Ver.1-(11-07-2019)

Elective Courses Syllabus – Monsoon 2019

Sl. No	Course Code	Course Name
1.	SCI541	Advanced Biomolecular Architecture
2.	CSE435	Advanced Computer Networks
3.		Advanced Mathematical Structures
4.	CEA711	Advanced Mechanics of Materials
5.	ECE441	Adaptive Signal Processing
6.	CES623	Advanced Structural Design
7.	ECE468	Analog IC Design
8.	SCI643	Biomolecular Structure Interactions And Dynamics
9.	CSE419	Compilers
10.	CSE411	Complexity and Advanced Algorithms
11.	CSE478/ ECE 478	Digital Image Processing
12.	CSE441	Database Systems
13.		Design and Principles of Chemical and Biological Sensors
14.	ECE469	Design for Testability
15.	CSE431	Distributed Systems
16.	CSE512	Distributing Trust & Block Chains
17.		Data Analytics-1
18.		Environmental Science & Technology
19.		Eco-Informatics
20.	CEA621	Finite Element Methods
21.	CSE464	Game Design and Engineering
22.		Hydrological Modeling and Software

		Development
23.	HSS368	Introduction to Sociology
24.	HSS343a	Introduction to History
25.	HSS316	Introduction to Philosophy
26.	HSS351a	Intro to Psychology
27.	CSE485	Intro to Cognitive Science
28.	HSS345a	Introduction to Shakespeare
29.	ECE539	Information Theory and Coding
30.	CSE474	Information Retrieval and Extraction
31.	CES644	IS Codes on Design and Structural Safety Assessment
32.	CSE483	Mobile Robotics
33.	SCI477	Machine Learning for Natural Sciences
34.	CSE472	Natural language Processing
35.	IMA404	Number Theory and Cryptology
36.	CSE415	Principals of Programming Languages
37.		Quantum Computing for Naturals Sciences
38.	CSE540	Research in Information Security
39.	CSE991	Research Methodology
40.		Structural Wind Engineering
41.	CSE591	Spatial Informatics
42.	ECE448	Speech Signal Processing
43.	CSE971	Speech Technology
44.	CSE861	Software Quality Engineering
45.	CSE471	Statistical Methods in AI
46.	CSE451	Social Science Perspective on HCI
47.	CEG445	Technology Product Entrepreneurship
48.	HSS445	Technology and Social Movements

49.	CSE975	Topics in Machine Learning
50.	CSE484	Topics in Applied Optimization
51.	ECE531	Topics in Wireless Communications
52.		Topics in SSMT
53.	ECE438	Wireless Communications
54.	HSS338	Understanding Raga: Semi Classical forms of Indian Music
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TITLE : **Advanced Bio-Molecular Architecture**

Course Code : SCI 541

CREDITS : 4

TYPE-WHEN : Monsoon semester: Domain core (M Tech I Bioinformatics) + Domain requirement for MS by research/ PhD (Bioinformatics) + Science Elective for B Tech

FACULTY NAME : Abhijit Mitra

PRE-REQUISITE : None

OBJECTIVE : First course on the basics of design principles of nature at the molecular level, which would provide breadth in structural and biophysical approaches and 'chemenable' students to understand structures and interactions in Biology

COURSE TOPICS :

• Mole Concept

• Atomic structure and the periodic table

• Quantum mechanical approach to atomic structure and bonding
• Bonding and intermolecular forces
• Nomenclature and isomerism
• Configuration and Conformation
• Structure and properties of molecules
• Computation of energies of molecules and their interactions
• Small biomolecules
• Biological macromolecules: Proteins, Nucleic acids, Lipids and carbohydrate

Syllabus and topic wise Coverage:

ABA 1-2: Design principles of nature – chemistry at the atomic level

Assignment – 1: Introductory lectures – **Due ABA 4**

ABA 3-4: Structure of atom and Chemical arithmetic

(Practice assignment-1 – **Try out by ABA 4)**
Assignment – 2: Chemical Arithmetic – **Due ABA 6**

ABA 5: Quantum mechanical structure of the atom

(Practice assignment -2 – **Try out by ABA 6**

(Work sheet only for M Tech to submit – **Due before Mid-1**

Practice assignment -3 for others)
Assignment – 3: Structure of atoms - **Due ABA 7**

ABA 6: Periodic table and its organization-The electronic configuration of atoms and periodic properties of atoms in their free and bonded state

(Practice assignment -4 – **Try out by ABA 8**
Assignment – 4: Periodic properties – **Due ABA 8**

ABA 7: Bonding and molecular properties -Theories of bonding

Types of bonds and their consequences
Assignment: Bonding (Practice assignment-5 – **Try out by ABA 8)**
Dry lab on structure drawing tool

ABA 8: Bonding and molecular structure -Theories of bonding
Electron distribution in molecules and their representation
Hybridization
Resonance and aromaticity
Assignment - 5: Bonding – **Due ABA 9**

ABA 9: Bonding, structure and intermolecular forces

Bond length, bond angle and shape of molecules
Dipole moments

Intermolecular forces
Assignment - 6: Bonding –**Due ABA 10**

ABA 10: Isomerism

Structural and stereo isomers
Nomenclature

Practice Assignment: Isomerism and nomenclature (**Try out before Mid-1**

Assignment – 7: Nomenclature and isomerism I – **Due ABA 13**

Mid-1

ABA 11-13: Configuration and conformation I
Chirality and optical activity
Representation of configuration and Stereochemical nomenclature

Sugars and carbohydrates
Tutorial
Assignment – 8: Nomenclature and isomerism II – **Due ABA 13**

ABA 14-15: Configuration and conformation III
Concept of prochirality

Conformations – energy barriers, torsion angles and representations

Conformations of cyclic compounds including cyclic sugars
Tutorial

Assignment – 9: Nomenclature and isomerism III – **Due ABA 16**

ABA 16: Structure and properties of molecules

Bond energy and type of bond breaking (Bonding III from resources)

Basics of thermodynamics and kinetics

Acids and bases

Familiarity with the different amino acids and their classification

Tutorial
Assignment – 10: Amino Acid Structure - **Due ABA 18**

ABA 17: Equilibria in aqueous solutions I

General characteristics of amino acids in aqueous solutions

Tutorial
Assignment – 11: Amino Acids and ionic equilibria: **Due ABA 20**

ABA 18: Equilibria in aqueous solutions II

Study of buffers

Amino acid pK values and isoelectric points (No ionizable side chains)

(Practice assignment – Food for thought **Try out by ABA 19)**

Tutorial

Mid-2

ABA 19: Equilibria in aqueous solutions III

Amino acid pK values and isoelectric points (ionizable side chains)

Tutorial
Dry lab on structure building and visualizing tool

ABA 20-22: Study of amino acids and proteins
Investigation of dipeptides and torsion angles
Levels of protein structure and forces stabilizing them
Primary structure and its relation with higher order structure
Secondary structure and Ramachandran plot
Dry lab on structure visualizing tool
Assignment – 12: Amino acids and proteins **Due ABA 24**

ABA 23-25: Study of nucleic acids
DNA-Components, chemical structures
Base pairing and hydrogen bonding
Types of DNAs A, B, Z and their structure parameters
Nucleic acid databases
Comparing DNA and RNA

Nucleic acid protein interactions
Dry lab on structure analysis tool
Assignment – 13: Nucleic acids **Due ABA 26**

ABA 26: Revision

PREFERRED TEXT BOOKS: Text books: Study material will be provided in the form of pdf files and web content. Also Atkins and Leach

***REFERENCE BOOKS:** 1.Bio-Chemistry – Stryer
2.Biochemistry – Voet, Voet and Pratt
3.Ralph H. Petrucci, General Chemistry: Principles & Modern Applications, 8th Edition, Addison Wesley Longman (2003)
4.P W Atkins, Elements of Physical Chemistry, 5/E, Oxford University Press (2010)

***PROJECT:** None

GRADING: Grading Plan: Assignments and quizzes - 40% Exams - 60 (15 + 15 + 30) % (2 midterm + 1 endsem) Total - 100% Modified Domain Grading Plan: Assignments and quizzes - 40% Domain Supplement (Lab + Theory) – 10% Exams - 50 (12.5 + 12.5 + 25) % (2 midterm + 1 endsem) Total - 100%

OUTCOME: Expected outcome:
1. Ability to carry out chemical calculations
2. Ability to write Lewis and other specialized structural formulae and use them to relate structures with properties

3. Ability to communicate with written structures of biological molecules
4. Ability to understand standard IUPAC nomenclature and numbering
5. Ability to understand structural features including Chirality and prochirality, structure parameters including torsion angles, their definitions and standard values for biomolecules
6. Ability to build molecules in silico and familiarity with some visualization and analysis tools
7. Understand the basis of computability of energetics of molecules and their ensembles
8. Ability to handle files containing structural information of molecules and mine structure databases of biological molecules

REMARKS: Load: Total contact hours ~5 hours per week
Live lectures: Two 1.5 hr lectures per week
Labs and/or Tutorials 1.5 - 2 hr per week
Assignment hours (including lab and reading assignments) around 3-4 hours per week

TITLE : Advanced Computer Networks

Course Code: CSE435

CREDITS : 3-1-0-4

TYPE-WHEN : Bouquet Core, Monsoon

FACULTY NAME : Sujit Gujar + Shatrunjay Rawat

PRE-REQUISITE : Computer Networks Course

OBJECTIVE : Introduce Advance Networking Concepts, Theories and Tools.

COURSE TOPICS:

Review of Networking Basics; Queuing theory; Advance Topics in IPv4 and TCP; Telecom Networks, Switching Techniques; Multicast Routing protocols; IPv6, IPv4 to IPv6; QoS; Network Monitoring – SNMP, RMON; VLAN; VPN; Firewall and IPS Concepts; Network Redundancy, Load Balancers, Caching, Storage Networks; VSAT, GSM/CDMA/WiMax; Ad-Hoc networks, Sensor Networks; Network Simulation.

PREFERRED TEXT BOOKS:

- RFCs and Standards Documents
- Communication Networking – An Analytical Approach, Anurag-Manjunath-Joy
- Probabilistic Modelling by Isi Mitrani

REFERENCE BOOKS:

- TCP/IP Illustrated (Vol.1,2), Stevens
- Data Networks, Bertsekas-Gallager
- An Engineering Approach to Computer Networking by S. Keshav

More books/references will be identified in due course

PROJECT: NA

GRADING:

- Assignments: 20
- Quiz: 20
- MidSem Exam: 20

•End Semester Exam**:** 40

OUTCOME:

•Understanding core concepts/theories/algorithms of computer networks

•Some hands-on capability on various network devices and tools

•Capability to design and implement a computer network

REMARKS:

Course may have lab component, depending on class strength

TITLE : **Adaptive Signal Processing**

Course Code : ECE441

Credits : 3-1-0-4

Type-When : Spring 2019

Faculty Names : Santosh Nannuru

Pre-Requisite : Signals and Systems, Digital Signal Processing, Probability

Theory and Random Processes

PRE-REQUISITE : Signals and Systems, Digital Signal Processing, Probability Theory and

Random Processes

COURSE TOPICS :

1. Review of Random Signal Theory & Discrete Time Systems

2. System Models: All Pole, All Zero. Pole-Zero models

Lattice structures, Direct to lattice conversions of AP, AZ, PZ systems

The problem of Spectral Factorization

3. Signal Models :

AR, MA,&AARMA Processes

Generation of Random processes and whitening

The AR process and Yule Walker equations

4. Introduction to Adaptive Signal processing & applications:

5. Statistical approach to ASP:

Mean Square Error Criteria

MSE Estimation

Properties of the Quadratic Error Surface

Levinson Durbin Method, Steepest Descent Method

Least Mean Square(LMS)

6. Data Dependant Approach to ASP:

Least square techniques

Geometrical interpretation

LS, WLS & their statistical properties

Orthogonalization techniques QR decomposition, House Holder Transformation,

Givens' Rotation, Graham Schmidt Orthogonalization

Recursive Least Square techniques

7. Applications:

Echo cancellation

Channel identification/equalization

BOOKS:

Statistical & Adaptive signal Processing by Manolakis, Kogan & Ingle, and McGraw Hill Pub.

Adaptive Signal Processing by Alexander

Adaptive Signal Processing by Widrow, Pearson Education.

GRADING:

Assignment – 10%

Project – 10%

2-Mid terms examinations – 40%

End term examination – 40%

OUTCOME:

On successful completion of this course, students should be able to demonstrate a theoretical

understanding and problem solving skills of statistical and data dependent approaches to the adaptive signal processing.

TITLE **:** Analog IC Design
Course Code **: ECE468**

CREDITS **:** 3-1-0-4
TYPE-WHEN **:** Monsoon 2019
FACULTY NAME **:** Zia Abbas

PRE-REQUISITE **:** Analog Electronics/Linear Electronic Circuits, Network theory
OBJECTIVE **:** To make students learn practical CMOS analog IC design with the emphasis on developing intuitive thinking for analog circuit analysis and design.

COURSE TOPICS :

Basics of analog design :MOS model for analog circuits, large signal modeling, incremental modeling, MOS parasitics, mismatches, speed (f_T), passive components for IC design (R, C and L), biasing,negative feedback for biasing, introduction to layout, Gain-BW-Swing-Power-Noise-Area trade-offs. (4)

Amplifier design : Review of single stage amplifiers, single-ended and differential amplifier design, gm/Id design technique, sub-threshold design technique for low power consumption, techniques to increase gain of amplifiers- active loads, cascode, differential amplifier with current mirror load, mirror pole, stability issues and utility of negative feedback in high gain amplifiers. (7)

Operational amplifier design : Review of op amp characteristics, CMRR, offset, single stage op amp, high gain op amps - telescopic, two stage, stability and frequency compensation, fully differential amplifier (FDA), common-mode-feedback, review of low noise, low voltage op amp design techniques. (8)

Other topics : Noise, layout techniques, effect of off-chip components and packaging on IC design, oscillators, phase noise and PLLs. (7)

PREFERRED TEXT BOOKS:

1. B. Razavi, "Design of Analog CMOS Integrated Circuits," 2nd ed., McGraw Hill, 2017.

2. P. E. Allen and D. R. Holberg, "CMOS Analog Circuit Design," 3rd ed., Oxford, 2013.

***REFERENCE BOOKS:**

1. Paul R. Gray & Robert G. Mayor, "Analysis and Design of Analog Integrated Circuits," 4th ed., JohnWily& Sons, 2008.

***PROJECT:** Two course projects will be given

GRADING PLAN:

Type of Evaluation	Weightage (in %)
Mid Sem Exam (1)	20%
Quiz (2)	10%
End Sem Exam	30%
Assignments (4)	20%
Project (2)	20%

SCI643 Biomolecular Structure Interactions And Dynamics 3-0-1-4

Type_When : Monsoon-2019

Faculty Name : Prof. Abhijit Mitra + B. Gopal

Pre-requisites : Advanced Biomolecular Architecture or General and Structural Chemistry or equivalent Max. No. of students (limit, if any): Science/Open elective for 'non CNS' B.

Tech students – no limit.

OBJECTIVE: Navigating the ıSequence ı Structure ı Functionı Space for Biomolecules.

Course Description: ı Structure and properties of biomolecules, ı Interactions between biomolecules, ı Properties of ensembles of biomolecules, ı Reactions and reaction mechanisms, ı Important biochemical reactions, ı Exploration and analysis of biomolecular structures and interactions, ı Molecular modeling and docking ı concepts and techniques, ıDatabases and tools.

