equation and two-equation models. Prandtls Mixing Length Theory. Empirical laws: law of the wall, velocity defect law, universal velocity distribution.

References:

1. R.N. Fox and A.T McDonald., 'Fluid Mechanics', John Wiley & Sons, 1994.
2. A.H. Shapin, 'The dynamics and thermodynamics of compressible fluid flow', Vol. I and II, The Ronald Press Co., 1955.
3. S.W. Yuan, 'Foundations of Fluid Mechanics', Prentice Hall of India, 1976.
4. Dr. J.K Goyal I K.P. Gupta., 'Fluid Dynamics', 3rd revised Ed., Pragathi Prakasan, Meerut, 1989.
5. Robertson. 'Hydrodynamics Theory and Application', Prentice Hall of India, 1965.

Course outcomes: Skill Development

After going through this course the students will be able to apply continuity equation to solve numerical flow problems, apply momentum equation to determine velocity distribution in the fluid flow and analyze flow using boundary layer theory.

Specialization Elective
Mechanics of Composite Materials
L P U: 4 0 4

Course Objectives:

The primary objective of this course is to understand the Composites, matrix materials, reinforced matrix of composites, Hooke's Law for a Two-Dimensional Angle Lamina, Failure Theories of an Angle Lamina, Macromechanical Analysis of a Lamina and Design of Laminates.

Contents:

UNIT I- Introduction to Composites: Introduction, Classification, matrix materials, reinforced matrix of composites

UNIT II-Hooke's Law for a Two-Dimensional Angle Lamina, Engineering Constants of an Angle Lamina, Invariant Form of Stiffness and Compliance Matrices for an Angle Lamina Strength Failure Theories of an Angle Lamina : Maximum Stress Failure Theory Strength Ratio, Failure Envelopes,Maximum Strain Failure Theory ,Tsai–Hill Failure Theory, Tsai–Wu Failure Theory, Comparison of Experimental Results with Failure Theories. Hygrothermal Stresses and Strains in a Lamina: Hygrothermal Stress–Strain Relationships for a Unidirectional Lamina, Hygrothermal Stress–Strain Relationships for an Angle Lamina

UNIT III-Macromechanical Analysis of a Lamina :Introduction ,Definitions: Stress, Strain ,Elastic Moduli, Strain Energy. Hooke's Law for Different Types of Materials, Hooke's Law for a Two- Dimensional Unidirectional Lamina, Plane Stress Assumption, Reduction of Hooke's Law in Three Dimensions to Two Dimensions, Relationship of Compliance and Stiffness Matrix to Engineering Elastic Constants of a Lamina.

UNIT IV-Micromechanical Analysis of a Lamina :Introduction, Volume and Mass Fractions, Density, and Void Content, Evaluation of the Four Elastic Moduli, Strength of Materials Approach, Semi- Empirical Models ,Elasticity Approach, Elastic Moduli of Lamina with Transversely Isotropic Fibers, Ultimate Strengths of a Unidirectional Lamina, Coefficients of Thermal Expansion, Coefficients of Moisture Expansion Macromechanical Analysis of Laminates: Introduction, Laminate Code , Stress–Strain Relations for a Laminate, In-Plane and Flexural Modulus of a Laminate, Hygrothermal Effects in a Laminate, Warpage of Laminates, hybrid laminates

UNIT V-Design of Laminates : Introduction , thin plate theory, specially orthotropic plate, cross and angle ply laminated plates, problems using thin plate theory, Failure Criterion for a Laminate, Design of a Laminated Composites.

References:

1.Engineering Mechanics of Composite Materials by Isaac and M Daniel, Oxford University Press, 1994.
2.B. D. Agarwal and L. J. Broutman, Analysis and performance of fibre Composites, Wiley-Interscience, New York, 1980.
3. Mechanics of Composite Materials, Second Edition (Mechanical Engineering), By Autar K. Kaw ,Publisher: CRC.
4. R. M. Jones, Mechanics of Composite Materials, Mc Graw Hill Company, New York, 1975.
5. L. R. Calcote, Analysis of Laminated Composite Structures, Van Nostrand Rainfold, New York, 1969.

Course Outcomes: Skill Development

Upon successful completion of the course students will be able to understand the Composites, matrix materials, reinforced matrix of composites, Two-Dimensional Angle Lamina, Failure Theories of an Angle Lamina, Macromechanical Analysis of a Lamina and Design of Laminates.

Specialization Elective
Vibration control
L P U: 4 0 4

Course Objectives:

The objective of the course is to learn the concepts of the basic vibration control, vibration generation mechanism, passive vibration control and active vibration control with vibration measurement with data acquisition and FFT analysis.

