### Courses Syllabus – Spring 2022

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<th>Sl. No.</th>
<th>Course Code</th>
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<td>Advanced Algorithms</td>
<td>Suryajith Ch</td>
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<td>Advanced Optimization: Theory and Applications</td>
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<td>Advances in Robotics &amp; Control</td>
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<td>Analog Electronic Circuits</td>
<td>Abhishek Srivastava</td>
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<td>K R Sarma</td>
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**Note:** The above courses highlighted in the RED color will be updated soon

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**Title of the Course:** Analog Electronic Circuits

**Name Of Faculty:** Abhishek Srivastava

**Name of the Academic Program:** B. Tech in ECE

**Course Code:** EC2.103

**L-T-P:** 3-1-1

**Credits:** 5

(L= Lecture hours, T=Tutorial hours, P=Practical hours)

**Prerequisite Course / Knowledge:** NeSS, DSM, EW1,

**Course Outcomes (COs) (5 to 8 for a 3 or 4 credit course):**

After completion of this course successfully, the students will be able to...

**CO-1** Describe the devices: diode, transistors and their operation.

**CO-2** Explain the operation for basic MOSFET & BJT circuits: mirrors, biasing circuits and different amplifier configurations.

**CO-3** Draw equivalent circuit and examine the circuit, formulate gain & ac/dc parameters (dc analysis & small signal analysis).

**CO-4** Demonstrate simulation of the above mentioned basic circuits, change parameters to obtain desired output.
CO-5 Simulate, plot & perform frequency analysis of amplifiers, predict temperature based behavior and explain mismatch.
CO-6 Design simple MOSFET biasing circuits and amplifiers.
CO-7 Design circuit on breadboard and characterize it.

3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix

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Note: Each Course Outcome (CO) may be mapped with one or more Program Outcomes (POs) and PSOs. Write ‘3’ in the box for ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low-level’ mapping

4. Detailed Syllabus:
Unit 1: Semiconductor Basics & P-N junction
Unit 2: MOSFET Operation & Biasing
Unit 3: Single stage Amplifiers
Unit 4: Differential Amplifier & Operational Amp
Unit 5: BJT
Unit 6: Misc Topics
Unit 7 (Laboratory): Super position theorem, transistor biasing etc.

Reference Books:
1. Fundamentals of Microelectronics by Behzad Razavi
2. Microelectronics Circuits by Sedra and Smith

5. Teaching-Learning Strategies in brief (4 to 5 sentences):
Students will be applying the lecture discussion to solved examples shared with them in the class. The assignments given will reinforce the concepts. Class room learning will be done in interactive method as much as possible. Occasionally self assessment test (1 minute paper) will be given. In lab class, students will make simple circuits using simple basic components.

6. Assessment methods and weightages in brief (4 to 5 sentences):

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<th>Type of Evaluation [3 credit-lecture]</th>
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1. Prerequisite Course / Knowledge:
Basic thermodynamics, mathematics, and computing skills

2. Course Outcomes (COs) (5 to 8 for a 3 or 4 credit course):

After completion of this course successfully, the students will be able to

- CO-1 Describe how different building blocks of biomolecules assemble to form diverse biomolecular architectures that drive many biological processes
- CO-2 Familiarize with different types of biomolecular interactions and analyze how they contribute to the structural and thermodynamic stability of biomolecules and biomolecular complexes
- CO-3 Outline different experimental techniques commonly used to characterize the structure and dynamics of biomolecules
- CO-4 Interpret experimental binding affinity data using molecular thermodynamic and statistical principles
- CO-5 Familiarize with the theory of enzymatic reactions

3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix

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4. Detailed Syllabus:
Unit 1: Hierarchy of length and time scales in biological systems and processes

Unit 2: Biological macromolecules: proteins, nucleic acids, lipids, carbohydrates (The building blocks of these biomolecules and their chemical bonding and interactions will be discussed. The following topics will be covered in this module: different amino acids, their classification, dipeptides, conformations, different nucleotides, nucleobases)

Unit 3: Structure and properties of biomolecules: (Levels of protein structure: primary, secondary, tertiary and quaternary structures, Ramachandran plot, double helical structure of DNA, RNA structures, experimental techniques commonly used for analyzing structures and interactions including NMR, ESR, X-Ray, CD, Fluorescence)

Unit 4: Interactions between biomolecules (covalent and noncovalent interactions, base pairing, hydrogen bonding, salt bridges, hydrophobic interactions, solvation, protein-ligand, protein-protein, protein-nucleic acid interactions)

Unit 5: Thermodynamics of protein folding (entropic vs enthalpic factors), energy landscape, structural stability and mutations

Unit 6: Introduction to enzymes, enzyme catalysis, enzyme kinetics, Michaelis-Menten equation

Unit 7: Biomolecular assemblies: bio membranes, chromatin, molecular motors, cellulose, riboswitches

Unit 8: Molecular modeling and docking: concepts and techniques

Unit 9: Biomolecular databases and tools: protein data bank, nucleic acid databases

Unit 10: Dry lab: Models, visualization, calculation of structural properties

Reference Books:
1. Lehninger Principles of Biochemistry - D. L. Nelson and M. M. Cox
2. Biochemistry - L. Stryer et al

5. Teaching-Learning Strategies in brief (4 to 5 sentences):

6. Assessment methods and weightages in brief (4 to 5 sentences):
Quizzes (20%), Assignments (25%), Reading Projects (25%), Final Exam (30%)

Title of the Course: Classical Mechanics
NAME OF FACULTY: Subhadip Mitra
Name of the Academic Program: CND
Course Code: SC1.102
L-T-P: 3-1-0.
Credits: 2
(L= Lecture hours, T=Tutorial hours, P=Practical hours)

1. Prerequisite Course / Knowledge:
None

2. Course Outcomes (COs):
After completing this course successfully, the students will be able to

CO-1 Discover how symmetry is connected to the conservation laws and identify the symmetries of mechanical problems and select the suitable generalized coordinates.

CO-2 Solve basic mechanics problems using Lagrangian or Hamiltonian formulation
CO-3 Explain the basic idea of special theory of relativity and compute simple problems involving length contraction and time dilation.