Text Book:

1. Bio-Chemistry - Lehninger
2. Bio-Chemistry ı Stryer
3. Biochemistry ı Voet, Voet and Pratt

Syllabus and topic wise Coverage:

Lectures Topics

Week 1

1 -2 Structure and properties of biomolecules: Steric and electronic effects, Electrophiles, nucleophiles, acids, bases and salts, Buffers

Week 2

3 Interactions between biomolecules: Hydrogen bonding and solvation, examples of structure property correlation

Assignment 1 : Due Week 3

Week 2 ı 4

4 ı 7 Properties of ensembles of biomolecules: Elementary concepts of chemical thermodynamics, Equilibrium and kinetics, Ionic equilibriums and chemistry in aqueous solution. Application to stability of proteins, nucleic acids and their interactions.

Assignment 2 : Due Week 5

Week 5

8 ı 9 Reactions and reaction mechanisms Classification of reactions and their mechanisms ı application to classification of biochemical reactions and their enzymes

Assignment 3: Due Week 6

Week 5 ı 6

10 ı 12 Important biochemical reactions Examples from enzyme classes, active site, target specificity, inhibition and activation. Reactions involved in storage and retrieval of energy. Enzyme kinetics.

Assignment 4: Due Weeks 8

Week 7 ı 9

13 ı 18 Exploration and analysis of biomolecular structures and interactions

Experimental methods and techniques for analyzing structures and interactions ı NMR, ESR, X-Ray, CD, Fluorescence etc. Detailed structural analysis of some representative proteins, Analysis of DNA and RNA structures,

Assignment 5 and 6: Due Weeks 9 and 11

Week 10 ı 12

19 ı 24 Molecular modeling and docking ı concepts and techniques:

Useful concepts in Molecular modeling - Tasks and techniques in molecular modeling, Identification of tasks e.g. alignment, minimization, conformational search, dynamics and simulation etc., Methods of analyzing structures, Methods of prediction and validation of structures

Assignment 7: Due Week 12

Week 13 ı 14

25 ı 28 Databases and tools: Classification of databases, databases of structures and functions, CATH, SCOP, PFAM, Functional domain ı Analysis servers

Assignment 8: Due Week 14

Laboratory:

ı Visualization & rendering

ı Building molecules-Physical (Ball & Stick, Paper models), in silico

ı Rendering of various aspects of structures of biomolecules

ı Web based tools

ı Query tools: i) Sequence retrieval, ii) Structure retrieval

ı Protein structure analysis tools:

i) Structure alignment.

ii) Homology search.

iii) Domain assignment.

iv) Fold recognition and analysis

ı Structure prediction tools: i) Secondary structure prediction. (1) Protein. structure. (2) RNA structure

ı Molecular modeling tools: i) Threading. ii) Comparative modeling, SwissMod.

ı Computational tools: i) Geometry optimization and Energy minimization. ii) Molecular dynamics simulation.

Projects (if any): Labs + Tutorials 1.5 hr per week Assignment hours (including lab and reading assignments) around 4 hours per week.

Grading: Assignments and quizzes - 50% (8-10 assignments) Exams - 50% (2 midterm (20) + End sem exam (30)) Total - 100%.

Outcome: 1. Review of physicochemical principles at the molecular level 2. From molecules to biochemical systems ı appreciation of principles of kinetics and thermodynamics for understanding mechanisms of interactions and reactions of biomolecules 3. Appreciation of the experimental methods used for exploring structures of biomolecules 3. Understanding of important structural concepts used for the analysis of protein and nucleic acid structures 4. Learning to use and understanding the principles of molecular modeling, docking and molecular dynamics simulations for inferring structures, functions and interactions from sequences ı 5. Familiarity with important structural and functional databases and their usefulness in biological contexts.

Remarks: Total contact hours 4-5 hours per week Live lectures: Two 1.5 hr lectures per week.

Title : Compilers

Course Code : CSE419

Credits : 3-1-0-4

Type When : Monsoon-2019

Faculty Name : Suresh Purini

Pre-Requisite : Formal Languages

OBJECTIVE: To learn the principles, techniques and tools behind designing and building a Compiler.

COURSE TOPICS:

Lexical Analysis, Syntax Analysis, Semantic Analysis, Run Time Environments, Intermediate Representations, Code Generation, Instruction Scheduling, Register Allocation, Local and Global Optimizations, Introduction to Data Flow Analysis

PREFERRED TEXT BOOKS:

Engineering a Compiler, By Keith Cooper and Lina Torczon

***REFERENCE BOOKS:**

Compilers by Aho, Hopcroft, Ullman, Sethi and Lam

***PROJECT:**

Students may have to build a Compiler for a toy programming language

GRADING:

percent each midterm, Final (30-40 percent) , Project (10-20 Percent)

Complexity & Advanced Algorithms

Credits : 3-1-0-4

Course Code : CSE411

Type-when : Monsoon-2019

Faculty Name : Kishore Kothapalli

Pre-Requisite: Should have taken Introduction to Algorithms or equivalent

Objective: The course is aimed at undergraduates and graduates who have done a first course in algorithms and a first course in formal languages. This course is intended to build up further on the above two themes. About a third of the course will cover topics in formal languages/computing theory such as reductions, NP, NP-Completeness, the language hierarchy, classical undecidability results, and the like. The remaining two-thirds of the course shall focus on two notions of recent advances in algorithms: parallel algorithms, and randomized algorithms.

In the case of parallel algorithms, focus will be on algorithm design and problem solving using the PRAM model. Classical PRAM algorithm design techniques such as binary tree based computations, accelerated cascading, divide and conquer will be covered. Also included in the coverage are PRAM algorithms for lists, trees, and graphs.

Course Topics: Basic concepts in randomized algorithms will be covered with applications to parallel algorithms. Topics covered include tail inequalities, independence, application to symmetry breaking and the like. Computing theory: Reductions, NP and NP-completeness, Language hierarchy, recursive/recursively enumerable, Undecidability. Parallel Algorithms: Models of computation and Flynn's taxonomy including SIMD and MIMD; Design paradigms including divide and conquer, binary tree based computations, accelerated cascading; and the like; Parallel algorithms for lists and trees : list ranking, tree traversal and evaluation; Parallel graph algorithms: connected components, matrix based computations. Randomized Algorithms: Tail inequalities including Chernoff bounds; Examples for parallel/distributed symmetry breaking, Luby's algorithm, graph coloring; Online algorithms for paging.

Preferred Text Books: 1) Introduction to Parallel Algorithms, J. JaJa. 2) Randomized Algorithms, by R. Motwani and P. Raghavan. 3) Introduction to the Theory of Computation, M. Sipser, 2nd edition.

Outcome: At the end of the course, a student shall be able to understand the implications of parallelism in problem solving, design parallel algorithms, and also reason about the efficiency of the same.

TITLE : Digital Image Processing

Course Code : CSE 478/ECE478

CREDITS : 4

TYPE-WHEN : Monsoon 2019

FACULTY NAME : S. Ravi Kiran

PRE-REQUISITE : Not anything in particular but knowing basic matlab and basic linear algebra might help you in the course.

OBJECTIVE : Digital images are now everywhere, capturing particles at the scale of few nanometers to galaxies with size of several light years. Not just that, with the revolutionary spread of smart phones, now you find a camera almost in every pocket. It is not difficult to argue that there is no limit to the useful possible applications, which could be built by harnessing the information contained in these captured images.

So, if you are excited to work with images, this course is for you. The course will explain how images are stored in a computer (any digital machine) and how they can be processed to retrieve important information or to facilitate the visualization process. The course will cover applications like retouching personal photos, enhancement of astronomical and medical images, biometrics, special effects in movies, detecting edges and contours, image compression etc. The goal of the course is to impart strong fundamentals in image processing algorithms, covering both the theoretical and coding aspects. This course is also a building block for understanding more advanced computer vision techniques.

COURSE TOPICS :

(please list the order in which they will be covered)

1. Introduction (Exposure to wide range of imaging applications)
2. Image enhancement in spatial domain (intensity transforms, histogram processing, spatial filtering etc.)
3. Image enhancement by transformation to a different space (fourier transform, wavelet transform etc.)
4. Color Image Processing
5. Morphological Image Processing
6. Feature representation and description (point, line, edge, corner, SIFT)
7. Image compression
8. Some basics on image segmentation and object detection

PREFERRED TEXT BOOKS: Digital Image Processing (Gonzalez and Woods, 2nd and 3rd edition), Fundamentals of Digital Image Processing (Anil K. Jain).

***REFERENCE BOOKS:** Digital Image Processing (Gonzalez and Woods, 2nd and 3rd edition)

*PROJECT: The course will include a final project

GRADING:

55% theory (30% for two mid semester exams and 25% for end semester exam)

45% practice (20% marks on assignments and 25% for final project)

OUTCOME:

1) Understand how images are stored and represented in digital machines

2) Understand how image are processed by discrete, linear, time-invariant systems

3) Understand how images can be transformed and edited in different spaces (Fourier, DCT, Haar)

4) Understand how color is represented in images

5) Understand transformation from RGB to other color spaces and respective applications

6) Understand how images can be enhanced to improve subjective perception

7) Understand variety of filters for noise removal and restoration of images

8) Experiment how storage space for images can be significantly reduced without noticeable perceptual differences

9) Understand how videos are stored and how they can be processed

10) Understand morphological operations

11) Understand how salient points in image can be detected and represented (with applications like image stitching, object detection etc)

12) Discover variety of modern applications in image and video processing

13) Understand theoretical aspects of image processing algorithms (to understand research papers and implement them)

14) Gain hand on experience in developing image processing algorithms

15) Get initiated towards higher-level computer vision tasks

REMARKS:

Get ready with your laptops, we will have a lot of fun.

TITLE : Database Systems

Course Code : CSE441

CREDITS : 4

TYPE-WHEN : Monsoon-2019

FACULTY NAME : Vikram Pudi

PRE-REQUISITE : Students should have knowledge of SQL, database design and operating systems, programming language, algorithms.

OBJECTIVE : Databases have become essential part of every business. A database system can be used to manage large amounts of data in a persistent manner. The objective of this course is to study the methods that have been evolved over several decades to build database systems or database management systems software in a focused manner which include storage management, index management, query processing, recovery management and transaction management.

COURSE TOPICS

Introduction (3 hours); Data storage (3 hours); Representing data elements (3 hours); Index structures (3 hours); Multidimensional indexes (6 hours); Query execution (6 hours); The query compiler (6 hours); Coping with system failures (3 hours); Concurrency control (6 hours); More about transaction management (6 hours)

PREFERRED TEXT BOOKS:

1. Database System Implementation, Hector Garcia-Molina, Jeffrey D. Ullman and Jennifer Widon, Pearson Education, 2003

OTHER TEXT BOOKS:

2. Elmasri & Navathe, Fundamentals of Database Systems, Pearson Education, 5th Education.
3. Raghu Ramakrishnan and Johannes Gehrke, Database Management Systems, Third edition, Mc Graw Hill, 2003.
4. Abraham Silberschatz, Henry F.Korth, S.Sudarshan, Database system concepts, fifth edition, Mc Graw Hill, 2006.

PROJECT:

A practical project on indexing, query optimization, and transaction management will be given. The project will be evaluated.

GRADING:

PROJECT and Assignments: 30%; MIDSEM: 30%; ENDSEM: 40%

OUTCOME:

The course will help the students in understanding the fundamental concepts of several database management systems like ORACLE, DB2, SYBASE and so on. Also, the students will understand the solutions/options to interesting problems which have been encountered by the designers of preceding DBMSs. Most important, the students will be exposed to internal design of DBMSs and able to tune the DBMSs to meet the performance demands of diverse applications.

TITLE : Distributed Systems

CREDITS : 4

FACULTY NAME : R. Govindarajulu

Foundations: Characterizations of Distributed Systems

System Models

Networking and Internetworking

Inter-process Communication

Logical Time:

A framework for a system of logical clocks

Scalar time, vector time and efficient implementation of vector clocks

Synchronization of physical clocks. NTP

Global state and snapshot recording algorithms:

System model and definition

Snapshot algorithms for FIFO channels

Middleware:

Distributed objects and RMI

Termination Detection:

Termination detection using distributed snapshots

A spanning-tree-based termination detection algorithms

Distributed mutual exclusion algorithms:

Lamport‘s algorithm, Ricart-Agarwala Algoritm

Sughal‘s dynamic information – Structure Algorithm

Quorum-based mutual exclusion Alogorithm

Maekawa‘s Algorithm

Deadlock detection in Distributed Systems:

Models of deadlocks, Knapp‘s classification of distributed deadlock detection algorithms. Mitchell and Merrit‘s

algorithm for single resource model

Consensus and agreement algorithm:

Problem definition. Agreement in a failure-free system (synchronous or asynchronous). Agreement in (messagepassing)

synchronous system with failures. Agreement in asynchronous message passing systems with failures.

The syllabus includes the following topics:
- RPC, Google protobufs
- Logical clocks, vector clocks, generalized clocks
- Totally ordered multicase
- Mutual exclusion, leader election algorithms
- Deadlock detection/prevention algorithms
- Consensus algorithm, Paxos (possibly Raft)
- Consistency, eventual consistency, monotonic reads, read your writes, etc
- Failure modes, types of failures
- Distributed transactions, 2 phase commit, 3 phase commit
- CAP theorem
- Apache HDFS, MapReduce
- Google BigTable
- Amazon Dynamo DB
- Kafka

Grading:

Mid-1: 15%
Final: 40%
Assignment-1: 5% (Compare Google Protobuf with JSON for serialization)
Assignment-2: 10% (Gossip protocol)
Assignment-3: 30% (Lab project, groups of 2. Implement MapReduce)

Reference Books

1) Ajay D. Kshemkalyani and Mukesh Singhal, —Distributed Computing Principles, Algorithms and

System‖, Cambridge University Press 2008.

2) Sukumar Ghosh, —Distributed Systems – An Algorithmic Approach‖, Chapman & Hall ICRC,

2007.

3) M. L. Liu, —Distributed Computing Principles and Applications‖, Pearson, 2004.

4) George Coulouris, Jean Dollimore, Tim Kindberg and Gordon Blair, —Distributed Systems Concepts and Design‖, Fifth Edition, Pearson 2011.

5) Mukesh Singhal and Niranjan G. Shivaratri, —Advanced Concepts in Operating Systems‖, TMH, 1994, 2010.

TITLE :Data Analytics I

Course Code :

CREDITS : (4)3-1-1-4

TYPE-WHEN :Bouquet Core for CSE, Offered in 5th semester.

FACULTY NAME :DSAC

PRE-REQUISITE :Data and Applications

OBJECTIVE :Theory and practice of data warehousing and data mining techniques and algorithms.

COURSE TOPICS :

Data Mining Process
Data Preprocessing
Data warehouse concepts and design
Frequent Patterns Mining
Classification

Clustering

< will not cover ML type oriented material, including neural networks, and statistical pattern recognition topics>

PREFERRED TEXT BOOKS:

Data Mining : Concepts and Techniques 3rd Edition: Han and Kember,

***REFERENCE BOOKS:**

***PROJECT:**

Compulsory Components:

A group project two students each with following compulsory components on any dataset of their choice.

1. CSV file to the data warehouse
2. Attribute-oriented induction
3. Frequent patterns
4. Classification
5. Clustering
6. Any other data mining exercise of their choice.

GRADING PLAN:

Type of Evaluation	Weightage (in %)
Mid Sem-1 Exam	**ADBI**
Mid Sem-2 Exam	**ADBI**
End Sem Exam	**ADBI**
Assignments	**ADBI**
Project	**At least 40%**
Term Paper	**N/A**

ADBI – As Decided By Instructor

OUTCOME:

A good understanding of theory and practice of data mining concepts and algorithms in a real-world setting.

REMARKS:

A cool first database course.

TITLE : Design for Testability

CREDITS : 3-1-0-4

TYPE-WHEN : Monsoon 2019

FACULTY NAME : TBD

PRE-REQUISITE : A course on Digital Circuits (or) B.Tech

OBJECTIVE: To expose the students to the various techniques adopted to make the testing (complicated) of manufactured ICs. To make the students to take care of the testing aspects into account at the design stage itself.