Contents:

UNIT I-Basic Concepts: Review of free and forced vibrations with and without damping; Free and forced vibration of single, two and multi-degree of freedom systems with and without viscous damping
Basic Vibration Control: reduction at source, Active feedback control, vibration isolation

UNIT II-Vibration Generation Mechanism: Vibration generation mechanisms: Source classification, self excited vibration, flow induced vibration, field balancing of rigid rotors/flexible rotors and damping models and measures, Design consideration of material selection.

UNIT III-Passive Vibration Control: Basics, design of absorber, absorber with ideal spring, shock absorber, isolators with stiffness and damping.

UNIT IV
Active Vibration Control: Basics, Piezoelectric materials, electro rheological fluids, magneto rheological fluids, Magneto- and Electrostrictive Materials in Vibration Control, shape memory alloys and electro-magnetic materials.

UNIT V-Vibration Measurement: Basics, data acquisition, FFT analysis and filters vibration.

References:

1. D. J. Inman R(2002), Vibration and Control, John Willey & Sons Inc.
2. J. S. Rao R(2006) Vibration Condition Monitoring of Machines, Tata Mc-Graw Hill.
3. S S Rao (2016). Mechanical Vibrations, 6th edition, Pearson.
4. S.P. Timoshenko (2007), Vibration problems in Engineering. Reprint Edition. Wolfenden Press Eduction.
5. Meirovitch. Elements of Vibration Analysis, 2nd Revised edition McGraw-Hill.

Course outcomes: Skill Development
Upon successful completion of the course students will be able to control the vibrations issues in the different mechanical systems using active and passive vibration techniques using FFT analysis..

Specialization Elective
Signal Analysis and Condition Monitoring
L P U: 4 0 4

Course Objectives:

The primary objective of this course is to understand the Basic concepts of fourier analysis. Bandwidth and Signal types and signal analysis. Practical analysis of stationary signals, Practical analysis of continuous non-stationary signals. practical analysis of transients and Condition monitoring in real systems.

Contents:

UNIT I-Introduction, Basic concepts. Fourier analysis. Bandwidth. Signal types. Convolution. **Signal analysis:** Filter response time. Detectors. Recorders. Analog analyzer types.

UNIT II-Practical Analysis of Stationary Signals: Stepped filter analysis. Swept filter analysis. High speed analysis. Real-time analysis.

UNIT III-Practical Analysis of Continuous Non-Stationary Signals: Choice of window type. Choice of window length. Choice of incremental step. Practical details. Scaling of the results.

UNIT IV-Practical Analysis of Transients: Analysis as a periodic signal. Analysis by repeated playback (constant bandwidth). Analysis by repeated playback (variable bandwidth).

UNIT V- Condition Monitoring in Real Systems: Diagnostic tools. Condition monitoring of two stage compressor. Cement mill foundation. I.D. fan. Sugar centrifugal. Cooling tower fan. Air separator. Preheater fan. Field balancing of rotors. ISO standards on vibrations, active, passive hybrid methods of condition monitoring.

References:

1. Condition Monitoring of Mechanical Systems / Kolacat.
2. Frequency Analysis /R.B.Randall.
3. Mechanical Vibrations Practice with Basic Theory / V. Ramamurti/ Narosa Publishing House.
4. Theory of Machines and Mechanisms/ Amitabh Ghosh & AK Malik/ EWP.

Course Outcomes: Skill Development

Upon successful completion of the course students will be able to understand the Basic concepts of fourier analysis. Bandwidth and Signal types and signal analysis. Practical analysis of stationary signals, Practical analysis of continuous non-stationary signals. practical analysis of transients and Condition monitoring in real systems.

Specialization Elective
Reverse Engineering
L P U: 4 0 4

Course Objectives:

The objective of the course is to obtain knowledge about reverse engineering. The detail information about the structure and function of the equipment that is used in reverse engineering. Also recognize and compare the technology in this field and use them in practice. And obtain the knowledge about control and maintenance of devices used for reverse engineering and work with these devices independently.

Contents:

UNIT I- Introduction to reverse engineering, Reverse Engineering–The Generic Process, The Potential for Automation with 3-D Laser Scanners, What Is Not Reverse Engineering.

UNIT II- System Reverse engineering, Reverse engineering Methodology, Reverse engineering Steps, System level design and Examples.

UNIT III- Computer-aided (Forward) Engineering, Computer-aided Reverse Engineering, Computer Vision and Reverse Engineering, contact Methods and Noncontact Methods, Destructive Method, and the Selection Process, Some Additional Complexities.

UNIT IV- Point Capture Devices, Triangulation Approaches, Time-of-flight" or Ranging Systems, Structured-light and Stereoscopic Imaging Systems, issues with Light-based Approaches, Tracking Systems, Internal Measurement Systems, X-ray Tomography, Destructive Systems.