3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix

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Note: Each Course Outcome (CO) may be mapped with one or more Program Outcomes (POs) and PSOs. Write ‘3’ in the box for ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low-level’ mapping

4. Detailed Syllabus:
Unit 2: Lagrangian formulation. Calculus of variations, Conserved quantities,
Unit 3: Central force motion. Conversion of a 2-body problem to c.m. and relative coordinates, elastic collisions, Rutherford scattering
Unit 4: Small oscillations & rigid body dynamics. Geometric description of mechanics, nonlinear oscillations
Unit 5: Hamiltonian formulation. Liouville Theorem. Virial Theorem
Unit 6: Special theory of relativity

Reference Books:
1. Classical Dynamics of Particles and Systems by S T Thornton and J B Marion
2. Course Of Theoretical Physics, Vol. 1 Mechanics by L D Landau & E M Lifshitz
3. Classical Mechanics by H Goldstein

5. Teaching-Learning Strategies in brief:
This is the basic course on Classical Mechanics. The focus would be on concepts and intuition building with reasonable stress on the underlying mathematical structure.

6. Assessment methods and weights in brief:
Assignments + Quizzes – (60%),
Final exam (40%)

Title of the Course: Communication Theory
Course Code: EC5.203
Faculty Name: Praful Mankar
L-T-P: 3-1-1.
Credits: 4
(L= Lecture hours, T=Tutorial hours, P=Practical hours)

1. Prerequisite Course / Knowledge:
A prior knowledge of signals and systems, probability theory, random variables, and random process is required.
2. Course Outcomes (COs)

After completion of this course successfully, the students will be able to

CO-1. Explain the basic elements of a communication system.

CO-2. Interpret the complex baseband representation of passband signals and systems and its critical role in modeling, design, and implementation.

CO-3. Explain the basic concepts and implementations of analog modulation and demodulation techniques.

CO-4. Explain different linear digital modulation techniques using constellations such as PAM, QAM, PSK, orthogonal modulation and its variants.

CO-5. Apply the concepts of power spectral density, energy spectral density and bandwidth occupancy, Nyquist pulse shaping criterion for avoidance of intersymbol interference.

CO-6. Derive the optimal demodulation schemes for the digital schemes in the presence of AWGN.

CO-7. Evaluate the performance of different digital communications schemes in the presence of AWGN.

3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix

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4. Detailed Syllabus: 
Unit 1: Representation of bandpass signals and systems; linear bandpass systems, response of bandpass systems to bandpass signals, representation of bandpass stationary stochastic processes

Unit 2: Analog Communication Methods: AM-DSB and SSB, PM, FM-narrowband and wideband, demodulation of AM and PM/FM, Phased locked loop (PLL); Brief view of Line Coding and PWM

Unit 3: Digital Modulation: Representation of Digitally Modulated Signals; Memoryless modulation methods: PAM, PSK, QAM, Orthogonal Multi-Dimensional Signals


Unit 5: Optimum digital demodulation: Hypothesis testing, Signal Space Concepts, Performance analysis of ML reception, Bit error probability, Link budget analysis

References:

5. Teaching-Learning Strategies in brief:

Lectures will be integrating ICT into classroom teaching, active learning by students, followed by weekly tutorials involving problem solving, and project-based learning by doing theoretical and simulation assignments.

6. Assessment methods and weightages in brief:

Quizzes: 20
MidSem: 20
Assignments: 20
Final Quiz: 40

Title of the Course: Computational Linguistics 1
Faculty Name: Radhika Mamidi
Course Code: CL3.101
L-T-P: 3-1-0
Credits: 4
( L = Lecture hours, T = Tutorial hours, P = Practical hours)
Name of the Academic Program: CLD

1. Prerequisite Course / Knowledge:

Introduction to Linguistics-1

2. Course Outcomes (COs) (5 to 8 for a 3 or 4 credit course):
After completion of this course successfully, the students will be able to:

CO-1 Use computational methods to analyse language at morpho-syntactic levels

CO-2 Develop requisite skills for text and speech problem solving

CO-3 Able to develop computational resources and tools for Indian languages with different language structures

CO-4 Able to do theoretical research at phonology, morphology and syntax levels

CO-5 Able to apply CL/NLP techniques for real world applications by using real time data.

3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix

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4. Detailed Syllabus:

Unit 1: What is CL and where does it apply? Issues and challenges; Language processing pipeline for text processing: Structural Analysis at various levels – word (POS, morphology), phrase (chunk), sentence (syntactic parsing). Word meaning: Lexical Semantics, Dealing with Ambiguities (WSD/WTD)

Unit 2: Morph analysis: Morph analysers and word generators; Recap of basic units in word formation: morphemes, allomorphs. Word formation: Affixation, suffixation, prefixation, infixation; Non-concatenative, Compounding, Morphotactics; Constraints on
affixes; Morphophonology; Types of word formation processes (function based): inflectional, derivational; Developing morph analysers and generators: finite state automata, paradigmtables, add-delete rules; **Word Meaning:** Lexical semantics, Hypernymy, hyponymy, synonymy, antonymy, lexicon and lexicography; machine readable dictionaries, WordNet, ConceptNet, VerbNet etc.

**Unit 3: Shallow parsing and sentence analysis:** Words and their arrangements in a sentence. **POS Tagging** Word classes, Parts of Speech, POS tagging, Rule based parts of speech taggers, Statistical parts of speech taggers, Annotating POS tagged data, Issues in tagging, Defining tagset for your languages. **Shallow parsing (arrangement of words in a sentence)** Local Word Grouping (LWG) Grouping functional words such as prepositions/postpositions and auxiliaries with the content words (nouns, verbs); **Chunking:** Forming minimal phrases; **Multi-Word Expressions (MWEs):** Named entities (NEs), Idioms, compounds. Types of named entities; compositionality in MWEs.

**Unit 4: Syntactic Parsing:** Analysing the structure of a sentence, grammatical approaches; Constituency Analysis: Constituents/ phases; Deriving sentences using phrase structure rules (CFG); Constraints on rules; Subcategorization; verb argument structure. Representing phrase structures: X-bar schema, Complements and Adjuncts; Syntactic operations: Substitution, adjunction and movement. Syntactic phenomena: Passive, Raising, Control; **Dependency Analysis:** Dependency structures: Head – modifier relations. Paninian grammar – a dependency framework – relations in Paninian grammar: karaka, tadarthya, hetu etc; Vibhakti - relation marker; karaka vibhakti mapping, karaka chart; Parsing approaches: English parsers, Hindi/IL parsing using Paninian framework.