COURSE TOPICS:

1) Introduction: Testing of electronic gadgets, various types of tests, VLSI design flow, role of modeling and simulation in testing.

2) Faults and fault modeling, detection of faults, fault simulation and its applications, functional testing, exhaustive and non-exhaustive testing, automatic testing procedures.

3) Design for testability: Various features are to be incorporated for carrying out testing from input & output pins, scan architecture, board level testing, signature analysis and testing.

4) Built in Self Test (BIST), BIST concepts, text pattern generation, BIST architectures.

5) Testing of Analog and mixed signal ICs, testing of system on chip.

PREFERRED TEXT BOOKS:

1) Miron Abramollici, Mellin A Breur, Arthur D. Friedman, Digital systems, testing and testable design, Jaico publishing house, 2001

2) Stanley L. Hurst, VLSI Testing, Digital and Mixed Analog / Digital Techniques, Institution of Electrical Engineers, 1998, London, United Kingdom.

3) Michael L. Bushnell, Vishwani D. Agarwal, Essentials of Electronic Testing for Digital & Mixed Signal FLSI Circuits, Springer 2000

***REFERENCE BOOKS:**

1. "VLSI Test Principles and Architectures: Design for Testability",Laung-Terng Wang, Cheng-Wen Wu, Xiaoqing Wen

2. "VLSI Testing", Stanley Leonard Hurst

3. "Electronic Design Automation", Laung-Terng Wang, Yao-Wen Chang, Kwang-Ting (Tim) Cheng

4. "System-on-Chip Test Architectures: Nanometer Design for Testability", Laung-Terng Wang, Charles

5. E. Stroud, Nur A. Touba

6. "Testing of Digital Systems", Jha and Gupta

***PROJECT:**

GRADING: 2 Mid Sem Exams 2 x 20 40 2 Surprise Tests 10 Final Examination 50 ---------

Total Marks 100 --------- A > 80 B 70 _ 79 C 60 _ 69 D 50 _ 59 E < 50

OUTCOME:

REMARKS:

TITLE : Distributing Trust and Blockchains
Course Code : CSE512

CREDITS : 3-0-0-4
TYPE-WHEN : Monsoon 2019
FACULTY NAME : Sujit P Gujar

PRE-REQUISITE : Nil

OBJECTIVE :

Bitcoin has made a big leap in alternative to centralized financial systems. It is one of the most impressive technological innovation of 21st century. There are people who believe it is a gold where as there is a section of population who believe this is just a bubble. What is that makes bitcoin so interesting? Answer is its underlying blockchain technology that not only enabled a first successful crypto currency but also many real-world applications through smart contracts. In

this course, we will study about bitcoins, blockchains and smart contracts along with key basic crypto fundamentals.

COURSE TOPICS :

(i) Basic maths (probability theory) and cryptography concepts such as encryption, hashing and Merkel Trees. (Introduction to basic stuff so that course can be self-sufficient).
(ii) What is cryptocurrency? What is bitcoin? How does bitcoin work?
(iii) What is double spending? How it is avoided by proof of work in bitcoins?
(iv) Bitcoin mining: strategies and incentives, and mining pools.
(v) Distributed consensus. Block chain technology.
(vi) Use of block chains to design smart contracts (Ethereum/solidity) and their applications such as secure auction, distributed machine learning, secure crowd sensing etc.
(vii) Other Cryptocurrencies: Altcoins, ZeroCash etc.

PREFERRED TEXT BOOKS:

Bitcoin and Cryptocurrency Technologies, Narayanan, Bonneau, Felten, Miller, Goldfeder, Clark, Princeton University Press 2016

***PROJECT:**
GRADING PLAN:

Type of Evaluation	Weightage (in %)
Mid Sem-1 Exam	**15**
Mid Sem-2 Exam	**15**
End Sem Exam	**-**
Assignments	**10**
Programming Assignments	**25**
Scribes	**5**
Course Participation	**5**
Reading Assignments (2)	**25**

OUTCOME:

In this course the participants will learn about bitcoin, security aspects of bitcoins, how alternate cryptocurrencies are proposed to improve certain aspects. Also, the participants will learn what are key concepts behind block chain technology, how to design smart contracts using block chains, program in solidity. The participants should be able to develop new applications using block chain technology.

REMARKS: The course has multiple aspects varying from implementation and hands on to reading recent research papers in this domain and present it to broader audience.

TITLE **: Environmental Science and Technology**

Course Code **:**

CREDITS **: 4**

TYPE-WHEN **:** Open Elective for UG and PG - Monsoon

FACULTY NAME **:** Rama Chandra Pillutla

PRE-REQUISITE **: Nil**

OBJECTIVE **:** Focus on integrating technology to understand various environmental processes and possible solutions to combat anthropogenic driven environmental degradation and problems.

COURSE TOPICS :

Basic of Environmental Science & Technology: Comprehend environment and its issues Environmental problems and challenges, Environmental Events, Environmental movements

Climate Change: Earth components, Climate system, Climate feedback loops, Climate impact on environment, unexpected climate changes, Climate models.

Co_2, Environmental Stress - Mitigation: Impact on vegetation, carbon sequestration methods – vegetation, ocean and geological sequestration, IPCC, Clean Development Mechanisms.

Environmental Impact Assessment: Procedure, regulations and case studies

Environment and Information technology: Green computation, Green energy, Green engineering and technology, e-waste-disposal mechanism – impact on health

Environmental Legislation & Impact Assessment: Important legislations related with environment; Environmental Auditing; Environmental Ethics

Role of geospatial technology: in assessing environmental degradation

Environmental Economics: Basics of economics, Green accounting- Evolution of process, history, case studies, Accounting of goods and services, Sustainability concepts-weak and strong, Hicksian income concept and green accounting.

PREFERRED TEXT BOOKS:

Khoiyangbam, R.S., and N Gupta. 2012. Introduction to Environmental Sciences. New Delhi: TERI

Y.K Singh 2006. Environmental Science. New Age International (P) Ltd., Publishers

Tery Sloan 2016. Introductory Climate Science; Global Warming Explained. New Age International (P) Ltd., Publishers

Clifford Jones 2015 Global trends and patterns in carbon mitigation.

(all available as e-books)

Reference Books

1. Environmental Science – The natural environment and human impact (1998): A. R. W. Jackson and J. M. Jackson, Longman

2. Environmental Science (2001): S. C. Santra, New Central Book Agency (P) Ltd

3. Environmental Science (6th ed) (1997): Jr. G. T. Miller, Wadsworth Pub. Co.

4. Dimensions of Environmental and Ecological Economics (2005): N. C. Sahu & A. K. Choudhury (Ed), Universities Press

***PROJECT:** Simulation and modeling of environmental processes, development of open source tools related to environmental applications, replication of case studies or working on new problem.

GRADING PLAN:

Type of Evaluation	Weightage (in %)
Quiz	**10**
Mid Sem-1	**20**
End Sem Exam	**30**
Assignments	**15**
Project	**25**

OUTCOME:

Understanding various environmental issues of concern

Identify and evaluate environmental technologies

Comprehend green accounting and evaluation methods for ecosystem goods and services

Implications of IT to combat emerging environmental problems

TITLE : Eco-Informatics

Course Code :

CREDITS : **4**

TYPE-WHEN : CS Elective for UG and PG - Monsoon

FACULTY NAME: Rama Chandra Pillutla

PRE-REQUISITE : Nil

OBJECTIVE : Application of computational techniques in understanding, ecological processes related to resource management, spatial distribution and modeling

COURSE TOPICS :

Ecological Informatics: An Introduction

Ecology: Basic concepts of ecology; Intro on Geographical ecology

Ecological Applications of Qualitative reasoning, fuzzy logic, unsupervised ANN, Genetic Algorithms, Evolutionary computation, adaptive agents to current ecological management issues. – Case studies

Spatial Ecology- Pattern and Processes: Basics of geospatial technology, models and application

Ecological modeling – Theory and Models in ecology, Resource Management, Case studies

Other topics: Biodiversity informatics, Wetland informatics, Agro informatics, Forest informatics.

PREFERRED TEXT BOOKS:

Friedrich Recknagel (2003) Ecological Informatics Understanding Ecology by Biologically-Inspired Computation. ISBN 978-3-662-05152-8 ISBN 978-3-662-05150-4 (eBook)
Friedrich Recknagel (2006) Ecological Informatics Scope, Techniques and Applications DOI 10.1007/978-3-662-05150
Wen-Jun Zhang. (2012) Ecological modeling .ISBN 978-1-62417-275-5 (eBook). Published by Nova Science Publishers, Inc. † New York
Virginia H. Dale. (2003) Ecological modeling for resource management. ISBN 0-387-95493-7. Springer-Verlag New York Berlin Heidelberg

***PROJECT:** Simulation and modeling of ecological processes, development of open source tools related to ecological applications, replication of case studies.

Type of Evaluation	Weightage (in %)

GRADING PLAN:

Quiz	**10**
Mid Sem-1	**20**
End Sem Exam	**30**
Assignments	**15**
Project	**25**

OUTCOME:

Integrating ecology and informatics in understanding and forecasting ecosystem functioning and processes. Comprehend concepts and tools for analysis and synthesis of ecological data.

TITLE : Finite Element Method

CREDITS : 4

TYPE-WHEN : Monsoon Semester

FACULTY NAME : Venkateswarlu M

PRE-REQUISITE : Calculus and Linear Algebra

OBJECTIVE: Solution of differential equations byFinite Element Method and its application to heat conduction and elasticity problems..

COURSE TOPICS: Introduction - Strong and Weak forms for one dimensional heat conduction and elasticity problems – Finite Element Formulation for one dimensional problems, shape functions, Finite Element Equations, Examples, numerical Integration – Mathematical Preliminaries, Green's theorem, Divergence theorem – Scalar Field Problems, Strong and weak forms for two dimensional heat conduction, Three Node Triangular Elements, four node rectangular elements, iso-parametric elements, four node quadrilateral element, numerical integration, higher order elements – Multi dimensional elasticity, strain tensor, stress tensor, constitutive law, coordinate transformations, strong form , weak form, finite element formulation, iso-parametric finite elements - Structural Mechanics, beams, Euler-Bernoulli beam theory, strong and weak forms, finite element formulation, coordinate transformations, Timoshenko beam theory, plane truss, plane frame.

PREFERRED TEXT BOOKS: Finite Element Method by Kwon

***REFERENCE BOOKS:**Finite Element Method by S.S.Rao, Finite Element method by JN Reddy

***PROJECT:**

GRADING:

40 marks : Assignments (8)

30 marks : Mid-Semester Exams (2)

30 marks : End-Semester Exams (1)

OUTCOME: Student will get a basic understanding of the use of Finite Element Method in heat conduction and elasticity problems and will enable him to pursue its other applications.

REMARKS:

TITLE : Game Design and Engineering
Course Code : CSE464
CREDITS : 4
TYPE-WHEN : Monsoon 2019
FACULTY NAME : Kavita Vemuri
PRE-REQUISITE : None
OBJECTIVE : The course introduces aspects fundamental to game design, genres, technology analysis and development for market. The course gives equal emphasis to digital, board and physical games.
COURSE TOPICS : This course is designed to introduce the critical aspects of games design and development. Students will go through a structured process involving theory and practical classes to understand game development. Equal emphasis is given to non-virtual or digital games including board games, electronic games like rhythm mat and/or games that require physical devices. The main goal is to get create patentable ideas. The theory classes will cover aspects like theme, narrative, technology(single player versus multiplayer, managing data, rendering etc.,), game play, player experience, material analysis in the case of physical games, marketing and animation. In game play, basics like game engine (digital) and game logic models will also covered. Experts from industry will cover animation and certain topics in marketing. In the lab class, the teams will huddle to conceptualize the idea, structure the game design documents, present their ideas and finalize technology issues. The secondary or even primary goal in some cases is to use of CAD/CAM like tools to come up with schematics of any physical implement required for the game and actually solder, cut, fabricate and paint ….

Syllabus (theory classes)

1. What is a game?
- Games Overview - A Theory of Fun; History of Games.
- History of Computer Games

2. What are the elements of a game?
In this part, we cover the elements of a game, with emphasis on the four major ones. Case studies of g ames in which one or more of these elements have made the game will be analysed.
- Mechanics: rules & procedures of the game.
- Story: events that bind the game together.
- Aesthetics: game's look, feel and sounds.
- Technology: high-technology to materials (paper, sensors, wood etc.,)

3. Principles of Game Design:
-Layers of Game Design
- Design Issues
- Preproduction and Documentation
- Design Trade Offs
- Poor Design
End of this part, the Game Design Document is prepared.

3. Who is the player?
- Game Genre and player
- Cutting through the noise from player (likes, dislikes...)

4. What is player's experience?
- measuring player's experience
- Cognitive behavior measurement techniques
Understanding and measuring player's experiences during game play is an important test for optimal game designs. Player's experiences are recorded by many techniques. This part will analyze each of the technique and the value addition of each. Some experimental work will be required using tools like simple EEG, ECG/GSR and eye tracking.

5. How to design game mechanics?
- Decision-making, types of decisions
- Flow theory.
- Special dynamics: feedback loops, emergence and intentionality

6. What's game interface?
- User Interface design.
- Differences between digital and non-digital UI.
- User Interface iteration

7. How to create a game script/story?
- Linear & Nonlinear storytelling

8. Building a game with technologies

-Analysis of game engines (Unity, XNA)
- AI versus HI in game development.
- Computer graphics & animation
- Physics engine –collision detection

9. Testing a game.
- Solo testing.
- Critical analysis
- Designer testing.
- Player testing

10. Marketing the game

11. Ethics, Culture, Violence in Games and Responsibilities

PREFERRED TEXT BOOKS:
1. The Art of Game Design, Jesse Schell, 2008. 2. Challenges for Game Designers, Brenda Brathwaite
***REFERENCE BOOKS:**
1. Characteristics of Games, Elias, Garfield, and Gutschera, 2012, MIT Press
2. Game Design and Development: Introduction to the Game Industry. Moore, Michael.
Reference papers on serious games, board games, swarm/biological behavior, cognition and games etc.,
***PROJECT:**
Each team of 3 will conceptualize, design, prototype and test 2 unique games .
Number of Project: 2
P1: Design and prototype a board game that explains a concept. This can be trading, friendship, education, jobs, global trade, social media etc., think on the lines of games like monopoly, go, chess etc., Use readily available material to make the prototype. Game play, rules and player demographics will make up your report.

P2: Design and develop/engineer a game virtual or live-action game that can be used for physical
therapy. Virtual game – for carpal tunnel syndrome (look up the web for this occupational hazard). Liveaction game: which can help people exercise their lower back (a major issue with people who sit for long hours)? Materials for the virtual game can include Kinnect or joy sticks. Interfaces need be assembled. For the live-action, raw materials which are readily available need to be used and also fabrication like injection molding should be avoided. Sensors can be used, if electronic games are selected.

GRADING:
Game ideas (15%), Mid-term (25%), Assignments (15%), projects (50%).
OUTCOME:

At least couple of design patents. Selected games ideas to the annual Game Developer Conference, transfer/license and most importantly connecting theory to practice/real product

REMARKS:

The course requires a lot lab type of work. Considering that animation experts and animators are not available, some creativity is encouraged to create avatars, characters for the digital games and layouts for the physical games. Half of the class hours will be in a lab room or work space. This space will be kept open throughout the semester for students to work at any time.