UNIT V-Some Comments on Accuracy, Positioning the Probe, Post processing the Captured Data, Handling Data Points, Curve and Surface Creation, Inspection Applications, Manufacturing Approaches.

References:

1. Raja, V. and Fernandes, K. J. (2008). Reverse Engineering: An Industrial Perspective. Springer-Verlag.
2. Kevin, O. Kristin W. (2001). Product Design: Techniques in Reverse Engineering and New Product Development, 1st ed. Pearson.
3. Eldad, E. (2005). Reversing: Secrets of Reverse Engineering. Wiley.

Course outcomes: Skill Development

After the completion of the course, students should be able to:

- Understand basics in Reverse engineering systems.
- Understand the terminologies related to re-engineering, forward engineering, and reverse engineering.
- Disassemble products and specify the interactions between its subsystems and their functionality.
- Understand Reverse Engineering methodologies.
- Understand Mechanical Reverse engineering.

Specialization Elective
Modeling and Simulation of Manufacturing Systems
L P U: 4 0 4

Course Objectives:

- To learn the concepts of principles and methods of statistical analysis of experimental designs.
- To gain the knowledge on process/product optimization through statistical concepts.

Contents:

UNIT I- Introduction to System and simulation: Concept of system and elements of system, Discrete and continuous system, Models of system and Principles of modeling and simulation, Monte carlo simulation, Types of simulation, Steps in simulation model, Advantages, limitations and applications of simulation, Applications of simulation in manufacturing system.

UNIT II- Review of statistics and probability: Types of discrete and continuous probability distributions such as Geometric, Poisson, Uniform, Geometric distribution with examples, Normal, Exponential distribution with examples

Random numbers: Need for RNs, Technique for Random number generation such as Mid product method, Mid square method, and Linear congruential method with examples.

UNIT II- Test for Random numbers: Uniformity - Chi square test or Kolmogorov Smirnov test, Independency- Auto correlation test.
Random Variate generation: Technique for Random variate generation such as Inverse transforms technique or Rejection method.

UNIT III- Analysis of simulation data: Input data analysis, Verification and validation of simulation models, Output data analysis.
Simulation languages: History of simulation languages, Comparison and selection of simulation languages.

UNIT IV- Design and evaluation of simulation experiments: Development and analysis of simulation models using simulation language with different manufacturing systems
Queueing models: An introduction, M/M/1 and M/M/m Models with examples, Open Queueing and Closed queueing network with examples

UNIT V- Markov chain models and others: Discrete time markov chain with examples, Continues time markov chain with examples, stochastic process in manufacturing, Game theory.

References:

1. Jerry Banks, John S. Carson, Barry L. Nelson, David M. Nicol, and P. Shahabudeen, Discrete Event System Simulation, PHI, New Delhi, 2008.
2. Averill M. Law and W. David Kelton, Simulation Modeling and Analysis, Tata McGraw Hill, New Delhi, 2006.
3. N. Viswanadham and Y. Narahari, "Performance Modeling of Automated Manufacturing Systems", PHI, New Delhi, 2007.

Course outcomes: Skill Development

- To to classify simulation and analytical models used in manufacturing system environment.
- To learn simulation languages, design and evaluate a given manufacturing system using simulation.
- To generate random numbers and variants to execute a simulation model, evaluate queuing networks and markov chains in the context of manufacturing.

Specialization Elective
Micro manufacturing and precession engineering
L P U: 4 0 4

Course Objectives:

- To have the knowledge of different micro machining methods.
- To understand the working principles of various Non-traditional methods in machining and forming.
- To understand the basic concepts and advances measurement methods

Contents:

UNIT I-Mechanical Micro machining – Ultra Sonic Micro Machining – Abrasive Jet Micro Machining – Water Jet Micro Machining – Abrasive Water Jet Micro Machining – Micro turning – Chemical and Electro Chemical Micro Machining – Electric discharge micro machining. Beam Energy based micro machining – Electron Beam Micro Machining – Laser Beam Micro Machining – Electric Discharge Micro Machining – Ion Beam Micro Machining –Plasma Beam Micro Machining – Hybrid Micro machining – Electro Discharge Grinding – Electro Chemical spark micro machining – Electrolytic in process Dressing.

UNIT II-Abrasive Flow finishing – Magnetic Abrasive Finishing – Magneto rheological finishing – Magneto Rheological abrasive flow finishing - Magnetic Float polishing – Elastic Emission Machining – chemmechanical Polishining.

UNIT III-Micro extrusion – Micro and Nano structured surface development by Nano plastic forming and Roller Imprinting – Micro bending with LASER – LASER micro welding – Electron beam for micro welding. Metrology for micro machined components – Ductile regime machining– AE based tool wear compensation– Machining of Micro gear, micro nozzle, micro pins – Applications.