**Unit 5: Speech Processing:** Introduction to speech processing: Speech production; Speech perception; Speech analysis; Speech Recognition; Speech Synthesis

**Reference Books:**

1. Jurafsky & Martin, 2000; Speech and Language Processing, Pearson Education
2. Bharati et al., 1995; Natural Language Processing: A Paninian Perspective
3. Fundamentals of Speech Recognition by Lawrence Rabiner, Biing-Hwang Juang

**5. Teaching-Learning Strategies in brief (4 to 5 sentences):**

This is a mix of theory and project based. The focus is on using the methods taught in class to extend to Indian languages

**6. Assessment methods and weightages in brief (4 to 5 sentences):**

How the students are able to connect the linguistic concepts by using computational techniques to analyse and generate data at the level of sound, word and sentence. The
The course will have a project content where students will study and solve a problem using real language data. The focus is on individual as well as collaborative learning.

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1. Prerequisite Course / Knowledge:


2. Course Outcomes (COs)

After completion of this course successfully, the students will be able to:

**CO-1:** Explain the Von Neumann Model of Computing. Describe all the steps involved in the execution of a program: composition, compilation, assembly, linking, loading and hardware interpretation of the program instructions. (Cognitive Level: Understand)

**CO-2:** Describe the instruction set architecture design principles. Show how programming language constructs can be mapped to sequences of assembly language instructions. Analyze and assess any given ISA. (Cognitive Levels: Analyze and Evaluate)

**CO-3:** Describe processor design architectural approaches. Compare and contrast sequential designs with pipelined designs. Propose new architectural approaches to optimize on performance and hardware costs (Cognitive Levels: Apply, Analyze and Create)

**CO-4:** Describe the basic functionality of an operating system. Clearly explain the system call interface, its design and implementation. Build systems akin to a bash shell, file server etc. using system calls. (Cognitive Levels: Understand and Apply)

**CO-5:** Describe the basics of process control and management. (Cognitive Levels: Understand and Apply)
CO-6: Describe the principles of virtual memory management. Analyze various memory management schemes for process isolation and physical memory utilization across multiple processes (Cognitive Levels: Understand, Apply and Analyze)

3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix

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4. Detailed Syllabus

- **Unit 1:**
  - Basic computer organization, Von Neumann architecture and stored program concept
  - High level programming languages, assemble code, binary instructions, compilers and assemblers
  - Programming editing, compilation and execution cycle

- **Unit 2:**
  - Instruction Set Architecture Design Principles
  - CISC vs RISC ISAs
  - Binary encoding of the instructions
  - Mapping language constructs such as expressions, if-then-else statements, loops, functions to assembly code
  - Machine representation of numbers

- **Unit 3:**
  - Processor design fundamentals
  - ALU Design
  - Single Cycle and Multi Cycle Processor Design
  - Pipelined Architectures
  - Hazards in Pipelined Architectures and approaches to resolve them.

- **Unit 4:**
  - Introduction to Operating Systems. Bootstrapping Process
  - System Calls, their design, implementation and application.

- **Unit 5:**
  - Process Control and Management
• Scheduling multiple processes on multiple cores.
• Basics of scheduling mechanisms and policies.

• Unit 6:
  • Physical vs Virtual Memory
  • Process and memory isolation/protection mechanisms
  • Virtual memory management
  • Page replacement algorithms

Reference Books:

5. Teaching-Learning Strategies in brief

Lectures are conducted in a highly interactive fashion. Use of various system tools such as compilers, assemblers, loaders, linkers, simulators etc. are demonstrated live in the class. Assignments include assembly language programming, digital system design exercises such as Arithmetic and Logic Unit Design, programming using system calls. Most of the ideas introduced in the class are emphasized through these assignments. Teaching Assistants and Faculty conduct office hours every day. Thus students have continuous access to resources to get their doubts clarified and seek any extra help that is required. Some times students are encouraged to come to the board and explain the novel design ideas they came up with while solving assignments or mini-projects.

6. Assessment methods and weightages in brief

1. Programming Assignments (5 to 6) : 25 percent
2. Two Quizes: 2 x 10 percent
3. Mid Term: 20 percent
4. Final Exam: 35 percent

______________________________________________________
NAME OF FACULTY : Prabhakar Bhimalapuram
Name of the Academic Program : CND
Course Code : SC4.102
Title of the Course : Computing in Sciences-2
L-T-P : 3-1-0
Credits : 2
(L= Lecture hours, T= Tutorial hours, P= Practical hours)

1. Prerequisite Course / Knowledge:
The course “Computing in Sciences-1” can be considered the paired-course; if the student has not done it before this course, it should be done after this course.

2. Course Outcomes (COs) (5 to 8 for a 3 or 4 credit course):
After completion of this course successfully, the students will be able to..
CO-1 Demonstrate skill of **converting** a word statement of a problem to a mathematical problem statement

CO-2 Formulate a solution by application of learned concepts (in other Math courses) and employ computer to solve the problem

CO-3 Demonstrate skills in computer visualization of data, solution.

### 3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix

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**Note:** Each Course Outcome (CO) may be mapped with one or more Program Outcomes (POs) and PSOs. Write ‘3’ in the box for ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low-level’ mapping.

### 4. Detailed Syllabus:

**Unit 1:** Introduction / review concepts in Python, data structures, flow control and modules NumPy, MatPlotLib, and SciPy

**Unit 2:** Simple integration of 1-d and 2-d functions. Adaptive grid scheme and monte carlo method.

**Unit 3:** Nonlinear dynamics of Logistic map: fixed point, bifurcation, period doubling, deterministic chaos.

**Unit 4:** Coin toss statistics, gaussian distribution, tails of distribution (Cramers Theorem)

**Unit 5:** Epicycles in 2-dimensions. Fourier analysis for characterization of periods and amplitudes of component circular motions.