TITLE **: Hydrological modelling and Software development**

Course Code **:**

CREDITS **: 4**

TYPE-WHEN **:** Open Engineering Elective - Monsoon

FACULTY NAME **:** Shaik Rehana

PRE-REQUISITE **: Nil**

OBJECTIVE **:**To develop a detailed understanding aboutwater resources systems and various modelling techniques involved to study water quantity, quality and demands. Development and real-world application of various water resources software technologies, information and decision support systems.

COURSE TOPICS **:**

- **Introduction:**fundamentals of fluid mechanics and open channel flows; hydrology, rainfall and runoff processes andhydro-climatology.
- **Water Resources Systems**:river basin and urban hydrology, river water quality modelling, flood and drought management,irrigation and reservoir operation and climate change.
- **Technologies and Software**: Open source public domain software based on Microsoft Windows environment: US Environmental Protection Agency'sEPANET, Qual2k, SWMM;MatlabTools: Air2stream; Windows based decision support system: WEAP
- **Development and Application of Software**:Real-world applications at various scales for waterresources management

PREFERRED TEXT BOOKS:

- Subrahmanya, K., 2008, Engineering Hydrology, Tata Mc Graw Hill Pub. Co., New Delhi.
- Chow, V. T., Maidment and Mays, L. A., 2010, Applied Hydrology, Tata Mc Graw Hill Pub. Co., New York.
- Haan T. C., *Statistical Methods in Hydrology*, East West Publishers, 1998.

- SK Som and G Biswas, Introduction to Fluid Mechanics and Fluid Machines

GRADING PLAN:

Type of Evaluation	Weightage (in %)
Mid Sem-1 and 2 Exams	**30**
End Sem Exam	**30**
Assignments	**15**
Project/Assignments	**25**

OUTCOME:

Integrating wind induced responses in the design of various structures such as tunnels, tall buildings etc.

TITLE **: Introduction to Sociology**
Course Code **: HSS368**
CREDITS **:** Four
TYPE-WHEN **:** Monsoon 2019
FACULTY NAME **:** Radhika Krishnan

PRE-REQUISITE **: UG 3, UG 4**
OBJECTIVE **:** This course aims to introduce students to basic concepts and theories in the field of sociology, while briefly discussing various sociological methods. It will introduce students to sociological approaches to various social institutions such as caste, class, tribe, family, religion and gender. It will also touch upon sociological approaches to politics, urbanisation, industrialisation, development and ecology.

COURSE TOPICS:
(1) Sociological concepts
(2) Sociological methods
(3) Study of social institutions in India
(4) Sociology of Politics, urbanisation, industrialisation and development

PREFERRED TEXT BOOKS:
Anthony Giddens, *Sociology* (Malden: Polity Press, 2009).

***REFERENCE BOOKS:**
Alpa Shah, *In the Shadows of the State: Indigenous Politics, Environmentalism, and Insurgency in Jharkhand, India* (Durham, NC: Duke University Press, 2010).

Carol Upadhyay, *Reengineering India: Work, capital, and class in an offshore economy* (Delhi: Oxford University Press, 2016).
Friedrich Engels, *The origin of the family, private property and the State* (New Delhi: Penguin, 2010).
Gail Omvedt, *Dalit Visions: the Anticaste movement and Indian Cultural Identity* (New Delhi: Orient Blackswan, 2006).
Indu Banga (ed.), *City in Indian history* (New Delhi: Manohar, 1991).
M.N. Srinivas, *Social Change in Modern India* (New Delhi: Orient Longman, 1985).
Nivedita Menon (ed.), *Gender and Politics in India* (New Delhi: Oxford University Press: 2001).
Ramachandra Guha (ed.), *Social Ecology* (New Delhi: Oxford University Press, 1994).
Shilpa Phadke et. al., *Why Loiter: Women and Risk on Mumbai Streets* (New Delhi: Penguin, 2011).
Uma Ramaswamy, *Work, Union and Community: Industrial man in South India* (Delhi: Oxford University Press, 1983).

***REFERENCE ARTICLES:**

Will be shared with students during the course of the semester. Each module in this course will have a reference reading list which can be used by students.

***PROJECT:** None.

GRADING PLAN:

Type of Evaluation	Weightage (in %)
Mid Sem-1 Exam	**20%**
Mid Sem-2 Exam	**20%**
End Sem Exam	**40%**
Assignments	
Project	
Term Paper (In Lieu of Mid Sem-1)	
Other Evaluation (Term Paper and Presentation)	**20%**

OUTCOME: The student will get an overview of theories, concepts and methods in Sociology. The lectures, discussions, readings and projects will enable the student to relate to contemporary debates and to engage with the complexity of contemporary Indian society. Apart from understanding various social institutions in India, s/he will grapple with modern

sociological concerns related to gender, the urban space, industrialization and the ecological contradictions of development.

REMARKS: The course will be based on lectures and the students will be expected to read the material mentioned in the reading list.

HSS343a **Introduction to History** **3-1-0-4**

TYPE-WHEN : Humanities Elective, Monsoon 2019

FACULTY NAME: Aniket Alam

PRE-REQUISITE:

ObJective : This course intends to introduce the non-historian student to the discipline of history and equip him/her with some ideas of how to look at the contemporary world with a historical perspective.

COURSE TOPICS:(1) Development of the ideas of memory, past and history;
(2) Conception of time;
(3) Making of the modern discipline of history;
(4) The main theories of history;
(5) The main methods of history.

PREFERRED TEXT BOOKS: E. H. Carr: *What is History*.
Marc Bloch, *The Historian's Craft*.

***REFERENCE BOOKS:** Romila Thapar, *Time as a Metaphor of History: Early India*.
Bernard S. Cohen, "History and Anthropology: The State of Play". Chapter in *An Anthropologist among the Historians and Other Essays*.

Ranajit Guha, "On Some Aspects of the Historiography of Colonial India". Chapter one in *Subaltern Studies* Vol 1.
Mircea Eliade, *The Myth of the Eternal Return: Cosmos and History*.

***PROJECT:** Written analysis of either one film or novel or a contemporary news event using historical methods.

GRADING PLAN:

Type of Evaluation	Weightage (in %)
Mid Sem-1 Exam	**20%**
Mid Sem-2 Exam	**20%**
End Sem Exam	**40%**
Assignments	
Project	**20%**
Term Paper	
Other Evaluation _____	

OUTCOME: The student will be able to identify the main theories and methods of the discipline of history. S/he will also be use some of these to understand and explain contemporary events.

REMARKS: The course will be divided into two parts. Part One will consist of lectures and readings which will introduce the students to the readings and also give information about the main theories and theoreticians of history. The readings will total about 250 printed pages. Part Two will consist of class discussions and group presentations, based on analysing films, novels and contemporary new reports using ideas and methods learnt in part one.

HSS351a **Introduction to Psychology** **3-1-0-4**

Type when: Monsoon 2019

Faculty Name: Priyanka Srivastava

Pre-requisite: None

Course Topics:

Objective: The aim of the course is to introduce various research-driven topics in psychological science. This course will help you understand how we perceive, think, feel and act, both as an individual as well as a social-cultural being. Emphasizing the role of critical thinking, empirical investigation and research design in psychology, this course will specifically highlight how psychological phenomena and processes are scientifically investigated.

Topics:

1. **Introduction to Psychology**
2. **The Matter of the Mind**
3. **Evolutionary Psychology**
4. **Human Development**
5. **Sensation, Perception, Attention, and Awareness**
6. **Consciousness**
7. **Learning**
8. **Memory**
9. **The Social Mind**
10. **Motivation and Emotion**
11. **Stress, Coping, and Health**

Books:

1. **Psychology: from Inquiry to Understanding, 3ed. 2014., by Lilienfeld, Lynn, Namy, & Woolf.**

Teaching approach: The course will be lecture cum seminar course. Students will be introduced to undergraduate-level introductory topics and issues in psychology. Relevant lecture videos and reading material will be provided before each topic.

In this course, we'll use online lectures from active scientists in the field of Psychological Sciences from MIT and University of Toronto. I have planned to follow MIT and Coursera, Introduction to Psychology Course for lectures, followed by twice a week active discussions in our scheduled classes. Mostly the lectures will be considered from Coursera videos on Introduction to Psychology by Prof. Joordens, except topic 10 and 11, which will be covered from MIT opencourseware (OCW) by Prof. Gabrielli.

To ensure the participation of each student, each student will be given a chance to briefly talk about the topic based on the assigned readings. Each student will be required to do at least one presentation.

Assignments: This exercise will consist of two brief write-ups (about 1000-1500 words) about psychological phenomena that will be assigned to them based on our everyday experiences. For instance, some of the questions will be as following:

1. How media affect the way we think? 2. Do we freely choose our actions or are they determined beforehand by factors beyond our awareness and control? 3. How our brain sculpted? 4. How do we develop an attitude about people, things, and events? 5. How your behavior get shaped? 6. Are there laws of perception?

The purpose of the assignment is to evaluate the conceptual mapping of the everyday phenomenon to psychological investigation and scope of generalization. This exercise will involve critically review of peer-reviewed journal articles and/or book chapters and state their position in reference to the topic assigned to them. General feedback will be given to students after evaluation.

Project: In this exercise students will be required to conduct an empirical study to understand the psychological phenomena or processes by employing the research methods used in psychological sciences. Students will be encouraged to replicate the classic psychological studies and get mesmerized with similar / contradictory findings ☺

Grading:

1. Assignments: 20%
    a. Brief Write up (10%)
    b. Class presentations (5%)
    c. Peer review (5%)
2. Quizzes 10%
3. Mid-Term II – 20%
4. Final Term – 20%
5. Project – 30%
    a. Project ideas (10%)
    b. Conducting study (10%)
    c. Final report and presentation (10%)

Outcome: By the end of the course students will be able to:

1. understand the research issues in Psychological Science
2. conduct an empirical investigation, by employing experimental or non-experimental approach and result interpretation

Remarks:

Maximum number: 35-40 students

Online Courses Link – massive open online courses

1. Coursera – Prof. Steve Joordens, Univesity of Toronto, Ontorio, Canada (https://class.coursera.org/intropsych-001)
2. CMU – Open Learning Initiative – Prof. … with Norma Bier director of OLI group.
3. Yale University – Prof. Paul Bloom , Lectures available on Youtube. (https://www.youtube.com/playlist?list=PL6A08EB4EEFF3E91F&feature=plcp)
4. MIT – Prof. John Gabrieli (http://ocw.mit.edu/courses/brain-and-cognitive-sciences/9-00sc-introduction-to-psychology-fall-2011/index.htm)
5. edX – Dr. Janeen Graham (https://courses.edx.org/courses/course-v1:SMES+PSYCH101x+2T2015/courseware/f3763236185c4c41ac182ad823e70b64/5e6428fae8ed446ba4ca1f07f80bc9c1/)

TITLE : Introduction to Cognitive Science

Course Code : CSE 485

Note: Please use course code for previously existing course

CREDITS : 4

TYPE-WHEN : Monsoon Semester (Aug-Dec)

FACULTY NAME : Priyanka Srivastava + Vinoo Alluri

PRE-REQUISITE : None (Open mind, Enthusiasm and Motivation!)

OBJECTIVE: The focus of this course is to understand the relationship between mind and behaviour or brain and behaviour. The objective is to give an appreciation for various Cognitive and Emotional processes that brain/mind sub-serves, what is known currently about these, the experimental methods used in unraveling these processes and finally some Philosophical and theoretical issues related to Mind and Consciousness. This is the first course in Cognitive Science that prepares the ground for students so that they can take other courses that focus on Computational / Mathematical Models, more detailed issues related to Cognitive Neuroscience, applications in Human-Computer Interaction, Neuroimaging Methods, etc. Apart from understanding the principles of Cognitive Science, the course requires students to actually

conduct experiments on human subjects to study any one of the topics covered in the class as part of the Project.

COURSE TOPICS: Introduction, History of Cognitive Science, Basics of Human Brain Anatomy, Learning and Development, Movement and Action, Vision and Attention, Auditory processes, Memory, Reasoning and Decision Making, Emotion, Language and Speech, Cognitive Disorders, Basic issues in Philosophy of Mind and Consciousness.

PREFERRED TEXT BOOKS: (PDF copies of material from the following will be made available for reading) Berm□ez, J. L. (2010). Cognitive Science: An Introduction to the Science of the Mind, Cambridge University Press. Friedenberg, J. and Silverman. G. W. (2006). Cognitive Science: An Introduction to the Study of Mind, Sage Publications (First Edition) Kandel, E.R., Schwartz, J. H., Jessell,

T. M., Siegelbaum, S. A., Hudspeth, A. J. (2012). Principles of Neural Science, (Fifth Edition), McGraw Hill.

***REFERENCE BOOKS:** Bechtel, W., & Graham, G. (Eds.). (1998). A Companion to Cognitive Science. Malden, MA: Blackwell. Gazzaniga, M., Ivry, R. B., & Mangun, G. R. (2002). Cognitive neuroscience: the biology of the mind. Cambridge: MIT press. Thagard, P. (2005). Mind: Introduction to Cognitive Science, Cambridge, MA: MIT Press. Marr, D. C. (1982). Vision: A Computational Investigation into the Human Representation and Processing of Visual Information. San Francisco: W. H. Freeman. Searle, John R. (2005). Mind: A Brief Introduction (Fundamentals of Philosophy Series), Oxford University Press.

***PROJECT:** Students will be assigned projects where small groups have to take up one topic from the course topics. The group will design and conduct experiments on human subjects and then process /analyze and interpret the data collected from the experiments. Performance assessment will be based on Group presentation, Viva and a Final report submission.

GRADING (indicative only): Mid-term Exams (2): 30% Final Exam: 40% Project: 20% Quizzes, Assignments, Class Attendance and Participation: 10%

OUTCOME: At the end of the course, students will have an appreciation of the principles of Cognitive Science and theoretical issues related to Mind and Consciousness. It is expected that students would acquire both the knowledge of the state-of-the-art in Cognitive Science and also

practical experience and appreciation of how empirical studies are conducted to investigate human behaviour.

REMARKS:

Title: Introduction to Philosophy: God, Knowledge and Consciousness

Credits: 4

Type-When: This is based on EdX course:
https://www.edx.org/course/introduction-philosophy-god-knowledge-mitx-24-00x
Students have to register at the above link to download study material for a self-study and attend a group discussion session once a week for 1.5 hrs.
Evaluations will be done by the course instructor and **not** EdX.
Monsoon 2019

Faculty : Nishad Patnaik

Pre Requisite: none

Objective: This course will look at some perennial philosophical problems: Is there a God? What is knowledge, and how do we get it? What is the place of our consciousness in the physical world? As this course is meant to develop self-learning, it is not lecture-based. This course will be carried out by having discussions and writing assignments as well as term paper. This will help to develop the critical reasoning and argumentative skills more generally.

Course topics and related readings

Part 1: God

Week 01

Meeting 1: Introduction (For God: The Ontological Argument)

Meeting 2: Assessing Arguments

Week 02

Meeting 3: For God: We See Design

Meeting 4: Against God: The Problem of Evil

Week 03

Meeting 5: For God: Pascal's Wager

Part 2: Knowledge and Justified Belief

Week 04

Meeting 6: What is Knowledge?