UNIT IV-Concept of accuracy, accuracy of numerical control systems, tolerance and fits, acceptance tests for machine tools, static stiffness and its influence on machining accuracy, inaccuracies due to thermal effects, influence of forced vibration on accuracy, dimensional wear of cutting tools and its influences on accuracy.

UNIT V-clamping and setting errors, location principles and errors due to location, surface roughness and micro finishing processes, dimensioning and dimensional chains, methods of improving accuracy and surface finish, thread and gear measuring instruments, coordinate measuring machines, introduction to computer aided tolerance.

References:

1. Kluwer, "A new direction in manufacturing", Academic Publishers, London, 1997
2. Kalpakjian, "Manufacturing engineering & technology", Addison – Wesley, 4nd Edition
3. J. A. McGeough, "Advanced methods of machining", Chapman and Hall, London, 1988
4. Jain V. K., "Introduction to micromachining", Narosa Publishers
5. Momber A. W. and Kovacevic R., "Principles of water jet machining", Springer –Verlag
6. R. L. Murthy., "Precision engineering manufacturing", New Age International

Course outcomes: Skill Development

Upon successful completion of the course students will be able to decide between the various micro manufacturing methods. To understand the various hybrid manufacturing methods and measurement machines.

Specialization Elective
Thermal System Simulation and Design
L P U: 4 0 4

Course Objectives:

- To impart knowledge on thermal system simulation and optimization methods.
- To design and study of optimization methods.
- To learn integer programming and linear programming.

Contents:

Unit I- Formulation of the design problem: design variables, constraints and limitations, requirements and specifications; Conceptual design, Steps in the design process (examples from thermal systems), Material selection.

Unit II- Modeling of thermal systems: types of models, mathematical modeling, physical modeling and dimensional analysis, curve fitting. Acceptable design of a thermal system: initial design, design strategies, some application illustrations (cooling of electronic equipment, heat transfer equipment, fluid flow systems etc.).

Unit III- Problem formulation for optimization: optimization in design, final optimized design, objective function, constraints, operating conditions, types of thermal systems, practical aspects in optimal design (choice of variables for optimization, sensitivity analysis, dependence on objective function and change of concept or model), Knowledge-based design and additional considerations, professional ethics.

Unit IV- Optimization of unconstrained problems, optimization of constrained problems, applicability to thermal systems, search methods (single variable problem, unconstrained search with multiple variables and multivariable constrained optimization).

Unit V- Integer programming - penalty function method. Use of artificial intelligence techniques (neural network, fuzzy logic and genetic algorithm) in thermal systems design and optimization (simple examples).

References:

1. Y. Jaluria, Design and Optimization of Thermal Systems, CRC Press, 2007.
2. S. S. Rao, Optimization methods, PHI, 1998.
3. W.F. Stoecker, Design of Thermal Systems - McGraw-Hill, 1971.
4. Bejan, G. Tsatsaronis, M.J. Moran, Thermal Design and Optimization - Wiley, 1996.
5. R. F. Boehm, Developments in the Design of Thermal Systems - Cambridge University.

Course outcomes: Skill Development

To create alternative designs of thermal systems that are able to fulfill the desired functionality in an optimal manner for given objectives.

Specialization Elective
Air-Conditioning and Ventilating System
L P U: 4 0 4

Course Objectives:

To impart knowledge on air-conditioning systems, psychrometry concepts and applications of air-conditioning systems and study of air distribution systems.

Contents:

Unit I: Psychometry: Definition, Psychometric terms, Degree of saturation, Humidity, Absolute Humidity, Relative humidity, dry bulb temperature, wet bulb temperature, wet bulb depression, Dew point temperature, Dew point depression, Dalton's law of Partial pressure, Psychometric Relations, Humidity ratio, Psychometer, Psychometric chart, Psychometric Processes, Sensible heating, Sensible cooling, By-pass factor of heating and cooling coils, Dehumidification and humidification , Methods of humidification and dehumidification.

Unit II: Air-conditioning systems: Introduction, Air conditioning system and equipments used in air-conditioning system, various types of air-conditioning systems, Comfort Air-conditioning, Factors affecting effective optimum temperature, Factors affecting comfort air-conditioning, Room Sensible heat factor and Grand sensible heat factor.

Unit III: Cooling Load estimation: Air-conditioning calculations, Comfort scales and measures concepts of effective temperatures, Solar heat gains through gains through glass, buildings, heat storage, diversity and stratification.

Unit IV: Internal heat gains: Sensible heat, Latent heat, Cooling towers, spray chambers, Cooling and humidifying coils, Design of air-duct system, Room air distribution principles, Temperature, pressure and humidity controls, Various types of system controls, Building automation systems.

Unit V: Ducts: Introduction, Classification, Material of duct, construction, shape, pressure in ducts, Continuity equation and Bernoulli's equation for ducts, Pressure losses inducts: Frictional losses & Dynamic losses, Duct design, pressure loss due to enlargement in area and static regain.