**Unit 6:** Simple molecular dynamics of noble gases. Fixed temperature simulation using Langevin dynamics.

**Reference Books:**
2. https://www.learnpython.org/

### 5. Teaching-Learning Strategies in brief (4 to 5 sentences):
After going over the theory in the first lecture, the next two meetings (1 lecture and 1 tutorial) will be hands on practice, after which student will hand in the submission for that Unit. Students are encouraged to form small groups and work through the computer programming and solving the problems.

6. Assessment methods and weightages in brief (4 to 5 sentences):

Each unit will have a submission of a workbook. All submissions will be given equal weightage and will have a weightage of 75% of the grade. An endsem will be conducted which will have one problem, and will have a weightage of 25%; the problem will be chosen to have (a) graphical visualisation, (b) use of one or more scientific modules in python and (c) some amount of theory covered in the lectures.

Title of the Course : Data Structures and Algorithms
Faculty Name : Sujit P Gujar
L-T-P : 3-1.5-3.
Credits : 4
(L = Lecture Hours, T = Tutorial Hours, P = Practical Hours)

Name of the Academic Program: B.Tech in Computer Science and Engineering

1. Prerequisite Course / Knowledge:

CS1.302 - Computer Programming

2. Course Outcomes (COs)

After completion of this course successfully, the students will be able to:

CO-1: Explain the design and implementation details of fundamental data structures and sorting/searching algorithms. (Cognitive Level: Understand)

CO-2: Write programs involving fundamental data structures and sorting/searching algorithms (Cognitive Levels: Apply and Analyze)

CO-3: Compare and contrast the performance of different data structures and sorting/searching algorithms with respect to time and memory. (Cognitive Levels: Analyze and Evaluate)

CO-4: Discover the algorithmic logic and new composite data structures required to solve well-defined computational problems while following specified compute constraints. (Cognitive Levels: Apply and Analyze)

3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix

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4. Detailed Syllabus

- Unit-1
  - Recap: Array, Pointers, Structures, Asymptotic Complexity
  - Abstract Data Types
- Unit-2: Linear Data Structures
  - Linked Lists
  - Stacks
  - Queues
- Unit-3: Non-linear Data Structures
  - Binary Trees and Search Trees
  - Hash Tables, Sets, Maps
- Unit-4: Sorting Algorithms
  - Sorting – Insertion
  - Sorting – Selection, Merge, Quicksort
  - Heapsort
  - Counting Sorts
  - Radix Sort, External Sorting
  - Sorting – External, Selection Algorithms
  - Selection Algorithms
- Unit-5: Graph Algorithms
  - Graphs – Representation and Algorithms
  - Graphs – Representation and Algorithms (DFS, Dijkstra, Bellman)
  - Graphs – Representation and Algorithms (MST)
  - Graphs - Strongly Connected Components
- Unit-6: Advanced Data Structures
  - AVL Trees
  - Suffix Trees

Reference Books:

1. Data Structures and Algorithm Analysis in C (M.A. Weiss), Pearson

5. Teaching-Learning Strategies in brief

Lectures are conducted in a highly interactive fashion. The design and implementation of data structures and sorting/searching algorithms is done as an in-class coding exercise. Tutorial sessions are used to teach the utilization of tools such as Visual Studio Code, Git etc. Lab sessions are used to solve programming assignments and teaching assistants help students in developing program logic, debugging etc. on an individual basis. Faculty conducts office hours once in week. Additionally, teaching assistants conduct office hours. This ensures continuous support to students. Five to six programming assignments are designed which gives an in-depth understanding of various concepts discussed in the class and their application to new problem scenarios along with proper analysis. Some problems involve evaluating, comparing multiple solution approaches.

6. Assessment methods and weightages in brief
1. Programming Assignments (5): 40%
2. Programming Lab Exam: 15%
3. Best 2 out of 3 Theory Quiz: 30%
4. Mini Project (4 members per team): 15%

For programming assignments and lab exams, online judges such as DMOJ are used to provide immediate feedback to students. While some test cases are revealed, others are hidden. Partial marks are allocated for code peer-reviewing in programming assignments. For mini project, a presentation followed by a code-execution demonstration is used for evaluation.

Title of the Course: Electrodynamics
NAME OF FACULTY: Subhadip Mitra
Name of the Academic Program: CND
Course Code: SC1.103
L-T-P: 3-1-0
Credits: 2
(L= Lecture hours, T=Tutorial hours, P=Practical hours)

1. Prerequisite Course / Knowledge:
None

2. Course Outcomes (COs):
After completing this course successfully, the students will be able to
CO-1 Explain how to compute the notion of scalar and vector potentials and use them
to compute electric and magnetic fields in various problems.
CO-2 Solve basic problems of finding electric and magnetic fields of configurations of
charges/currents including dipoles in free space or in matter.
CO-3 Recognize the Maxwell’s equations and explain how they lead to electromagnetic waves
in free space.

3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific
Outcomes (PSOs) – Course Articulation Matrix

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Note: Each Course Outcome (CO) may be mapped with one or more Program Outcomes (POs) and PSOs. Write ‘3’ in the box for ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low’-level’ mapping.

4. Detailed Syllabus:
Unit 1: Mathematical background. Basic vector calculus, orthogonal coordinate systems and
Dirac delta function.
Unit 2: Electrostatics. Coulomb’s law, electric field, Gauss’s law, electric potential, electrostatic
energy, conductors, electric fields in matter: polarization, bound charges, dielectrics
Unit 3: Magnetostatics. Lorentz force law, Bio-Savart law, Ampère’s law, vector potential,
magnetic fields in matter: dia-/para-/ferro-magnets, bound currents
Unit 4: Electromotive force, Faraday’s law
Unit 5: Maxwell's equations and electromagnetic waves

Reference Books:
1. Introduction to Electrodynamics by David J Griffiths
2. Classical Electrodynamics by J D Jackson
3. The Feynman Lectures on Physics, Volume II

5. Teaching-Learning Strategies in brief:
This is the basic course on Electrodynamics. The focus would be on concepts and intuition building with reasonable stress on the underlying mathematical structure.