Meeting 7: SkepticismAbout Knowledge

Week 05

Meeting 8: SkepticismAbout Justified Belief, Part 1: The Old Problem of Induction

Meeting 9: SkepticismAbout Justified Belief, Part 2: The New Problem of Induction

Part 3: Mind and Consciousness

Week 06

Meeting 10: How Things Feel

Meeting 11: Science Strikes Back

Week 07

Meeting 12: Thinking Machines

Part 4: Free Will

Week 08

Meeting 13: Free Will and Determinism

Meeting 14: Freedom Without Alternatives

Week 09

Meeting 15: A Compatibalist Theory of Free Will

Part 5: Personal Identity

Week 10

Meeting 16: The Psychological Criterion of Personal Identity Over Time I

Meeting 17: The Psychological Criterion of Personal Identity Over Time II

Grading:

Assignments = 20%

Discussion group participation = 30%

Term paper 20%

Final exam = 30%

HSS345a **Introduction to Shakespeare** **3-1-0- 4**

TYPE-WHEN : Monsoon 2019

FACULTY NAME: Aruna Chaluvadi

PRE-REQUISITE : 3rd and 4th year students
OBJECTIVE : To introduce Shakespeare through critical readings from his Plays and Sonnets

COURSE TOPICS :

Reading with Explanation : Romeo and Juliet
: King Lear
: Henry IV

General Introduction (Movies) : Othello, Hamlet, Macbeth, Julius Caesar, The Merchant of Venice, The Taming of the Shrew

Sonnets: Explanation and Recitation
PREFERRED TEXT BOOKS:

***REFERENCE BOOKS:**

***PROJECT:**

GRADING PLAN:

Type of Evaluation	Weightage (in %)
Mid Sem-1 Exam	**20%**
Mid Sem-2 Exam	**20%**
End Sem Exam	**40%**
Assignment : Characters and Contexts	**10%**

in Shakespeare (Presentation)	
Surprize Quiz	**10%**

OUTCOME: Introduction to Shakespeare; Students would be able to read and appreciate Shakespeare on their own.

REMARKS

TITLE : Information Theory and Coding

Course Code : ECE437

CREDITS : 3-1-0-4

TYPE-WHEN : Aug-Dec (monsoon) 2019

FACULTY NAME : Lalitha V

PRE-REQUISITE : Basics of probability theory are a must

OBJECTIVE : To introduce students to the basics of information theory, which establishes the limits of communication and data compression.

COURSE TOPICS :

1. Motivation for digital communication and information theory, Probability overview.
2. Source Coding - Entropy and its properties, Relative entropy, Mutual information, Huffman codes and optimality, Asymptotic Equipartition Property and Typical set based source coding.
3. Channel coding - Channel capacity motivation and definition, Discrete memoryless channel, Channel coding theorem for DMC- achievability and converse.
4. Gaussian channel - Differential entropy, Gaussian channel with power limitation, Gaussian channel coding theorem and converse.
5. Error control coding - Goals, Block codes and bounds, Repetition Hamming code, Convolutional codes, Viterbi hard decision decoding.

TEXT:

1. “Elements of Information Theory”, Thomas Cover and Joy Thomas.
2. “Error Control Coding” Shu Lin and Costello.

REFERENCES

1. “Information theory”, Robert Ash.
2. “Information Theory, Inference and learning algorithms”, David McKay (available online)
3. “Error Correction Coding”, Todd K Moon.
4. “Stochastic Processes”, Sheldon M Ross.
5. “Introduction to Probability”, Bertsekas and Tsitsiklis (Available online).
6. “Principles of Digital Communications”, by Robert Gallager (Lecture notes available online).

TITLE : Information Retrieval and Extraction

CREDITS : 3-1-0-4

Course Code: CSE474

TYPE-WHEN : Monsoon-2019

FACULTY NAME : Vasudeva Varma

PRE-REQUISITE:

OBJECTIVE :

COURSE TOPICS: Search, Information Retrieval, Information Extraction - An Introducion (Function of an IR system, Kinds of IR systems, Components of an IR system, Problems in designing an IR system., The nature of unstructured and semi-structured text). Role of Language Processing in Search, IR and IE, Role of Machine Learning in Search, IR and IE, Modeling documents for IR purpose - Vector model, term weighing, Similarity measures, text collections and issues, Text processing and Indexing Techniques (Preliminary stages of text analysis and document processing, tokenization, stemming, lemmatization, stop words, phrases), Data Structures for IR and IE, distributed and Parallel IR (Advanced Indexing, query expansion, Postings size estimation, merge sort, dynamic indexing, positional indexes, n-gram indexes, Index compression, Web Based Search, Page Ranking, LSI, Evaluation of IR and IE Systems, Ontologies and Categorization, Named Entity Recognition, Personalization, Question Answering, Summarization Cross Lingual Information Retrieval, Other applications and Conclusions,

PREFERRED TEXT BOOKS:

***REFERENCE BOOKS**: 1. Modern Information Retrieval, by R. Baeza-Yates and B. Ribeiro-Neto. 2. Information Retrieval: Algorithms and Heuristics by D. Grossman and O. Frieder

***PROJECT:** There are no home assignments. This is a project Intensive course. Groups will have project

deliverables every alternate week. Project Deliverable: Finalize the project, Preliminary study and requirements Specification document, Architecture and D

GRADING:

Two Mid Semester Exams	(10% each)
End Semester Exam	(20%)
Project with several deliverables	(50%) – Mini Project 20% and major Project 30%
Assignments	(10%)

OUTCOME:

IS Codes on Design and Structural Safety Assessment

TITLE : IS Codes on Design & Structural Safety Assessment

Course Code : CES 611

CREDITS : 3-1-0-4

TYPE-WHEN : Monsoon

FACULTY NAME : R. Pradeep Kumar

PRE-REQUISITE : Reinforced Concrete Design, Strl Analysis, EQE
OBJECTIVE : To understand and interpret the codes and use them in design
COURSE TOPICS :

1. IS 16700-2017: Criteria for Structural Safety of Tall Concrete Buildings (8 classes)
    a. General requirements
    b. Loads and load combinations
    c. Structural analysis of tall buildings
    d. Structural design of tall buildings
    e. Foundations for tall buildings
    f. Non-structural elements in tall buildings
    g. Recommendations for monitoring deformations in tall buildings
2. IS 1893-2016: Criteria for Earthquake Resistant Design of Structures (6 classes)
    a. General principles
    b. Design criteria
    c. Design of buildings
    d. Regular & Irregular buildings
3. IS 13920-2016: Ductile Design & Detailing of RC structures subjected to seismic forces – Code of Practice (5 classes)

    a. General specifications
    b. Beams, Columns & Inclined members
    c. Special Confinement reinforcement
    d. Beam-column joint
    e. Special shear walls
    f. Gravity columns in buildings
4. IS15988-2013: Seismic evaluation & strengthening of existing RC Buildings-Guidelines (5 classes)
    a. Preliminary evaluation
    b. Detailed evaluation
    c. Seismic strengthening

BOOKS:

- IS 16700-2017: Criteria for Structural Safety of Tall Concrete Buildings
- IS 1893-2016: Criteria for Earthquake Resistant Design of Structures
- IS 13920-2016: Ductile Design & Detailing of RC structures subjected to seismic forces – Code of Practice
- IS 456-2000 Plain and Reinforced Concrete - Code of Practice
- IS15988-2013: Seismic evaluation & strengthening of existing RC Buildings-Guidelines

GRADING:

- 50 marks: Assignments (6) + Project (2)
- 20 marks: Mid-Semester Exams (1)
- 30 marks: End-Semester Exam (1)

OUTCOME:

- Student will be confident in interpretation the current version and all future versions of the above codes.

REMARKS: None

TITLE : Mobile Robotics

Course Code : CSE483/ECE483

CREDITS : 4

TYPE-WHEN : Elective-Monsoon

FACULTY NAME : K Madhava Krishna

PRE-REQUISITE : None

OBJECTIVE: The course introduces the student to fair detail on the basic modules for automating a mobile robot such as localization, mapping, navigation, planning and collision avoidance. The course draws upon state of the art practices in probability and statistical methods, optimization techniques and shows how they are dovetailed to a robotics setting. The course has a strong coding and project component in the form of 3 projects wherein the student is expected to simulate and implement the algorithms taught in class.

COURSE TOPICS:

Month 1: Introduction to Path Planning, AI style planning, Kinematics, randomized planning, trajectory optimization, collision avoidance in dynamic environments

Month 2: Kalman and Extended Kalman Filters (EKF), EKF based Localization and SLAM

Month 3 till End: Graph Optimization, Graph SLAM, Occupancy Grid Mapping, Exploration

PREFERRED TEXT BOOKS: Probabilistic Robotics by Wolfram Burgard, Deiter Fox and Sebastian Thrun

***REFERENCE BOOKS:** Research papers uploaded on course portal

*PROJECT: 3 projects

GRADING:

Mid Sem II - (20%)

End Sem - 20%

3 Projects - 20% Each

OUTCOME: The student is expected to be aware of state of the art mobile robotic algorithms and should feel comfortable reading and assimilating state of the art research papers in areas covered in the course/class.

REMARKS:

TITLE **: ML for Natural Sciences**

Course Code **:**

CREDITS **:** 4 credits

TYPE-WHEN **:** Science/CNS elective - Monsoon 2019

FACULTY NAME **:**U. Deva Priyakumar, Girish Verma, C. V. Jawahar, Prabhakar. B, Raghunathan Ramakrishnan (TIFR Hyd) and Vinod PK

PREREQUISITE **:** Statistical methods in AI (additionally Science-I and Science-II for non-CND students)

OBJECTIVE **:** This course will attempt to enable students along with faculty mentors to review the emerging utility of machine learning in natural sciences, and to apply state-of-the-art machine learning methods to solve problems in natural sciences.

COURSE TOPICS **:**

Application of machine learning in the following broad areas:

- Materials discovery
- Molecular design in chemistry and biology
- Higher-dimensional molecular potential energy surfaces
- Molecular simulations
- Bioinformatics

Additionally, lectures by scientists from academia and industry working in these areas.

PREFERRED TEXT BOOKS:

Review papers in the broad areas listed above published during the last three years; recent research articles related to the chosen project. Material will be provided from time to time.

***REFERENCE BOOKS:**

1. Introduction to Computational Chemistry by Frank Jensen

2. Modern Quantum Chemistry by Attila Szabo and Neil Ostlund

***PROJECT:** Major component of this course is a project during the last two-thirds of the semester. Students will form teams of two or three (one from CNS + one from CSE + one from TIFR Hyderabad) to do projects. Each faculty member involved in the course will guide one or two teams with weekly meetings for discussions and assessment of the progress of the projects.

GRADING PLAN:

Grading will be based on literature review and project.

Type of Evaluation	Weightage (%)
(A) Literature review (30%)	
Class participation	10%
Presentation & term paper	20%
(B) Project (70%) - after Midsem-I	
Weekly progress (as assessed by faculty mentor)	20%
Intermediate presentations (once in two weeks)	20%
Final presentation	20%
Final Scientific report	10%

OUTCOME: An understanding of how AI/ML is applied for solving problems in natural sciences, and hand-on experience in problem solving.

REMARKS: This course is being offered on an experimental basis and will be continued to be offered based on the experience after suitable modifications. It is proposed that a limited number of students (6 CSD/CSE Honors + 6 CND + up to 6 early-PhD students from TIFR) will be interviewed and selected for this course.

TITLE : **Natural Language Processing**

Course Code : CSE472

CREDITS : 3-0-1-4

TYPE-WHEN : Monsoon-2018

FACULTY NAME : Manish Srivastava + Rajeev Sangal

PRE-REQUISITE : Intro to NLP

OBJECTIVE : This is the advanced course in Natural Language Processing intended for honors, dual degree, BTP, MTech and PhD students.

COURSE TOPICS : In this course, students get an overview of various areas in NLP and the current research trends in each of them. The topics covered include machine translation (rule based & statistical), discourse, statistical parsing, word sense disambiguation, natural language generation, coreference resolution, semantic role labeling etc.. The course also covers two of the most popular machine learning methods (Expectation-Maximization and Maximum Entropy Models) for NLP. Students would be introduced to tools such as NLTK, CoreNLP to aid them in their research.

***PROJECT:** There will be a mini project and research readings once every alternate week.

TITLE: Number Theory and Cryptology
Course Code: IMA404
CREDITS: 4
TYPE-WHEN: Maths Elective - Monsoon Semester
FACULTY NAME: Rajat Tandon
PRE-REQUISITE: Algebraic properties of the set of Integers and Real Polynomials. A familiarity with the language of modern algebra will help though all concepts will be defined with examples**.**

OBJECTIVE: To introduce undergraduate students with elementary number theory especially useful in cryptography. cryptosystem.

COURSE TOPICS:

1. The set of integers and real polynomials and similar finitesets.
2. Euler's theorem with application to the RSA.
3. The Chinese remainder theorem and Carmichael Numbers.
4. The Legendre symbol and probabilistic tests for determining whether a givennumber input is a prime
5. Pseudoprimes, Euler pseudoprimes and strong pseudoprimes with applications.
6. Elliptic curves with applications to cryptography.

7. A brief history of Fermat's Last Theorem. Its proof for n=3 and 4. A proof ofFermat's Last Theorem for polynomials.

PREFERRED TEXT BOOKS:
N. Koblitz: An introduction to Number Theory and Cryptography.

***REFERENCE BOOKS:** Herstein: Algebra
***PROJECT:**

GRADING PLAN:

Type of Evaluation	Weightage (in %)
Quiz-1	**10**
Mid Sem Exam	**25**
Quiz-2	**10**
End sem Exam	**50**
Assignments	**5**

OUTCOME:

REMARKS: The course will be at the level of any second year undergraduatestudent.

TITLE : **Principles of Programming Languages (PoPL)**

Course Code : CSC415

CREDITS : **4**

TYPE-WHEN : Monsson-2019

FACULTY NAME : Venkatesh Choppella

PRE-REQUISITE : Programming in any programming language.
OBJECTIVE :This course is an introduction to the principles behind the design and interpretation of programming languages. Understanding the abstraction mechanisms in the language and their implementation is key to successfully using the language, i.e., doing programming and understand the behavior of the program. One way is to understand that programs are translated (compiled) into another, lower-level language, which is executed by

hardware. Another way to think of programs and programming languages is that they are mathematical objects. Programming languages draw their foundations from mathematical logic, universal algebra and the theory of computation.

In this course, we take an interesting approach. We build a series of *interpreters*, each a virtual machine for a mini language with specific features. This approach draws from the denotational and the operational formalisms, but couches them in the notation of a programming language, viz., **Scheme**. The bulk of the course will therefore be driven by studying and constructing *definitional interpreters* in Scheme. Using this approach we study standard features of procedural languages like abstract syntax, lexical scoping, stack architectures, parameter passing, environments and store, and also more advanced features like computational effects, continuations, exceptions, and imperative form transformation.

COURSE TOPICS :

(please list the order in which they will be covered)

The role of Programming languages, Syntactic structure – grammars.ImperativeProgramming. Values, types and expressions. Semantic methods. Inductive datatypes and recursive programming, Functional programming – list manipulation, high order functions and currying. Data abstraction and Abstract Data Types. Arithmatic and Algrbricinterpreters. Block structure and lexical environments. Scope and binding.

Procedures and closures. Recursion. Implementing recursion. Dynamic scope. Stores. Computational effects. Explicit and implicit references. Implementing mutation. Expressible and denotable values. Parameter passing – Call by Value, Call by Reference, Call by Name. Lazy evaluation. Introduction to Lambda Calculus.

Tail recursion. Iterative systems. Continuation-passing style (CPS). Converting to CPS. Continuation-passing interpreters. Trampolining. Debugging - Single Stepping and breakpoints. Making control context explicit, Imperative form. Modeling exceptions and threads.

Other Programming Paradigms like logic and object oriented programming. Comparative study of languages.

PREFERRED TEXT BOOKS:
Essentials of Programming Languages (EoPL) by Friedman and Wand. Prentice Hall India.

***REFERENCE BOOKS:**

Programming Languages –Concepts and Constructs by Ravi Sethi

Simply Scheme: Introducing Computer Science by Brian Harvey and Matthew Wright.