Reference Books

1. W.F. Stoecker, and J.W. Jones, Refrigeration and Air Conditioning, 2nd Edition, Tata McGraw Hill, New Delhi, 1982.
2. Jordan and Priester, 'Refrigeration and Air conditioning', Prentice Hall of India, 1974.
3. M. Prasad., 'Refrigeration and Air Conditioning', Willey Eastern Ltd., 1990.
4. R.C Legg, Air Conditioning Systems - Design, Commissioning and maintenance, Batsford Ltd, London 1991.

Course outcomes: Skill Development

To apply thermodynamic principles to various air-conditioning system, design of air-conditioning systems and analyze fan and duct system.

Specialization Elective
Two-Phase Flow and Heat Transfer
L P U: 4 0 4

Course Objectives:

To impart knowledge two phase flow regime mappings, modeling of two phase flow with different models and study of measurement technique for multiphase flow.

Contents:

Unit I: Introduction, different terminologies, flow regimes for single and two component vertical and horizontal flow, flow regime mappings.

Unit II: Conservation equations based on homogeneous flow, drift flux model, separated flow model (multi-fluid model), flooding, fluidization, two phase transportation. Brief discussion on critical flow condition. Introduction to Lockhart-Martinelli and other important correlations for pressure drop, correlations for void fraction.

Unit III: Hydrodynamics of solid-liquid and gas-solid flow, Principles of hydraulic and pneumatic transportation.
Measurement techniques for multiphase flow: Flow regime identification, pressure drop, void fraction and flow rate measurement.

Unit IV: Heat Transfer with Change of Phase: Film wise condensation of pure vapours – Drop wise condensation in plated surfaces – condensation in presence of non condensable gas – pool boiling – Boiling in forced flow inside tubing.

Unit V: Gas – Liquid Fluidization: Gas liquid particle process, Gas liquid particle operation – Gas liquid fluidization. Flow of Gas – Bubble formation, bubble growth gas hold up – Gas mixing liquid hold up – liquid mixing – flow of liquid mixing – Gas liquid mass transfer.

References:

1. J.N. Ginou, 'Two Phase Flow & Heat Transfer', McGraw Hill, New York, 1978.
2. S.C. Kutateladeze, 'Problems of Heat Transfer and Hydraulics of Two Phase Media', Pergamon Press, 1982.
3. J.F Davidson and D.Harrison, 'Fluidization', Prentice Hall, 1976.
4. L.S. Tong., 'Boiling Heat Transfer and Two Phase Flow', Wiley, New York, 1965.

Course outcomes: Skill Development

- To analyze two phase flow patterns for thermal systems and apply analytical tools for design and performance assessment of two-phase devices.
- To generate conservation equations based on homogeneous flow
- To apply heat transfer for various phase

Interdisciplinary Course
Computational Methods in Engineering
L P U: 4 0 4

Course Objectives:

The primary objective of this course is to understand the numerical methods applied to engineering problems, Boundry value problems and charecteristic value problems, Transformation Techniques, Numerical solutions of partial differential equations, Partial differential equations: Explicit method.

Contents:

UNIT I-Introduction to numerical methods applied to engineering problems: Examples, solving sets of equations – Matrix notation – Determinants and inversion – Iterative methods – Relaxation methods – System of non-linear equations. Least square approximation fitting of non-linear curves by least squares –regression analysis- multiple linear regression, non linear regression - computer programs.

UNIT II-Boundry value problems and charecteristic value problems: Shooting method – Solution through a set of equations – Derivative boundary conditions – Rayleigh – Ritz method –Characteristic value problems.

UNIT III-Transformation Techniques: Continuous fourier series, frequency and time domains, laplace transform, fourier integral and transform, discrete fourier transform (DFT), Fast fourier transform (FFT).

UNIT IV-Numerical solutions of partial differential equations: Laplace's equations – Representations as a difference equation – Iterative methods for Laplace's equations – poisson equation – Examples – Derivative boundary conditions – Irregular and non – rectangular grids – Matrix patterns, sparseness – ADI method – Finite element method.

UNIT V-Partial differential equations: Explicit method – Crank-Nickelson method – Derivative boundary condition – Stability and convergence criteria. Solving wave equation by finite differences-stability of numerical method –method of characteristics-wave equation in two space dimensions-computer programs.

References:

1. Steven C.Chapra, Raymond P.Canale "Numerical Methods for Engineers" Tata Mc-Graw Hill
2. Curtis F.Gerald, Partick.O.Wheatly,"Applied numerical analysis"Addison-Wesley,1989.
3. Douglas J.Faires,Riched Burden"Numerical methods", Brooks/Cole publishing company,1998.Second edition.
4. Ward Cheney and David Kincaid "Numerical mathematics and computing" Brooks/Cole
5. publishing company1999, Fourth edition.
6. Riley K.F,. M.P.Hobson and Bence S.J,"Mathematical methods for physics and engineering", Cambridge University press,1999.
7. Kreysis, Advanced Mathematics.