6. Assessment methods and weights in brief:
Assignments + Quizzes – (60%), Final exam (40%)

Title of the Course: Electronic Workshop-1
Course Code: EC2.102
L-T-P: 0-1-3
Credits: 2

Typical Course Design Name of the Academic Program B. Tech. in ECE

Pre-requisite Course/ Knowledge:
Basics of Circuit Analysis
Introductory C Programming

Course Outcome EW1:

CO1 - Familiarization and demonstration of skill in handling electronic equipment and components such as Power Supplies, Signal Generator, CRO, bread-boards, soldering iron, passive components and active devices.
CO2 - Design and implementation of electronic circuits that involve analog and digital components, on breadboard and further observing, recording, analyzing and interpreting the results therein.
CO3 - Demonstration of psycho-motor skills in the form of connecting components on a breadboard, wiring, soldering circuits, and understanding of electronic hazards.
CO4 - Understanding and demonstration of tool usage in the form of Multi-Sim/LTSpice for simulation, verification and analysis of circuits
CO5 - Understanding the role of software – hardware interface in the form of software implementation on controller boards and their interface to electronic circuits. Demonstrate proficiency on the same

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Detailed Syllabus:

1. **Know your equipment and components** - Lab Equipment and components familiarization such as Power supply, Signal Generator, Oscilloscope, Breadboard, Transistor, Resistor etc...

2. **Design, Implementation and Analysis** - Implement circuits such as Voltage Regulator record, analyze and interpret the results. Around 3-4 circuits will be dealt with in this section.

3. **Electronic Circuit Design Simulation Software** - Learning to install and use Multisim. Design one of the earlier experiments on Multisim and compare hardware and simulation results.

4. **The Art of Soldering** - Solder one of the implemented circuits now on a general purpose PCB/Vector Board, record results, compare with the previous implementation on the breadboard.

**Hardware Software Symbiosis** - Use of controller boards to interface with electronic circuits and actuators, showcase the need for software-hardware interplay.

Teaching-Learning Strategies in Brief:

Learning by Implementation and Verification of Theoretical Understanding on Hardware, Individually learning through Experimentation, Participatory Learning and Learning by Interaction and Teamwork through Final Project. The experiments and projects are designed to materialize the above learning strategies. Individual experiments teach and enable real world understanding of concepts of electronic and circuit theory. Quizzes provoke the students towards the connections between theoretical understandings and their actual realization on hardware, often not touched in the regular coursework. Final project materializes an integrated and application driven understanding of the learnings acquired from the experiments.

Reference Books:

1. Hayt, Kemmerly and Durbin, “Engineering Circuit Analysis”
2. Sedra and Smith, “Microelectronic Circuits”,
3. Atmel, ATMega2560, User Manual

Grading:

1. Assessment of Lab Performance in 5 Experiments: 30%
2. Quizzes/Viva on Assessment of Theoretical Foundations: 30%
3. Final Project Performance: 40%

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<tr>
<th>Title of the Course</th>
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Prerequisite Course / Knowledge:

Basic knowledge of Electronics design (digital, analog, etc.).

Course Outcomes (COs):

After completion of this course successfully, the students will be able to.

**CO-1**: EW-II will enable students to have conceptual understanding and practical implementations of theoretical knowledge e.g., p-n junction diode, need of rectifiers, understanding of filters, understanding the working of transistors in various
configuration; understanding of MOSFET, amplification, conversion, processing, etc. Practical implementations will reinforce various concepts.

CO-2: Able to use various tools used in electronic, such as Soldering Iron, soldering wire, flux, Multimeter (analog and digital), male and female connectors (audio, video), Use of various devices (MOS, transistors, Diodes, SCR, etc.), Op-amp, Use of electronic instruments (multi-meter, signal generator, power supply, oscilloscope), etc.

CO-3: At the end of the course students are expected to be able to design and analyse electronic circuits, which involve many discrete active and passive components.

CO-4: Able to articulate the functionality of such circuits as well as be proficient in implementing the same in various domains.

CO-5: Posed with a non-obvious design problem the student should feel adequately confident to come up with the design, implement, debug and get it to work.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

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Each Course Outcome (CO) may be mapped with one or more Program Outcomes (POs). Write ‘3’ in the box for ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low’-level’ mapping.

Mapping with PSOs, where applicable.

Detailed Syllabus:

EW-II is a project intensive course focused on Electronics (analog, digital, mixed) design and application while elements of microcontroller programming that aids this design is an option. The course is broadly divided in two projects;

**Project-1** (e.g., Design of an Audio Amplifier) is common to all students (in a group of 2 students with the following specifications (for illustration only)

- Supply: 5V
- Input: 10-20 mV peak to peak
- Gain: G1 x G2 ≥ 500 (Pre amp and Gain stage)
- Frequency: Audible range (20 Hz - 20KHz)
- Power: P ≥ 1.5 W
- Filter should not attenuate the gain; Power amp shouldn’t be used for gain.
- Load: 10 Ω

**Project-2** is an individual project (in a group of 2 students), which are very applied test the students' mettle in the following areas broadly-

- Filter Design
- Amplifier and Rectifier Design
- Regulator Design
- ADC
- Sensor Integration to Controllers and Calibration
- Signal Processing
- Robotics
- IoT, etc.

Reference Books:

No preferred text book as this is a project course. Indicative textbook include Microelectronic Circuits by Sedra and Smith.
Teaching-Learning Strategies in brief (4 to 5 sentences):
Projects are the best way to open student minds to learning electronics practically. Making projects that do an exciting real-world task will make students curious to understand electronics better. The aim of this subject is to provide the knowledge of the fundamental concepts related to Electronics. The learning will involve handling wide variety of instruments while testing, trouble shooting, calibration etc. The study of EW-II will help students to gain the knowledge of working principles and operation of different instruments. During EW-II practical sessions, they will acquire the requisite skills.

Assessment methods and weightages in brief (4 to 5 sentences):
- Project 1: 40%
- Project 2: 60%

Title of the Course: GENERAL AND STRUCTURAL CEMISTRY
Name of the Faculty: Tapan Kumar Sau
Name of the Academic Program: CND
Course Code: SC2.101
L-T-P: 4-0-0
Credits: 4

1. Prerequisite Course / Knowledge: None
2. Course Outcomes (COs):
   - CO-1. Define quantum numbers for electrons, draw orbital diagrams, and state and apply the Pauli Exclusion Principle and Hund’s Rule to write the electronic configurations of atoms.
   - CO-2. Explain the position of elements in the periodic table and the general periodic trends in atomic size, ionic size, ionization energy, etc. of elements.
   - CO-3. State why chemical bonds form, identify the types of bonding that occur between metals/metal-nonmetal/nonmetal, state the current bonding models for simple inorganic and organic molecules, and predict important bonding parameters, structures, and properties.
   - CO-4. Compare the various acid base theories, identify acid-base conjugate pairs, predict the strengths of acids and bases, and describe the properties of acids and bases.
   - CO-5. Apply bonding theories of coordination compounds to explain their optical and magnetic properties.
   - CO-6. Describe the properties and applications of various modern materials like semiconductors, superconductors, magnetic materials, polymers and composite materials, and nanomaterials.
   - CO-7. Distinguish intermediates and transition state; use chemical reaction theories to explain chemical reactions and their rates.
   - CO-8. Be able to describe how chemistry plays a central role in modern science.