***PROJECT:**

GRADING PLAN:

Type of Evaluation	Weightage (in %)
Mid Sem-1 Exam	**20**
Mid Sem-2 Exam	**20**
End Sem Exam	**30**
Assignments	**30**
Project	
Term Paper	
Other Evaluation _____	

OUTCOME:

PoPL is useful because it encourages the student to think about software artefacts as virtual machines, with a well-defined interface (a programming language) and an internal structure consisting of symbolic structures operating according to well-defined rules. With a background in the Principles of Programming Languages, one starts thinking about the quality of a software artefact by relating it to the properties of the virtual machine that is implicitly defined underneath it.

More concretely, a student graduating from a PoPL course should be able to perform each of the following sample tasks:

- Identify and understand the abstract syntax aof any programming language like C or Java
- Design small, domain specific languages from scratch and implement them either as interpreters or embeddings in another language.
- Analyse and critique the design of programming languages like C, C++ or Python.
- Specify the structure of a software application like a spreadsheet or a word processor in terms of its interface as a language of user operations and its internal structure as a virtual machine.

REMARKS:

Course Title Quantum computing for natural sciences

Course Credits 4

Course Type CNS Elective for CNS students/General elective for others

Semester : Monsoon

Academic Year 2019-20

Course Instructor(s) Harjinder Singh

Rationale :

Quantum computing is fast becoming a reality and an appropriate complete course for training students of computational sciences in this emerging area is imperative.

Objectives:

Sec. I: Learning the basics of quantum computing

Sec. II: Understanding how quantum computing can be used to solve scientific problems with greater efficacy

Sec. III : foundation for research in applying quantum computing to problems in natural sciences.

Prerequisite : One prior course in elementary quantum mechanics

Syllabus:

Sec. I.

1. Vector space, qubits in Hilbert space, Bloch sphere representation of a single qubit, unitary operators, tensor products, density operator, Stern Gerlach filters, pure and mixed states entanglement, EPR paradox, the Bell inequality and its violation (4 lectures),

2. Schrödinger equation and time evolution of a quantum system, Free particle and Gaussian wavepacket, Wigner representation of the density operator, review of atomic and molecular structure, first and second quantization approaches (6 lectures)

Sec. II.

3. Fast Fourier transform method and its applications in quantum mechanics, Correlation

functions and spectra (3 lectures)

4. Multiple qubit gates, Quantum Fourier transform, Phase estimation algorithm, Iterative phase estimation algorithm (3 lectures)

Sec. III.

5. Simulations on a quantum computer :

a) one-dimensional Ising spin-chain,

b) molecular vibrations

c) electronic structure (5 lectures)

6. Adiabatic quantum computation and its applications. (1 lecture)

7. Physical realisation of quantum computers. (2 lectures)

Required readings : Select parts of the following text books and review articles:

1. Quantum Computation and Quantum Information, I. Chuang and M. Nielsen, CUP, 2000

2. Introduction to Quantum Mechanics : a Time-Dependent Perspective, D J Tannor, University Science Books, 2007

3. Simulating Chemistry Using Quantum Computers, I. Kassal et al., Annual Review of Physical Chemistry, 2011 (Vol. 62:185-207)

4. Quantum Information and Computation for Chemistry, ed. S. Kais, Advances in Chemical Physics, 2014

Grading :

assignments : 20%

1 mid sem exam. : 20%

quizzes : 5%

End sem exam : 55% (option A)

40 % (option B)

term paper (written report and presentation) : 15 % (option B)

Title : Research in Information security

Course Code : CSE540

Credits : 4

Type When : Monsoon 2019

Faculty Name : Ashok Kumar Das

PRE-REQUISITE: programming languages (C/C++, Python), operating systems, compilers, introduction to security.

OBJECTIVE: This course is intended to introduce students the exciting world of information security research. The main focus of this course would be on non-cryptographic security research i.e. topics related to software vulnerabilities, malware, intrusion detection/prevention systems. The renowned Cryptographer Dr. Bruce Schneier once said that ".. security is a chain and is as strong as its weakest link. Cryptography is already a string link, problem lies somewhere else- in networks and software ...."

Following the aforementioned suggestion, the course is designed to introduce software security issues and state-of-the-art in techniques to address those issues. At the end of the course, the students should:

1. understand the various issues in software security;
2. understand the techniques that are applied in order to address security issues;
3. understand the majority of the attacks that hamper the security of the networks, e.g. bug exploitation (aka hacking);
4. learn basics of malware analysis and defensive techniques;
5. learn basics of program analysis (static and dynamic program analysis) that are applied to analyze software for vulnerability detection;
6. get familiar with the state-of-the-art in security research to lay foundation for their advance research.

COURSE TOPICS: Syllabus

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* Elliptic-Curve Cryptography (ECC)

* Key management in hierarchical access control
* Lightweight Security Protocols for Wearable Devices
* Security protocols for Implantable Medical Devices
* Key management in wireless sensor networks
* User authentication in wireless sensor networks
* User access control in wireless sensor networks
* Access control in wireless sensor networks and wireless body area sensor networks
* Proxy signature
* Password-based remote user authentication and key agreement using smart cards
* Biometric-based remote user authentication and key agreement using smart cards
* Security in vehicular ad hoc networks
* Security in smart grid
* Security in cloud computing
* Intrusion detection in wireless network security

PREFERRED TEXT BOOKS:

The course is mainly based on research articles and notes given by the instructor.

***REFERENCE BOOKS:**

= Any compiler book for dataflow analysis

= Assembly book for x86

= Practical malware analysis, by Sikorski and Honig

*PROJECT: Student can choose some topic that can be extended to major project for the master degree or advance research. However, if student choose to work on the project during the course, they can do. So, this is optional.

Grading Policy

Grading Method:: Relative

* Mid Sem 1: 15% (Closed books and notes exam)
* Mid Sem 2: 15% (Closed books and notes exam)
* End Sem: 40% (Closed books and notes exam)

* Assignments: 15%

* Term project: 15% (including report and presentation)

OUTCOME: The students will be well aware of state-of-the-art in non-cryptographic security issues and their proposed solutions. The student will also get to know about the opportunities that exist in the research space. Some of the topics are very practical from industry point of view, especially when it comes to proactive approach to security i.e. security during development process.

REMARKS: The course is highly flexible in its contents and approach. Based on the student's participation and interest, the course may progress in a particular direction.

TITLE : RESEARCH METHODOLOGY

Course Code : CSE 991

CREDITS : 4

TYPE-WHEN : Monsoon 2019

FACULTY NAME : Vinoo Alluri + Nimmi Rangaswamy

PRE-REQUISITE : Basic statistics, mathematics 12th standard

OBJECTIVE: This course will introduce students how to carry out research design and think like a researcher independently. More specifically they will get an introduction to research design, methods, analysis, interpretation and presentation of research outcomes. They will also be able to design their own experiments as a part of the course project/assignment to have hands on experience.

COURSE TOPICS : (please list the order in which they will be covered)

This is a course on research methodology specifically focusing on introduction to design of research, behavioral methods and acquisition, analysis of data using scientific methods. Following a brief overview, the course will broadly aim to cover key aspects in research methods from a scientific point of view. This will include the list of topics described below and in that order

1. Introduction

2. Defining and measuring variables, hypothesis and prediction

3. Ethics in research

4. Sampling methods

5. Research design and validity

6. Experimental research

1. General introduction

2. Within group design

3. Between group designs

4.Issues with Validity and Reliability

7. Non-experimental research

8. Factorial Design

9. Correlational research

10. Data coding and Analysis

11. Result Interpretation

12. Report Writing

PREFERRED TEXT BOOKS:

[1] Gravetter and Forzano (2011). Research Methods in Behavioural Sciences

[2] Stangor (2011). Research Methods for Behavioural Sciences

[3] Cozby and Bates (2011). Methods in Behavioural Research

***REFERENCE BOOKS:**

[1] Gravetter and Walnau (2008). Statistics in Behavioural Sciences

***PROJECT:**

Each project would be carried out in groups. Project would involve behavioral data acquisitions based on list of prepared questions. Projects would be evaluated on the basis of following criterions

Project evaluation

Organization

* Project summary/ Abstract

*Problem Statement

*Motivation and Hypothesis

* Methodology

* Results

* Discussion and Conclusion

* Future Direction

* Limitation and scope of the research / objective

Content

Impact

GRADING:

Exams (70%)

* Mid sem-I (20%)

* Mid sem –II (20%)

* Final Exam (30%)

Project (30%)

* Preliminary Design Presentation (10%)

*Final Presentation + VIVA (10%)

*Report (10%)

OUTCOME: Specific deliverables from this course are 1. Basic understanding of research methods 2. Construct, design study 3. Hands on experience on the following areas a) Data collection b) Data coding and analysis c) Result interpretation d) Report writing in APA format.

TITLE **: Structural Wind Engineering**

Course Code **:**

CREDITS **: 4**

TYPE-WHEN **:** CASE Elective - Monsoon

FACULTY NAME **:** Shaik Rehana

PRE-REQUISITE **: Nil**

OBJECTIVE **:**To develop a detailed understanding about wind engineering, various principles involved in the design of wind loads, wind induced responses onstructures, application on solving wind induced problems on structures

COURSE TOPICS **:**

- Wind climate, nature and types of high winds and storms
- Wind damages, damage index, wind impact on structures
- Estimation of design wind speed and pressure distribution
- Estimation of wind loads on buildings, factors affecting wind load
- Prediction of design wind speed and structural safety
- Estimation of extreme wind speeds
- Atmospheric boundary layer and wind turbulence: mean wind speed profiles, wind spectra, topographic multipliers
- Structural interaction with aerodynamic forces, pressure, lift, drag and moment effects on structures
- Wind loads, codes and standards

PREFERRED TEXT BOOKS:

Y. Tamura A. Kareem (2013), Advanced Structural Wind Engineering, ISBN 978-4-431-54336-7 ISBN 978-4-431-54337-4 (eBook), DOI 10.1007/978-4-431-54337-4, Springer Tokyo Heidelberg New York Dordrecht London.

John D. Holmes (2003), Wind Loading of Structures, ISBN 0-419-24610-X, ISBN 0-203-30164-1 Master e-book ISBN.

GRADING PLAN:

Type of Evaluation	Weightage (in %)
Mid Sem and Quiz	**30**
End Sem Exam	**30**
Assignments	**15**
Project	**25**

OUTCOME:

Integrating wind induced responses in the design of various structures such as tunnels, tall buildings etc.

TITLE : Spatial Informatics

Course Code : CSE591

Credits : 3-1-0-4

Type-When : Monsoon-2019

Faculty Name : KS Rajan

Pre-Requisite : Open to PG, UG-4 & UG-3

OBJECTIVE: Spatially explicit information like a map (e.g. Google Maps) informs us not just the geographical location but also the relationship between the objects in it, as the saying goes, A Picture is worth thousand words. This course gives an introduction to Remote Sensing and GIS, the science behind it and how this technology can benefit many disciplines, including navigation, environmental systems, disaster response, etc.

COURSE TOPICS: 1.Introduction. 2.Fundamentals of Remote Sensing. 3.Image Acquisition and Digital data. 4.Image Processing and Analysis. 5.Applications of Remote Sensing Land Use and Land Cover. 6.Geographical Information Systems (GIS) - Fundamental concepts. 7.Geospatial data and its Digital representation Vectors and Rasters. 8.Data structures in GIS and its Representation. 9.Projections and Georeferencing. 10.Spatial Data Query and Analysis. 11.Special Topics in Spatial Informatics. a.Web-GIS and GML. b.Open Source Initiatives in GIS/RS. c.3D GIS. d. Environmental and Health Informatics. e.Risk Mapping and Vulnerability Assessments

A few lectures, will be given by Invited Speakers in related areas during the course to provide the students a wider understanding of its relevance and application. In addition, there will be a hands-on (lab tutorials) introduction to some of the RS and GIS software and tools at relevant times during the course

PREFERRED TEXT BOOKS:

1 .Introduction to Remote Sensing by James B. Campbell

2.Geographic Information Systems by Paul A. Longley, Michael F. Goodchild, David J. Maguire, and David W. Rhind

3.Introduction To Geographic Information Systems by Kang-Tsung Chang

***REFERENCE BOOKS:**

GRADING:

1. Assignments (max. of 4) 15% 2. Project 10% 3. Mid-term Exams (2) 30% [15% + 15%] 4. End-Semester Exam (1) 45% Details of Assignments/Projects will be announced during the course

OUTCOME:

Students will learn the basic concepts of geospatial data representation, cartography, visualization, data manipulation and how to extract meaningful information from it. In addition, they will be exposed to the application potential of this fast developing domain cutting across disciplinary interests.

T ITLE: Speech Signal Processing

Course Code: ECE448

Credits: 3-1-0-4

Type-when: Monsoon-2019

Faculty Name: Anil Kumar V

Pre-Requisite: (PG, research and BTech students from 3rd year onwards will be permitted) Signal and systems Digital signal processing.

COURSE TOPICS: Background and need for speech processing, Speech production mechanism, Nature of speech signal, Basics of digital signal processing, Equivalent representations of signal and systems, Speech signal processing methods, Linear prediction analysis, Basics of speech recognition.

PREFERRED TEXT BOOKS: 1. L.R.Rabiner and B.H Juang, Fundamentals of speech recognition, Pearson LPE (1993). 2. L.R.Rabiner and R.W.Schafer, Digital processing of speech signals, Pearson LPE (1993).

GRADING: Based on lab reports, midsem exams and final exam. Weightage depends on the number of registrants.

Title: Speech Technology

Course Code: CSE971

Credits: 3-1-0-4

Type When: Monsoon-2019

Faculty Name: Suryakanth V gangashetty

Pre-Requisite : Speech Signal Processing

Objective: This is an advance course whose objective is to discuss and provide hands-on experiance on implementstion of algorithms, models used in feature extraction and in building speech systems.

COURSE TOPICS :

1. Introduction to speech technology
2. Feature extraction from speech signal
3. Algorithms for speech recognition
4. Methods for speech synthesis
5. Approaches for speech enhancement
6. Approaches for speaker recognition

PREFERRED TEXT BOOKS: Fundamentals of Speech Recognition (Prentics Hall Signal Processing Series) (Paperback) by Lawrence Rabiner and Biing-Hwang Juang

***REFERENCE BOOKS:** Spoken Language Processing: A Guide to Theory, Algorithm and System Development by Xeudong Huang, Alex Acero, and Hsiao-Wuen Hon

***PROJECT:** Mini projects on each topic

GRADING: 20% - Laboratory Assignments 20% - Review papers reading and presentation 20% - Midterm-1 20% - Midterm-2 20% - Final Examination

OUTCOME: At the end of the course, the students are expected to attain the theoretical and practical knowledge of the different algorithms used in speech technology.

TITLE : Social Science Perspective on HCI

CREDITS : 4

Course Code : CSE451

TYPE-WHEN : Monsoon 2019

FACULTY NAME : Nimmi Rangaswamy

PRE-REQUISITE : U3 and above

OBJECTIVE :

To introduce Human-Computer Interaction as an inter-disciplinary domain of study to students of Engineering and the Social Sciences

To bring a social perspective and the importance of lived contexts in the framing and understanding of man-machine interaction

To get a grasp of the theoretical and applied frameworks supporting the domain of HCI

Importantly, to introduce the idea of cross-fertilisation of academic domains, especially computer sciences and humanities to originate Human-Computer Interaction as a fertile research and academic science

COURSE TOPICS/OUTLINE/CONTENT

Overview of Course

Quote: "A sushi restaurant puts sensors on its plates to assess, in real time, what's being eaten so it can adjust its food offerings" [Goodman, The Atomic Age of Data, 2015]" End Quote.

Radically different ways of interacting with computationally based systems are possible, ranging from the visual [surfaces, input devices] to the invisible [sensor technologies, back end processors] and importantly social [which means non-technological] affectations triggering diverse ways of interfacing with technology. Human-Computer Interaction [HCI] is a vision for a world of interconnected devices, that have acquired smartness due to computing power. As computational technologies continue to 'disappear' and merge with the physical world, becoming increasingly tangible, embedded and embodied in a range of environments, architectures and artifacts, new research agendas and design approaches are called for [Nansen et al, 2014].