Course Outcomes: Skill Development

Upon successful completion of the course students will be able to understand the numerical methods applied to engineering problems, Boundry value problems and charecteristic value problems, Transformation Techniques, Numerical solutions of partial differential equations, Partial differential equations: Explicit method.

Interdisciplinary Course
Design and Analysis of Experiments
L P U: 4 0 4

Course Objectives:

- To learn the concepts of principles and methods of statistical analysis of experimental designs.
- To gain the knowledge on process/product optimization through statistical concepts.
- To introduce the concepts of influence and contribution factors etc.

Contents:

UNIT I: Fundamentals of Experimentation: Role of experimentation in rapid scientific progress, Historical perspective of experimental approaches, Steps in experimentation, Principles of experimentation.

UNIT II: Experiments with a Single Factor: Basic Principles and Guidelines of Design of Experiments - Single Factor Experiments – ANOVA - Model Adequacy Checking - Determining Sample Size - Comparing Pairs of Treatment Means - Introduction to DOAE software.

UNIT III: Factorial Designs: Two levels - 2k factorial designs - Confounding and Blocking in factorial designs. Fractional Factorial Designs: The One-Half and One-Quarter Fraction of the 2k Design - General 2k–p Fractional Factorial, Design – Resolution.

UNIT IV: Taguchi's Parameter Design: Concept of robustness, noise factors, objective function & S/N ratios, inner-array and outer-array design, data analysis. Regression Analysis: Introduction - Simple Linear Regression Analysis - Multiple Linear Regression Model – Model Adequacy Checking.

UNIT V: Response Surface Methodology: Response surface methodology, parameter – optimization - robust parameter design and its application to control of processes with high variability.

References:

1. Douglas C. Montgomery, Design and Analysis of Experiments, John Wiley & Sons, Inc., 9th edition, 2017.
2. Philip J. Rose, Taguchi Techniques for quality Engineering, Prentice Hall, 2000.
3. Charles R. Hicks, Kenneth V. Turner, Fundamental concepts in the Design of Experiments, Oxford University Press, 5th edition 1999.

4. K. Krishnaiah, P. Shahabuddeen, Applied Design of Experiments and Taguchi Methods, PHI Publications, 2012.

Course outcomes : Skill Development

- To select an appropriate design,
- To conduct the experiment and interpret the result using appropriate statistical techniques.
- To solve the problem by optimizing the product/process parameters.
- To predict the outcomes through statistical concepts.

Interdisciplinary Course
Advanced Finite Element Analysis
L P U: 4 0 4

Course Objectives:

The primary objective of this course is to understand the Formulation Techniques, One-dimensional elements, Two dimensional problems. Isoparametric formulation, Static and dynamic analysis, eigen value problems.

Contents:

UNIT I-Formulation Techniques: Methodology, Engineering problems and governing differential equations , finite elements, Variational methods-potential energy method, Raleigh Ritz method, strong and weak forms, Galerkin and weighted residual methods, calculus of variations, Essential and natural boundary conditions.

UNIT II-One-dimensional elements: Bar, trusses, beams and frames, displacements, stresses and temperature effects.

UNIT III-Two dimensional problems: CST, LST, four noded and eight nodded rectangular elements, Lagrange basis for triangles and rectangles, serendipity interpolation functions. Axisymmetric Problems: Axisymmetric formulations, Element matrices, boundary conditions. Heat Transfer problems: Conduction and convection, examples: - two-dimensional fin.

UNIT IV- Isoparametric formulation: Concepts, sub parametric, super parametric elements, numerical integration, Requirements for convergence, h-refinement and p-refinement, complete and incomplete interpolation functions, pascal's triangle, Patch test.

UNIT V-Finite elements in Structural Analysis: Static and dynamic analysis, eigen value problems, and their solution methods, case studies using commercial finite element packages.

References:

1. J.N. Reddy, Finite element method in Heat transfer and fluid dynamics, CRC press, 1994
2. Zienckiwicz O.C. & R. L. Taylor, Finite Element Method, McGraw-Hill,1983.
3. K. J. Bathe, Finite element procedures, Prentice-Hall, 1996.
4. Finite element methods by Chandrubatla & Belagondu.
5. Finite element methods by Logan.

Course Outcomes: Skill Development

Upon successful completion of the course students will be able to understand the Formulation Techniques, One-dimensional elements, Two dimensional problems. Isoparametric formulation, Static and dynamic analysis, eigen value problems.