3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix

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Note: Each Course Outcome (CO) may be mapped with one or more Program Outcomes (POs) and PSOs. Write ‘3’ in the box for ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low-level’ mapping.

4. Detailed Syllabus:

Unit 1. **THE STRUCTURE OF ATOMS – A BASIC QM TREATMENT (2L)**
- Quantization of the energy levels; quantum numbers; s, p, d and f atomic orbitals; Pauli’s Exclusion Principle and Hund’s Rule of Maximum Multiplicity.

Unit 2. **CHEMICAL PERIODICITY (2L)**
- Periodic classification of elements; Atomic Radius; Ionic Radius; Ionization Energy; Electron Affinity; Polarizability; The Inert-Pair Effect; Diagonal Relationships; Chemistry with emphasis on group relationship and gradation in properties (metals and non-metals; Main Group Elements (s and p blocks); Transition Metals (d block): 3d elements); Relativistic Effects.

Unit 3. **CHEMICAL BONDS, MOLECULAR GEOMETRY AND STRUCTURE (6L)**
- a. Ionic Bond Formation and Lattice Energy
- b. Covalent Bonding; Valence-Bond Theory; Molecular Orbital Theory; How do we know that electrons are not paired; How do we know the energies of MOs? Major technique: XPS.
- c. Strengths and Lengths of a Bond; How do we know the length of a bond? How do we know the strength of a bond? Major techniques: Rotational & Vibrational Spectroscopies.
- d. VSEPR Model.
- e. ISOMERISM: Types; Optical isomerism in compounds (containing one and two asymmetric centers); Isomerism in coordination compounds; Major Techniques: Chromatography/Mass Spectroscopy.

Unit 4. **COORDINATION COMPOUNDS (2L)**
- The Shapes of Complexes; The electronic structures of complexes: Crystal Field Theory; Ligand Field Theory; Color and magnetic properties; Major technique: UV-Vis Spectroscopy.

Unit 5. **SOLIDS AND MODERN MATERIALS (4L)**
- Solid structures; Bonding in the Solid State; Semiconductors; Superconductors; Luminescent Materials; Magnetic Materials; Composite Materials; Nanomaterials; Major Technique: XRD

Unit 6. **POLYMER MATERIALS: SYNTHETIC AND BIOLOGICAL (2L)**
- Synthetic Polymers: Synthesis of Organic Polymers; Electrically Conducting Polymers; Biological Polymers: Proteins and Nucleic Acids; Major Techniques: NMR & CD spectroscopy.

Unit 7. **LIQUIDS (1L)**
- Intermolecular forces; Liquid structure; Liquid Crystals; Ionic Liquids.
Unit 8. PROPERTIES OF SOLUTIONS (2L)
Solubility and Common ion effect; Vapor Pressure; Colligative Properties; How to use colligative properties to determine the molar mass? The impact on biology and materials: Colloids; Biomimetic materials

Unit 9. SOLUTION CHEMISTRY (2L)
Bronsted-Lowry Acids; Buffers; Polyprotic systems

Unit 10. KINETICS (3L)
Mechanism of chemical reactions; Activated Complex Theory; Reactions in Solution; Reaction Dynamics; Enzymatic Catalysis

Reference Books:

Teaching-Learning Strategies in brief (4 to 5 sentences):
The course will involve lectures, exercises/assignments, quizzes, tutorials, and exams.

Assessment methods and weightages in brief (4 to 5 sentences):
The student assessment in the course involves written tests, quizzes, and assignments.

1. Assignments: 20%
2. Quizzes (2*10): 20%
3. Mid-Sem Exam: 20%
4. End-Sem Exam (WHOLE Syllabus): 40%

Title of the Course: Information and Communication
Faculty Name: Lalitha V
Name of the Academic Program: B. Tech in Electronics and Communication Engineering
Course Code: EC5.102
L-T-P: 3-1-0
Credits: 4

1. Prerequisite Course / Knowledge:
Basic idea of communication system, analog modulation and demodulation, basics of signals in time and frequency, basics of probability, basic understanding of binary number system.

2. Course Outcomes (COs):
After completion of this course successfully, the students will be able to:

CO-1: List all components in a typical communication system, and distinguish between analog and digital communications.
CO-2: Apply principles of information theory to calculate the entropy of a random source and the channel capacity of some simple noisy communication channels.

CO-3: Discuss Shannon’s Source Coding and Channel Coding Theorems and recognize their significance for modern communication.

CO-4: Employ probabilistic and combinatorial ideas to obtain a sketch of the proof of the Shannon’s source coding and channel coding theorems for some simple sources and channels.

CO-5: Analyze the performance of Huffman source coding for any given random source and some basic error correcting codes for some simple noisy communication channels.

CO-6: Evaluate the essential information and communication theoretic quantities in a wide variety of communication systems used in practice.

3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix

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4. Detailed Syllabus:

Unit 1: Examples of analog and digital signals, Conversion of Signals to Bits via Sampling, Quantization and Analog-Digital converters.

Unit 2: Sources of information, Information measure, Entropy, Representing sources as bit sequences, Source codes, Shannon’s Source Coding Theorem, Huffman Coding

Unit 3: Communication Resources – Analog and Digital Modulation, Probability of Error, Types of Channels (Wireless/Wireline), Noise, Binary Input-Binary Output Channels, Derivation of Binary Symmetric Channel from Gaussian Channels with Power Limitations.