This course is an introduction to the field of Human-Computer interaction research with a focus on 'human' and how the HCI domain interfaces with the social sciences. The course begins with a selection of seminal work that establish the HCI domain: interactive systems/techniques, design and user interfaces. We will then move on to topics including social and context aware computing, design research and evaluation methods.

The course will also present a perspective based on the importance and role of objects in social relations. We situate this work in relation to a conceptual understanding of objects and social relations, suggest effective methodological and theoretical tools to study of a more object-centered sociality and suggest design opportunities to make better products.

The course will center on the processes and challenges of ideating, designing and evaluating technologies as products, their usability and immersion into the social contexts of users. We will study contextual design as a field that emerged in response to the challenges of designing for context and usability. Another important strand in this course will dwell on the sociological aspects of HCI and explore the 'mediation' of technology use by a range of contextual situations: socio-cultural obligations, habits, values, infrastructure, material objects and not in the least family, kinship and human bonds. Some examples of the above are:

Understanding social interactions with a webcam as an important new development in communication interfaces and its widespread adoption in the real world supporting family relationships, business work flows and social networking.

A deep look at social networking as everyday HCI- Facebook; Twitter; Messaging applications.

Another example will be looking at technologies driven by data science, like mobile marketing analytics, and their consequences for society.

A third example will be studying real world application of big data to social situations: real time traffic; real world geographic navigation; geo-location based services [food delivery; friendship; dating]; Consumer-centric health care services [monitoring parameters; precision medicine; Health care platforms]

A close look at the impacts of peer to peer sharing platforms [Uber, AirBnB]

This class has no pre-requisite requirements and open to students from any background. Students are expected to do all of the readings. Students will be evaluated with a quiz or a test and a presentation that will gauge student ability in engaging with and comprehending the course readings and class room discussions. The class test and the presentation will be based on the class lectures and readings assigned for the course

PREFERRED TEXT BOOKS:

***REFERENCE BOOKS:**

Norman, D. A. (1990). *The design of everyday things*. New York: Doubleday.

Miller, D and Sinanan, J, *Webcam*, Polity Press, 2014

Sterling, B. *The Epic Struggle Of The Internet Of Things*, Moscow: Strelka Press, 2014.

Rogers, Y. *HCI Theory: Classical, Modern, and Contemporary*. [San Rafael, Calif.], Morgan & Claypool, 2012

Blomberg, J., Burrell, M., and Guest, G. *An Ethnographic Approach to Design,* Human-Computer Interaction Handbook, L. Erlbaum Associates Inc. Hillsdale, NJ, USA,2003

***REFERENCE ARTICLES:**

Bell, G., Blythe, M., and Sengers, P. 2005. Making by Making Strange: Defamiliarization and the Design of Domestic Technology. *ACM Trans. Computer-Human Interaction*, 12(2), 149-173.

Dourish, P. 2006. Implications for Design. *Proc. ACM Conf. Human Factors in Computing Systems CHI 2006* (Montreal, Canada), 541-550.

O'Brien, J., Rodden, T., Rouncefield, M., and Hughes, J. 1999. At Home with the Technology: An Ethnographic Study of a Set-Top Box Trial. ACM Trans. Computer-Human Interaction, 6(3), 282-308.

Kelson, J.A.S. (1982). The process approach to understanding human motor behavior: An introduction. In J.A.S. Kelso (Ed.), Human Motor Behavior: An Introduction, 3-19, Hillsdale, N.J.: Lawrence Erlbaum Associates.

Bell, G., Blythe, M., Gaver, B., Sengers, P., and Wright, P. Designing culturally situated technologies for the home. *Ext. Abstracts CHI 2003.* ACM Press (2003), 1062-1063.

***PROJECT:**

GRADING PLAN:

Type of Evaluation	Weightage (in %)
Mid Sem-1 Exam	**25%**
Mid Sem-2 Exam	**25%**
End Sem Exam	
Assignments	**50%**
Project	
Term Paper (In Lieu of Mid Sem-1)	

Other Evaluation (Term Paper and Presentation)	

OUTCOME:

Students will be able to identify and apply a sociological lens to a human-computer interaction context. This will mean applying informed ways to draw boundaries to an HCI context, use the right theoretical tools of study and processing appropriate data to conduct an independent academic study of selective HCI situations in the real world

REMARKS:

TITLE : Software Quality Engineering

Course Code : CSE861

Credits : 3

Type-when : Monsoon -2019

Faculty Name : Raghu Reddy

Pre-Requisite : SSAD & Project or Software Engineering. If neither course is taken, the student should get permission from the Instructor.

OBJECTIVE: The course will impart quality analyze software systems. Topics include verification software quality assurance, standards, etc. concepts and skills necessary to design and and validation, metrics and measurements,

COURSE TOPICS:

 Software process models and relation to quality

o Traditional models *

o Agile models

 Quality Assessment Standards and Models

o CMMI

o ISO 9000

o Software Productivity research assessment

o Malcolm Baldridge assessment

- Quality at various levels of SDLC
  - o Requirements and formalization of requirements
  - o Architecture and Qualities
  - o Design Reviews
  - o Code Reviews/inspections
- Software Testing and Quality
  - o Unit, Integration, System, Acceptance, Regression
  - o Blackbox Testing
    - Equivalence
    - Boundry value
    - Decision table
    - Pairwise
    - State-transition
    - Use case based
  - o White box
    - Control flow
    - Data flow
    - Mutation
- Measurement and Metrics
  - o Complexity
  - o Reliability
  - o Availability
- Risk Management
- Defect Removal
- In-process quality assessment

PREFERRED TEXT BOOKS:

***REFERENCE BOOKS:**

- Metrics and Models in Software Quality Engineering by Stephen H. Kan
- Software Metrics: A rigorous and practical approach by Fenton and Pfleeger.

 A practioner's guide to Software Test Design by Lee Copeland

*PROJECT: No project. Students will be assessed using activities and exams. If the class is not large, we may require a term paper submission.

GRADING: Traditional grading. Consists of 2 mid-terms, 1 final, set of activities and term paper.

OUTCOME: The course begins with an exploration of the concepts underlying quality systems and the use of metrics. Students are encouraged to discuss the advantages as well as the limitations of systems and quantitative approaches, with a view to understanding the importance of interpretation in metrics usage and of matching quality systems choices to organizational objectives and culture. They learn the use of modern measurements and metrics through exercises. By the end of the course students should be able to design/evaluate a software system from a quality perspective.

REMARKS: Ideally we could like the class strength to not exceed 50 students.

TITLE : Statistical Methods in AI
Course Code : CSE471
CREDITS : 3-1-0-4
TYPE-WHEN : Monsoon - 2019
FACULTY NAME : C.V. Jawahar

Lectures : Mondays, Thursdays; 3:30pm - 5:00pm

COURSE TOPICS :

. Introduction, Feature Representation
. Nearest Neighbor Classification
. Random Variables, Probability Densities, Multivariate Densities
. Bayesian Decision Theory
. Naive Bayes Classifier
. Maximum Likelihood Estimation (MLE)
. Linear Discriminant Functions
. Perceptron Learning
. Minimum Squared Error Procedures

. Logistic Regression
. Neural Networks, Backpropagation, Training Methods
. Principal Component Analysis and Eigen Faces
. Linear Discriminant Analysis and Fischer Faces
. Max-Margin Classification (SVM), SVM variants, Kernalization
. Data Clustering, Kmeans (EM) and variants, Hierarchical Clustering
. Decision Trees
. Graphical Models, Bayesian Belief Networks
. Combining Classifiers, Boosting

REFERENCE BOOKS:
***** Pattern Classification by Duda, Hart & Stork
* Machine Learning - A Probabilistic Perspective by Kevin Murphy (free ebook available online),
* Neural Networks - A Comprehensive Foundation by Simon Haykin

Pre-requisite : Basics of Linear Algebra, Calculus, Probability Theory and Statistics. Programming in Matlab and C/C++.

GRADING Scheme:
*** Assignments 3: 20% (1 Mini-project + 2 Assignments)**
*** Homeworks: 30% (2-4 problems given after each lecture; Top 80% counted)**
*** Two MidSems : 30%**
*** Final Exam : 20%**

OUTCOME:
This course will enable students to understand pattern recognition techniques namely, classification and clustering in detail including both theoretical and practical aspects.

Technology Product Entrepreneurship- Tools & Techniques

Faculty: Ramesh Loganathan.

Description:

This course introduces the fundamentals of technology product entrepreneurship. In a workshop format, you will learn the process of building a technology enterprise. Starting from a technology idea, mapping the idea to a high-potential commercial opportunity, defining/designing/validating the product, figuring out the market avenues & how to sell the product, and planning/managing rapid growth. Class will apply the learning on their tech

product ideas and create a venturable product & plan; in a workshop mode thru extensive hands on assignments concurrent with course modules.

Aim: The aim of this course is to introduce students to the process to take technology from research labs towards the market as a end product. As a venturable business.

Key Takeaways:

Pedagogy Format

• Classroom sessions, guest lectures (from serial tech entrepreneurs/investors) and case study discussions in class

• Assignments applied on tech product ideas from the class

Prerequisites:

• A technology product idea that has come out of an internship, research work or honors work in

one of IIIT-H research centers

• Students register for class as teams (2-4 students) with a tech product idea

• Basic knowledge of cloud computing and mobile appls is preferred

Outline (Tentative):

Sl No	Topics	Week
1	Introduction • Technology Product innovation. • Successful products cases review	1
2	Creativity & Innovation • Stretch the idea. Idea Hexagon framework applied	
3	Frameworks & Models • Product & Market first • Vision first (Vision/Strategy/Execution) • Large opportunity (Big untapped market/ Much better product/ Much better team) • Lean Startup models • Crossing the chasm”	2
4	Customer Discovery/Opportunity mapping	

	• LEAN Startup methodology	
	• Business Model canvass Tool	2
5	Design Thinking	
	_ Design thinking process: understand, observe, define, ideate, prototype, test	2
6	Customer Development	
	• Models: through trial and error, hiring and firing, successful startups all invent a new, parallel process to product development for sales, marketing and business development	
	• Market & Competitive Positioning	2
7	Sales & Market Strategy	
	• Go to Market avenues, and projections	
	• GTM Planning	1
8	Business Plans	
	• Creating, developing and evaluating the Technology Product's "concept of a business"	
	• innovation? Is it a business or a product or both? Sizing the market? The technology, market and competitive risks? Competitive proposition	2
9	Technical Architecture considerations	
	_ Leveraging Mobile and Cloud	1
10	Corporate Technology Innovation	1
	_ Applying research technology in corporate environments	
11	Tech Product Pitch/Plan presentations	
	_ What makes a good product pitch and demo	1
12	Final Demo and presentations	1
TOTAL		**17 classes**

Evaluation (tentative)

4 quizzes (20%), 4 labs (20%), Tech Product Biz plan (20%), Demo & Presentation (10%), Final Exam (30%)

Assignments:

Students will apply the learning on your tech product idea and create a venturable product and plan; in a workshop mode thru extensive hands on assignments concurrent with course modules. Submissions each week.

• Introduction : Assignment: Create startup website; Vision; Basic Positioning statement;

• Creativity & Innovation: Assignment: Based on team's tech idea considered, list 3 product possibilities, applying Idea hexagon framework.

• Frameworks & Models: Assignment: Assess opportunity for the ideas. And pick the "venturable business."

• Customer Discovery/Opportunity mapping: Assignment: Apply Lean Startup Methodology, and Validate customer interest, need & … ; Assignment: First cut of Musiness Model Canvass filled in

• Design Thinking: Assignment: Rapidly create and refine the product functionality for the teams

product using design thinking process

• Customer Development: Assignment: Competitive Positioning; Assignment: Update Product functionality capturing the competitive proposition

• Sales & Market Strategy: Assignment: Evolve the GTM plans

• Business Plans: Assignment: Completed, defensible, business model canvass; Assignment: Product roadmap- market & technical, GTM plans, revenue projections

• Technical Architecture considerations: Assignment: Study 2 similar solutions in market and compare/contrast tech architecture used by your product

• Corporate Technology Innovation : TBD

• Tech Product Pitch/Plan presentations

References

Required Readings:

1. The Startup Owner's Manual: The Step-By-Step Guide for Building a Great Company

2. by Steve Blank and Bob Dorf

Reference papers

3. Technology Entrepreneurship: Overview, Definition, and Distinctive Aspects

4. http://timreview.ca/sites/default/files/article_PDF/Bailetti_TIMReview_February2012.pdf

5. Toward a General Modular Systems Theory and Its Application to Interfirm Product Modularity

6. http://amr.aom.org/content/25/2/312.abstract

7. Harvard: Why Lean Startup Changes everything

8. http://host.uniroma3.it/facolta/economia/db/materiali/insegnamenti/611_8959.pdf

9. The Power of Integrality: Linkages between Product Architecture, Innovation, and Industry Structure

10. http://www.sciencedirect.com/science/article/pii/S0048733308001091

Suggested Reading:

1. High Tech Start Up, Revised and Updated: The Complete Handbook For Creating Successful New High Tech Companies by John L. Nesheim

2. The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses by Eric Ries

Additional Reference

1. The Art of the Start by Guy Kawasaki

2. Demand: Creating What People Love Before They Know They Want It by Adrian J. Slywotzky with Karl Weber

3. The Innovator's Dilemma: The Revolutionary Book That Will Change the Way You Do Business by Clayton M. Christensen

4. Running Lean: Iterate From Plan A to a Plan That Works by Ash Maurya

5. Positioning: The Battle for Your Mind by Al Ries and Jack Trout

6. Venture Deals by Brad Feld and Jason Mendelson

7. Lean Analytics by Alistair Croll and Benjamin Yoskovitz

8. Crossing the Chasm by Geoffrey A. Moore

TITLE : Technology and Social Movements

Course Code : **HSS445**

CREDITS : Four

TYPE-WHEN : Monsoon 2019

FACULTY NAME : Radhika Krishnan

PRE-REQUISITE : **UG 3, UG 4**

OBJECTIVE : This course aims to introduce students to theories of social movements, and more specifically to the intersections and boundaries between social movements and technology. Students will be encouraged to look for the question of technology embedded within the demands emerging from social movements. Secondly, the use of technology as a tool for social movements will be dealt with. The course will also look at the relationship between the scientific 'expert' and civil society, and will analyse the role of social movements in transforming the scientific enterprise.

COURSE TOPICS: (1) Theories of social movements, Analysing movements in India
(2) Movements as sites of knowledge production
(3) Activism, Media and the Internet
(4) Battling technologies of the State

PREFERRED TEXT BOOKS:

David J. Hess, *Alternative Pathways in Science and Industry: Activism, Innovation and the Environment in an Era of Globalization* (London: MIT Press, 2007).

Sidney Tarrow, *Power in Movement* (New York: Cambridge University Press, 2011 [3rd edition]).

***REFERENCE BOOKS:**

Abby Kinchy, *Seeds, Science and Struggle: The Global Politics of Transgenic Crops* (London: MIT Press, 2012).

Andrew Jamison, *The Making of Green Knowledge: Environmental Politics and Cultural Transformation* (Cambridge: Cambridge University Press, 2004).

Daniel Lee Kleinman et. al (eds.), *Controversies in Science and Technology: From Maize to Menopause* (London: University of Wisconsin Press, 2005).

Daniel Lee Kleinman et. al (eds.), *Routledge Handbook of Science, Technology and Society* (New York: Routledge, 2014).

Darryl D'Monte, *Temples or Tombs? Industry Versus Environment Three Controversies* (New Delhi: Centre for Science and Environment, 1985).