Interdisciplinary Course
Advanced Computational Fluid Dynamics
L P U: 4 0 4

Course Objectives:

The primary objective of this course is to understand the difference method, finite volume method, finite element method, Solution methods and Standard variational methods. Hyperbolic equations, Formulations of incompressible viscous flows, Treatment of compressible flows, Finite volume method.

UNIT I- Introduction: Finite difference method, finite volume method, finite element method, governing equations and boundary conditions. Derivation of finite difference equations. Treatment of compressible flows.
Solution methods: Solution methods of elliptical equations – finite difference formulations, interactive solution methods, direct method with Gaussian elimination. Parabolic equations-explicit schemes and Von Neumann stability analysis, implicit schemes, alternating direction implicit schemes, approximate factorization, fractional step methods, direct
method with tridiagonal matrix algorithm.

UNIT II-Hyperbolic equations: explicit schemes and Von Neumann stability analysis, implicit schemes, multi step methods, nonlinear problems, second order one-dimensional wave equations. Burgers equations: Explicit and implicit schemes, Runge-Kutta method.

UNIT III- Formulations of incompressible viscous flows: Formulations of incompressible viscous flows by finite difference methods, pressure correction methods, vortex methods.
Treatment of compressible flows: potential equation, Eluer equations, Navier-stokes system of equations, flow field-dependent variation methods, boundary conditions, example problems.

UNIT IV-Finite volume method: Finite volume method via finite difference method, formulations for two and three-dimensional problems.

UNIT V-Standard variational methods: Linear fluid flow problems, steady state problems, Transient problems.

References:

3. Text book of fluid dynamics, Frank Chorlton, CBS Publishers &distributors, 1985
4. Computational fluid dynamics, T. J.Chung, Cambridge University press, 2002.

Course Outcomes: Skill Development

Upon successful completion of the course students will be able to understand the difference method, finite volume method, finite element method, Solution methods and Standard variational methods. Hyperbolic equations, Formulations of incompressible viscous flows, Treatment of compressible flows, Finite volume method.

Course No	Course Title	L	P	U
EC501	Pattern Recognition	3	0	5

Learning Outcomes

After successful completion of the course student will be able to

5. Understand the need for image transforms ,different types of image transforms and their properties.
6. Learn different techniques employed for the enhancement of images.
7. Learn different causes for image degradation and overview of image restoration techniques.
8. Implement simple pattern classifiers, classifier combinations, and structural pattern recognizers.

Unit 1

Introduction, Image acquisition process, Sampling & quantization, Pixel neighborhood properties, Geometric Transformations, Frequency Transformations, Multi-resolution Expansions

UNIT 2

Edge Detection, Multiresolution Expansions, Wavelet Transforms, Image Segmentation, Thresholding, Edge-based Segmentation, Region-based Segmentation, Matching, Evaluation Issues in Segmentation, Mathematical concepts, Operators based on first order derivative (Roberts, Prewitt and Sobel),

UNIT 3

Image Data Compression, Image Data Properties, Discrete Image Transforms in Image Data Compression, Laplacian (Second order derivative based edge detection), LOG

UNIT 4

Morphological Image Processing, Dilation and Erosion, Opening and Closing, Basic Morphological Algorithms, Supervised algorithm.

UNIT 5

Unsupervised Clustering Algorithm, K-NN, Support Vector Machine, Neural Networks, Deep learning Overview

Text Book

3. Digital Image Processing, Rafael C. Gonzalez and Richard E. Woods, Pearson Education, Second Edition.
4. Image Processing, Analysis and Machine Vision, Sonka, Hlavac, Boyle 3rd edition

Reference book

3. Fundamentals of Digital Image Processing, Anil K. Jain, PHI.
4. Pattern Recognition and Image Analysis, Earl Gose and Richard Johnsonbaugh Steve Jost, PHI.

Learning Outcomes: Skill Development

Upon successful completion of the course, student will be able to:

1. Define and describe pattern Recognition and its main constituents.
2. Distinguish class of problems suitable for solving with expert systems.
3. Assemble various parts of knowledge and skills in order to devise the approach to solution.
4. Application of Pattern recognition to solve various problem in real life situation.

Course No: EC502	Course Title: **Design for Testability Yield and Reliability**	L	P	U
		3	0	5

Course Objectives

4. To study techniques in testing of VLSI chips.
5. To understand fault models and their use in testing of VLSI Circuits.
6. To learn fault modelling and testing for memory.

Syllabus:

Chapter 1: Scope of testing and verification in VLSI design process. Issues in test and verification of complex chips, embedded cores and SOCs.

Chapter 2: Basics of Testing: Introduction, Fault models, Combinational logic and fault simulation, Test generation for Combinational Circuits. Current sensing based testing.