Unit 4: Channel Codes, Shannon’s Channel Coding Theorem, Motivation and Simple Examples of Error Correcting Codes

Reference Books:
5. **Teaching-Learning Strategies in brief (4 to 5 sentences):**

The course is conducted through systematically prepared lectures and tutorial sessions. The lecture sessions are held in an interactive manner with short pop-quizzes for 1-2 minutes at appropriate junctures through which the instructor can understand the pulse of the classroom and whether the students are able to follow the class or otherwise. Based on these the lectures are fine-tuned (increase/decrease in pace or complexity of material covered). Further, the students are divided into groups of 4 or 5 each, and each group presents their understanding of the lectures in a short 10 minute presentation video per week as home assignment group wise. We call these as course summaries. Programming assignments are also given as home assignments which promote implementation-level understanding of theoretical topics taught in the class. In the tutorial sessions conducted with the help of teaching assistants, students learn to solve problems associated with the material covered in the lectures. These sessions are generally highly interactive and offer a platform for students to correct their understanding and also serve as a launching pad for students to pursue further directions of learning in Information and Communication theory advanced material that is not usually part of the regular lectures.

6. **Assessment methods and weightages in brief (4 to 5 sentences):**

<table>
<thead>
<tr>
<th>Type of Evaluation</th>
<th>Weightage (in %)</th>
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<tr>
<td>2 Mid Semester Exams</td>
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<td>Home assignment (Course Summaries and Programming assignments – group wise)</td>
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<td>End Semester Exam</td>
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**Title of the Course** : Introduction to Human Sciences  
**Name of the faculty** : Don Wallace Freeman Dcruz, Sushmita Banerji  
**Name of the Academic Programs** : B.Tech. in CSE, B.Tech in ECE  
**Course code** : HS8.102  
**L-T-P** : 3-1-0  
**Credits** : 4

1. **Prerequisite Course / Knowledge:** Nil

2. **Course Outcomes (COs)**

After completion of this course successfully students will be able to:

- **CO1:** Discuss the origin and development of key disciplines in the human sciences
- **CO2:** Identify some of the fundamental questions that shape and drive inquiry in human sciences
- **CO3:** Demonstrate knowledge of concepts related to theorizing about reflection, society, and culture
- **CO4:** Analyze crucial normative elements and descriptive frameworks in human sciences inquiry
- **CO5:** Develop skills to formulate nuances involved in problems concerning humans and societies
CO6: Write clear and well thought out short essays on topics in humanities and social sciences

3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix

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‘3’ in the box denotes ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low-level’ mapping

4. Syllabus:

The course will be divided into four modules, each of which will introduce students to a particular discipline in the human sciences. The various disciplines that constitute human sciences are:

1. Philosophy
2. Psychology
3. Literature
4. History
5. Sociology
6. Anthropology

Each module will offer a systematic worldview, tools of enquiry to study and analytical frameworks to make sense of topics taken up for discussion. Detailed list of topics under a module will be provided by the faculty teaching that module when the lectures begin. The overarching theme for the topics are the fundamentals of human sciences so that students grasp what humans sciences are all about.

Reference books:

Readings for each of the modules will be given with the commencement of the lectures. There is no single textbook as such for all four modules.

5. Teaching-Learning Strategies in brief:

Each module will have one faculty giving six lectures of 90 mins each. Through discipline specific modes of understanding and everyday examples, class lectures will enable students to connect and ponder about themselves, the society and cultures that surrounds them. The teaching-learning strategy emphasises the merits of avoiding simplistic solutions to complex problems and instead ask meaningful questions that enrich debates about how we produce, distribute,
consume, reflect, represent, and govern ourselves. Lectures impress upon students the need to critically reflect on issues that are impacted by technology, the historical and social context of the world they live in, the literary and philosophical ideas that permeate human thought and psychological principles of human behaviour.

6. Assessment methods and weightages in brief:

This is mainly a writing-driven course, and the evaluation questions are carefully designed to make students think independently. Students are assessed for abilities like critically assessing issues, questioning assumptions, clarifying distinctions, and bringing out nuances. In assignments and exams, students are expected to demonstrate these abilities by presenting their views clearly and systematically. Students will be evaluated for each of the four modules and the pattern of evaluation will be decided by the respective faculty. Evaluation pattern can include weekly assignments, quizzes and term papers. Each module will carry 25% of total marks.

Title : Intro to Processor Architecture
Course Code  : EC6.202
Faculty Name  : Deepak Gangadharan
L-T-P  : 3-1-0
Credits  : 2
(L=Lecture hours, T=Tutorial hours, P=Practical hours)

1. Prerequisite Course/Knowledge
Digital Systems and Microcontrollers

2. Course Outcomes (COs)

After completion of this course successfully, the students will be able to

CO-1. Explain Instruction Set Architecture (ISA) and the different paradigms RISC and CISC.

CO-2. Employ the different instructions and addressing modes to write assembly programs.

CO-3. Describe the instruction encoding in an ISA.

CO-4. Design and Develop Sequential and Pipelined Implementation of a Processor.

CO-5. Explain the different types of cache memories in memory hierarchy and its impact.

CO-6. Explain the importance of virtual memory and associated concepts such as page table, page faults and address translation.

3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix

| CO1 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 | PSO4 |
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4. **Detailed Syllabus**

**Unit 1:** Introduction to Processor Architecture – Definition of Computer System, Models of Computer Architecture, Programming Abstractions, Definition of Instruction Set Architecture, ISA Design Paradigms: RISC vs CISC

**Unit 2:** Machine Level Representation of Programs – Accessing Information: Operand Specifiers, Addressing Modes, Data Movement Instructions, Push and Pop Instructions, Arithmetic and Logic Operations, Condition Codes, Accessing Condition Codes, Jump Instructions and Encoding, Conditional Branches, Loops, Switch Statements

**Unit 3:** Processor Architecture – Instruction Set Architecture, Sequential Implementation, Principles of Pipelining, Pipelined Implementation

**Unit 4:** Memory Hierarchy – Storage Technologies, Locality, Types of Cache Memories, Impact of Cache on Program Performance

**Unit 5:** Virtual Memory – Physical and Virtual Addressing, Page Tables, Page Hits, Page Faults, Address Translation

**Reference Books:**


5. **Teaching-Learning Strategies in brief**

Weekly lectures cover the topics in the syllabus. Tutorials introduce the students to Verilog programming and general instructions on how to write Verilog program for various building blocks of a processor architecture – such as instruction decode, ALU, etc. There is one major project where each student designs and develops a HDL program for a pipelined processor architecture based on the theory covered in the lectures.