Edward J. Hackett et.al (eds.), *Handbook of Science and Technology Studies* (London: MIT Press, 2008 [3rd edition]).

Kelly Moore, *Disrupting Science: Social Movements, American Scientists and the Politics of the Military 1945-1975* (Princeton: Princeton University Press, 2008).

KSSP, *Science as Social Activism: Reports and Papers on the People's Science Movements in India* (Trivandrum: Kerala Shastra Sahitya Parishad, 1984).

Marco Giugni et. al. (eds.), *How Social Movements Matter* (Minneapolis and London: University of Minnesota Press, 1999).

Oommen, T.K. (ed.), *Social Movements I: Issues of Identity* (New Delhi: Oxford University Press, 2010).

Oommen, T.K. (ed.), *Social Movements Part II*: *Concerns of Equity and Security* (New Delhi: Oxford University Press, 2010).

Praful Bidwai and Achin Vanaik, *South Asia on a Short Fuse: Nuclear Politics and the Future of Global Disarmament* (New Delhi: Oxford University Press, 2002).

Raka Ray and Mary Katzenstein (eds.), *Social Movements in India: Poverty, Power, and Politics* (Lanham, MD: Rowman and Littlefie, 2005).

Ravi Rajan (ed.), *Amulya Reddy: Citizen Scientist* (New Delhi: Orient Blackswan, 2009).

Sanjay Sangvi, *The river and life – story of the Narmada Bachao Andolan* (Kolkata: Earthcare Books, 2002).

Sara C. Motta and Alf Gunvald Nilsen (eds.), *Social Movements in the Global South: Dispossession, Development and Resistance* (New York: Palgrave Macmillan, 2011).

Steven Epstein, *Impure Science: AIDS, Activism and the Politics of Knowledge* (Berkeley: University of California Press, 1996).

***REFERENCE ARTICLES:**

Andrew Jamison, 'Social Movements and Science: Cultural Appropriations of Cognitive Praxis', *Science as Culture* Volume 15 No 1 (2006), 45-59.

Ann Capling and Kim Richard Nossal, 'Death of Distance or Tyranny of Distance? The Internet, Deterritorialization, and the

Anti-Globalization Movement in Australia', *The Pacific Review* Vol 14 No 3 (2001), 443-465.

Brian Martin, 'Suppression of dissent in science', in William R. Freudenburg and Ted I. K. Youn (eds.) *Research in Social Problems and Public Policy*, Volume 7 (Stamford, CT: JAI Press, 1999), 105-135.

David J. Hess, 'Crosscurrents: Social Movements and the Anthropology of Science and Technology', *American Anthropologist* Volume 109 No 3 (2007), 463-472.

Donatella Della Porta and Herbert Reiter, 'Introduction', in Della Porta and Reiter (eds.), *Policing Protest: The Control of Mass Demonstrations in Western Democracies* (Minneoapolis: University of Minnesota Press, 1998).

Langdon Winner, 'Do artifacts have politics?', in *Daedalus*, Vol. 109, No. 1, Modern Technology: Problem or Opportunity? (Winter,1980), 121-136.

Mondli Hlatshwayo, 'NUMSA and Solidarity's responses to technological changes at the ArcelorMittal Vanderbijlpark Plant: Unions caught on the back foot', *Global Labour Journal* Vol 5 No. 3 (2014), 283 - 305.

Mondli Hlatshwayo, 'A reactive approach to technological changes: Solidarity's responses to technological changes at the Arcelor Mittal Vanderbijlpark Plant, 1989 to 2012', *Transformation: Critical Perspectives on Southern Africa*, Vol 85, Issue 1 (2014), 43-63.

Oliver Froehling, 'The Cyberspace War of Ink and Internet in Chiapas, Mexico', *Geographical Review* Vol 87 No 2 (1997), 291-307.

Peter Brinson, 'Liberation Frequency: The Free Radio Movement and Alternative Strategies of Media Relations', *The Sociological Quarterly* Vol 47 (2006), 543-568.

Rachel Schurman and William Munro, 'Ideas, Thinkers, and Social Networks: The Process of Grievance Construction in the Anti-Genetic Engineering Movement', *Theory and Society* 35 (2004), 1-38.

Radhika Krishnan, 'Rethinking Technological Choices and Knowledge Production in the Mines and on the Factory Floor', *African Journal of Science, Technology, Innovation and Development*, Special Issue on Informal Innovations, Vol 6 Issue 3 (2014), 213-221.

Robert D. Benford and David A. Snow, 'Framing Processes and Social Movements: An Overview and Assessment', *Annual Review of Sociology* 26 (2000), 611-639.

V. V. Krishna, 'Science, Technology and Counter Hegemony — Some Reflections on the Contemporary Science Movements in India', in T. Shinn et.al. (eds.), *Science and Technology in a Developing World* (Netherlands: Springer, 1997), 375-411.

Victor W. Pickard, 'Assessing the Radical Democracy of Indymedia: Discursive, Technical, and Institutional Constructions', *Critical Studies in Media Communication* Vol 23 No 1 (2006), 19-38.

***PROJECT:** None.

GRADING PLAN:

Type of Evaluation	Weightage (in %)
Mid Sem-1 Exam	**20%**
Mid Sem-2 Exam	**20%**
End Sem Exam	**40%**
Assignments	
Project	
Term Paper (In Lieu of Mid Sem-1)	
Other Evaluation (Term Paper and Presentation)	**20%**

OUTCOME: The student is expected to get an overview of the manner in which technology interacts in society. Students will critically reflect on the notion that 'science' is unaffected by those operating in world outside of science. They will be introduced to the complex interactions between science, civil society and social movements in a variety of contexts. The Indian and

South African contexts, in particular, will be helpful to understand the specific interactions between science and society in the Third World.

REMARKS: The course will be based on lectures and the students will be expected to read books and articles mentioned in the reading list. The term paper is expected to be an original work, reflecting on the dynamics of technology in the Indian context.

TITLE : **Topics in Wireless Communications**

Course Code : ECE531

CREDITS : 4

TYPE-WHEN : Monsoon 2019

FACULTY NAME : P. Ubaidulla

PRE-REQUISITE : Wireless Communication or Communication Theory-II

OBJECTIVE : To explore recent developments in wireless communications, especially the emerging techniques that will be used in 5G systems.

COURSE TOPICS :

Review of fading, diversity, MIMO;
MIMO channel modeling and estimation;
Large/Massive MIMO, low-complexity precoding;
Millimeter wave communications, transceiver architectures;
Full-duplex radio;
Multiple access schemes for 5G

PREFERRED TEXT BOOKS:

***REFERENCE BOOKS:**

David Tse and Pramod Viswanath, "Fundamentals of Wireless Communication", Cambridge University Press

T. S. Rappaport, R. W. Heath et al, "Millimeter Wave Wireless Communications", Prentice Hall.

Papers from recent research literature.

***PROJECT:**

GRADING PLAN:

Type of Evaluation	Weightage (in %)
Mid Sem-1 Exam	
Mid Sem-2 Exam	
End Sem Exam	**40**
Assignments	
Project/Other	**60**
Term Paper	
Other Evaluation _____	

OUTCOME:

REMARKS:

TITLE : Topics in Machine Learning

Course Code : CSE975

CREDITS : 4

TYPE-WHEN : Monsoon2019

FACULTY NAME : Naresh Manwani

PRE-REQUISITE : SMAI

OBJECTIVE : Covering important topics in online learning and reinforcement learning

COURSE TOPICS :

1. **Online Learning**: Online classification/regression, Online learning from experts, Online- to-batch conversions

2. **Reinforcement Learning**: Multi-arm Bandits, The exploration-exploitation dilemma,

Markov Decision Processes, Dynamic Programming, Monte Carlo Methods, Temporal-Difference Learning, Sarsa: On-Policy TD Control, Q-learning, Value-function Approximation, Policy gradient methods

3. **Deep Reinforcement Learning**: Back-propagation, Recurrent Neural Networks, Deep Q-Networks, Variational Auto-encoders, Importance Weighted Auto-encoders

PREFERRED TEXT BOOKS:

1. Reinforcement Learning: An Introduction, Second Edition", Sutton & Barto. 2012. The MIT Press

***REFERENCE BOOKS:**

1. Mehryar Mohri, Afshin Rostamizadeh, and Ameet Talwalkar. 2012. *Foundations of Machine Learning*. The MIT Press

2. Goodfellow, Bengio & Courville, *Deep Learning*

3. Research Papers

GRADING PLAN:

Type of Evaluation	**Approximate Weightage (in %)**
Mid Sem-1 Exam	**15**
Mid Sem-2 Exam	**15**
End Sem	**20**
Assignments	**20**
Scribing of Lecture Notes	**10**
Project	**20**

TITLE : Topics in Applied Optimization

Course Code : CSE484

CREDITS : 3-1-0-4

TYPE-WHEN : Monsoon

FACULTY NAME : Pawan Kumar

PRE-REQUISITE :Linear Algebra, Calculus, Statistics, and any one of the programming languages: C/C++/Python/Matlab/Octave to write codes for assignment problems. Basic knowledge of machine learning (linear regression, logistic regression, SVMs, NN) is desirable, but not necessary.

OBJECTIVE : To learn selected advance optimization techniques, and to apply them to solve selected problems stemming from data sciences, and scientific computing.

COURSE TOPICS :

0.Review of Linear Algebra, Calculus, Probability and Statistics.
1.Concept of Convex Sets, Convex functions, Convex Optimization Problems, Duality.
2.Algorithms for Constrained and Unconstrained Minimization. Applications.
3.Algorithms for Interior Point Methods. Applications.
4.Algorithms for Stochastic Gradient Methods: 1^{st} order and 2^{nd} order methods. Preconditioning. Momentum based and Nestrov Accelerated Gradient Descent. Applications.
5.Algorithms for Non-smooth Optimization: Sub-gradient Methods; Primal-dual sub-gradient methods; Stochastic subgradient methods. Applications.
6.Variants of Conjugate Gradient Methods and Truncated Newton Methods. Applications .
7.Algorithms for Non-convex Minimization and Applications.

PREFERRED TEXT BOOKS:

1. ***Numerical Optimization***, J. Nocedal, S. J. Wright, Springer, 1999
2. ***Optimization Methods for Large Scale Machine Learning***, arXiv 2016
3. ***Optimization for Machine Learning***, Suvrit Sra et. al., MIT Press

***REFERENCE BOOKS:**

***PROJECT:** Projects will be primarily from the domains of Scientific Computing and Machine Learning. A student will be asked to read a paper, implement optimization algorithms mentioned in the paper, and present their work using overhead projectors.

GRADING PLAN:

Type of Evaluation	Weightage (in %)
Mid Sem-1 Exam	**15**
Mid Sem-2 Exam	**15**
End Sem Exam	**30**

Assignments	**10**
Project	**20**
Term Paper	
Other Evaluation: Quizzes	**10**

OUTCOME: After taking this course, student should be able to formulate a problem as optimization problem, select appropriate algorithm, and implement it efficiently.

REMARKS:

1. Due to lack of TAs for this new course, the maximum number of students allowed for this course is 15. Students are encouraged to meet me before taking this course.

2. This is a relatively advance course, and preference will be given to senior UG and PG students, or Honors students working in these areas.

TITLE **: Wireless Communications**

Course Code **: ECE 438**

CREDITS **: 4**

TYPE-WHEN **: Monsoon 2019**

FACULTY NAME **: Sachin Chaudhary**

PRE-REQUISITE **:** Basics of random variables (Gaussian RVs, and random vectors and functions of Gaussians), Digital Communication (Comm. Theory 1)

OBJECTIVE **:** Learn fundamentals of wireless communications with focus on mobile technologies, and understand the current frontiers of research

COURSE TOPICS **:** (Note : More time will be spent on the fundamentals, and more complex topics (even those not listed) will be optionally taken up based on time available)

1. Wireless channel modelling (Single-input single output): Time and frequency coherence, fading
2. Probability of error vs SNR: exploiting channel diversity.

3. Cellular systems: Frequency reuse, GSM, CDMA.
4. Capacity considerations
5. Beamforming
6. MIMO Channel model, transmission schemes and receivers.
7. Multiuser MIMO.
8. 5G physical channel models, transmission techniques.
9. Interference channel, Interference alignment, topological interference alignment.

PREFERRED TEXT BOOKS: Fundamentals of Wireless Communication by David Tse and Pramod Vishwanath

***REFERENCE BOOKS**: Wireless Communications- Principles & Practice (Rappaport).

***PROJECT:** (List of topics will be mentioned later)

GRADING PLAN:

Type of Evaluation	Weightage (in %)
Mid Sem-1 Exam	**25**
Mid Sem-2 Exam	**25**
End Sem Exam	**-**
Assignments/Quizzes	**20**
Project	**30**
Term Paper	**--**
Other Evaluation:	**---**

OUTCOME:

REMARKS:

TITLE : Understanding Raga: Semi Classical forms of Indian Music

Course Code : HSS338

CREDITS : 4

TYPE-WHEN : Open Elective- Monsoon 2019

FACULTY NAME : TK.SAROJA

PRE-REQUISITE : Instructors consent
OBJECTIVE :

1. Conceptual study of raga by introducing around ten ragas in both North and South Indian music systems.

2. Practice of different Semi classical forms including some folk forms of Indian music.

3. Understanding the importance of Semi classical genre in Indian music.

4. Role of music in bringing out the rich ideas and expressions in the compositions….inter relationship of the musical and linguistic expressions.

5. Introducing different composers whose musical experiences and ideas resulted in the existing semi classical forms.

6. Experiencing the techniques of composing and learn to compose some simple songs.

COURSE TOPICS :
(please list the order in which they will be covered)

Lesson 1,2, 3 : Introduction to ragas. Basic exercises in different ragas.

Lesson 4,5: Introduction of various semi classical forms of Indian music

Lesson 6, 7: Bhajans

Lesson 8, 9,10: Annamayya compositions

Lesson 11, 12, 13: Contribution of some Composers whose compositions are identified as separate genres in Indian music.

Lesson 14, 15: Ghazals

Lesson 16, 17: Techniques of composing

Lesson 18: Qawwali

Lesson 19, 20: Abhang and Purandara dasa compositions

Lesson 21, 22: Contribution of some more composers.

Lesson 23: Comparitive study of Semi classical forms and Folk forms of music.

Lesson 24: Study of the inter relationship of musical and lyrical expressions in bringing out the beauty of the compositions.

Lesson 25, 26: Practical exercises of all the concepts.

PREFERRED TEXT BOOKS:

***REFERENCE BOOKS:**

1. The Hindu Speaks on Music - compilation of 232 selective music articles by The Hindu.

2 . A Southern Music (The karnatic story) by T.M. Krishna

3. Videos and audios to demonstrate different concepts.

***PROJECT:** Practical oriented project

GRADING PLAN:

Type of Evaluation	Weightage (in %)
Mid Sem-1 Exam	**20**
Mid Sem-2 Exam	**20**
End Sem Exam	**----**
Assignments	**20**
Project	**40**
Term Paper	**-----**
Other Evaluation _____	**For all the exams Practicals 60% and Theory 40%**

OUTCOME:

1. Ability to recognize some ragas with their very characteristics.

2. Ability to identify, sing or play different semi classical

compositions like Bhajan, Ghazal, Annamayya composition,

Qawwali, Abhang etc

3. Understand the importance of raga in Indian music.

4. Know the importance and role of the composers in bringing out

variety in music.

5. Basic attempt to compose simple songs.

6. Knowledge of different rhythmic structures that play a major role

in the compositions.

7. Ability to sing or play compositions in atleast 10 ragas.

8. Videos and audios to demonstrate different concepts.

REMARKS: Students with minimum of vocal or instrumental experience are encouraged.

Sd/-

Dean (Academics)