Chapter 3: Classification of sequential ATPG methods. Fault collapsing and simulation. Testing of static and dynamic circuits

Chapter 4: Fault models for diagnosis, Cause- effect diagnosis, Effect-cause diagnosis. Scan design, Partial scan, use of scan chains, boundary scan. DFT for other test objectives, Memory Testing.

Chapter 5: Pattern Generators, Estimation of test length, Test points to improve testability, Analysis of aliasing in linear compression, BIST methodologies, BIST for delay fault testing

Text Book:

1. N. Jha & S.D. Gupta, "Testing of Digital Systems", Cambridge, 2003.

References:

2. W. W. Wen, "VLSI Test Principles and Architectures Design for Testability", Morgan Kaufmann Publishers. 2006
3. Michael L. Bushnell &Vishwani D. Agrawal," Essentials of Electronic Testing for Digital, memory & Mixed signal VLSI Circuits", Kluwar Academic Publishers. 2000.

Learning Outcomes:

Upon successful completion of the course, student will be able to:

11. Apply the concepts in testing which can help them design a better yield in IC design.
12. Tackle the problems associated with testing of semiconductor circuits at earlier design levels so as to significantly reduce the testing costs.
13. Ability to use Fault models for testing various VLSI circuits.
14. Design Circuits for Testability.
15. Recognize the BIST techniques for improving testability.

Course No: EC503	Course Title: **Advanced Real Time Systems**	L	P	U
		3	0	5

Course Objectives

4. develop an understanding of various Real Time systems Application
5. obtain a broad understanding of the technologies and applications for the emerging and exciting domain of real-time systems
6. get in-depth hands-on experience in designing and developing a real operational system.

Syllabus:

Chapter 1: Introduction: Real- Time Systems, Hard versus soft Real- Time Systems: Jobs and Processes, Release Times, Deadlines and Timing Constraints, Hard and Soft Timing Constraints, Hard Real Time Systems, Soft Real Time Systems

Chapter 2: A Reference Model of Real – Time Systems: Processors and Resources, Temporal Parameters of Real Time Workload, Periodic Task Model, Precedence Constraints and Data Dependency, Functional Parameters- preemptivity of jobs, criticality of jobs, Resource Parameters of Jobs and Parameters of Resources, Scheduling Hierarchy- Scheduler and Schedules, Feasibility, Optimality and Performance Measures.

Chapter 3: Classification of Real Time Scheduling Approaches: Clock- Driven Approach, Weighted Round- Robin Approach, Priority- Driven Approach, Dynamic versus Static Systems, Effective Release Times and Deadlines, optimality of the EDF and LST algorithms, Non optimality of the EDF and LST algorithms, Challenges in validating timing constraints in priority –driven systems Off-line versus On-line Scheduling

Chapter 4: Clock-Driven Scheduling : Notations and Assumptions, Static, Timer -Driven Scheduler, General Structure of Cyclic Schedules, Cyclic Executives, Improving the Average Response Time of Aperiodic Jobs, Scheduling Sporadic Jobs-Acceptance test ,EDF Scheduling of accepted jobs and implementation, Pros and Cons of Clock Driven Scheduling.

Chapter 5: Priority-Driven Scheduling of Periodic Tasks: Static Assumption, Fixed Priority v/s Dynamic Priority Algorithms, schedulability test for the EDF algorithm, sufficient schedulability conditions for RM & DM algorithms: schedulable utilization of the RM algorithm for tasks with Di=pi, schedulable utilization of fixed priority tasks with arbitrary relative deadlines. Scheduling Aperiodic and Sporadic Jobs in Priority-Driven Systems: Assumptions and Approaches, Deferrable Servers- Operations of Deferrable Servers, Constant utilization server Scheduling of sporadic jobs-a simple acceptance test in deadline driven systems, a simple acceptance test in fixed- priority driven systems.

Text Book:

1. Real - Time Systems, Jane W S Liu, Pearson Education, ISBN 81 – 7808 – 463 - 5.

References:

1. Real-Time Systems and Software, John Wiley& Sons Inc., 2001. ISBN 0-471- 35490-2
2. Real Time Systems : C.M. Krishna & Kang G. Shin : McGraw Hill.
3. C.Sivamurthy, G. Manimaran, Resource Management in Real-Time Systems and Networks, PHI, New Delhi,2005.

Learning Outcomes: Skill Development

Upon successful completion of the course, student will be able to:

1. Enumerate the need and the challenges in the design of hard and soft real time systems.
2. Compare different scheduling algorithms and the schedulability criteria.
3. Determine schedulability of a set of periodic tasks given a scheduling algorithm.
4. Develop algorithms to decide the admission criterion of sporadic jobs and the schedule of aperiodic jobs.
5. Integrate resource access mechanisms with the scheduling techniques and develop integrated schedulability criteria.



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