6. **Assessment methods and weightages in brief**
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**Course Name**: Introduction to IoT  
**Faculty Name**: Deepak Gangadharan  
**Name of the Academic Program**: B-Tech in Computer Science and Engineering  
**Course Code**: CS3.303  
**Credits**: 3  
(L=Lecture hours, T=Tutorial hours, P=Practical hours)

1. **Prerequisite Course/Knowledge**  
Basic knowledge of C/C++ programming, Digital Systems and Microcontrollers

2. **Course Outcomes (COs)**

After completion of this course successfully, the students will be able to

**CO-1**: Explain the definition of IoT and the various IoT architectures.  
**CO-2**: Explain the types and characteristics of commonly used sensors, actuators and microcontrollers.  
**CO-3**: Explain the communication and application layer IoT protocols.  
**CO-4**: Explain the concepts of Cloud+Fog Computing, IoT Interoperability, data handling and analytics.  
**CO-5**: Employ the Arduino Programming concepts to program microcontrollers.  
**CO-6**: Employ the interfacing of sensors and actuators with microcontroller.  
**CO-7**: Employ few communication and application layer protocols.  
**CO-8**: Employ an Interoperability standard called oneM2M.

3. **Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix**

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Note: Each Course Outcome (CO) may be mapped with one or more Program Outcomes (POs) and PSOs. Write ‘3’ in the box for ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low-level’ mapping.

Detailed Syllabus

Unit 1: Introduction – Definition, Architectures and Use Cases

Unit 2: Sensor and Actuators – Definition, features, classification, characteristics, physics of few basic and important sensors and actuators

Unit 3: Microcontroller and Programming –
- Basics of a controller, popular microcontrollers
- Microcontroller programming (Arduino/ESP32)
- Overview of different peripherals: ADC, DAC, Memory, GPIO, Timers
- Interfacing of Sensors and Actuators to microcontrollers: UART, SPI, I2C

Unit 4: Communication Protocols –
- Basics of communication network
- Overview of different communication technologies for IoT: LoRaWAN, Cellular (3G/4G/5G), WLAN, Bluetooth, Zigbee
- Overview of application/middleware protocols: MQTT, HTTP, CoAP
- Connecting the sensor node to the internet


Unit 6: Interoperability –
- Concepts and Types of Interoperability
- Interoperability Standards and oneM2M

Unit 7: Data Handling and Analytics –
- Handling - Definition, Data Types, Characteristics of Big Data, Data Flow (Generation, Acquisition, Storage, Analysis)
- Analytics - Definition, Types of Analytics (Descriptive, Diagnostic, Predictive, Prescriptive), Qualitative and Quantitative Analysis

Reference Books:

4. Teaching-Learning Strategies in brief
Weekly lectures cover the theory in the syllabus and the labs will deliver the hands-on experience in building IoT systems. The comprehensive quizzes and end semester exam will test the students on the relevant theory taught for IoT systems. The
The project will give the students an end-to-end IoT system development covering all the concepts learned in the labs.

5. Assessment methods and weightages in brief

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<td>Labs</td>
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<td>Project</td>
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Title: Introduction to Linguistics 2: Semantics, Pragmatics and Discourse

Credits: 3-0-1-4

Faculty name: Aditi Mukherjee

Type when: Spring 2022

Prerequisite: Introduction to Linguistics 1.

COURSE TOPICS:

SEMANTICS

PRAGMATICS

DISCOURSE

SEMINARS: Students will be expected to read research papers on various topics and make presentations in the class.

TEXT BOOKS:
John Saeed (2009) Semantics

SUGGESTED READINGS:

**OUTCOME:** Students will have a good understanding of semantic and contextual analysis of texts which will enable them in building text processing tools and systems.

<table>
<thead>
<tr>
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<th>Introduction to Quantum Information and Computation</th>
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<tbody>
<tr>
<td>Course Code</td>
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<tr>
<td>Faculty Name</td>
<td>Indranil Chakrabarty</td>
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**Prerequisite Course / Knowledge:**
Knowledge of Advanced Linear Algebra, Quantum Mechanics, Classical information Theory

**Course Outcomes (COs):**

After completion of this course successfully, the students will be able to..

CO-1. Understand the basic idea of Qubits (Quantum States), Pure and Mixed States, Quantum Measurements, Entanglement, Quantum Gates and the idea of extension of Entropy from Classical to Quantum. Learning Dirac Algebra to solve problems of Quantum Computing and Information

CO-2. Demonstrate familiarity with process like Quantum Measurement, Information processing tasks like Teleportation, Superdense Coding, Entanglement Swapping, s Quantum Circuits.

CO-3: Synthesize proofs of theorems related to Quantum Entropy using the mathematical and logical arguments.

CO-4. Design Quantum Circuits with Universal Gates,

**Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)**

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‘3’ in the box denotes ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low’-level’ mapping

Detailed Syllabus:

Unit 1. Introduction and Overview: Transition from Classical to Quantum (2L)


Unit 3. Quantum Entropy and Entanglement: Quantum Entropy, EPR Paradox, Schmidt Decomposition. (2L)

Unit 4. Basic Quantum Information Processing Protocols: Teleportation, Super Dense Coding, Entanglement Swapping. (2L)

Unit 5 Quantum Computation: Introduction to quantum computing, Pauli Gates, Hadamard Gates, Universal Gates, Quantum algorithms. (2L)

Reference Books:


Teaching-Learning Strategies in brief (4 to 5 sentences):

First of all there will be lectures which will introduce the motivations, concepts, definitions along with simpler examples. After that there are going to be assignments and quizzes that will make sure that the students have understood the concepts. These will be followed by deeper lectures and assignments as the area is interdisciplinary and new. These will also be supplemented with innovative problems so that they can apply the concepts learned by them.

Assessment methods and weightages in brief (4 to 5 sentences):

Mid - 20%
End Sem- 30%
Assignment- 15%
Quiz- 15%
Project -20%
Title of the Course: Introduction to Software Systems
Faculty Name: Raghu Reddy
Name of the Academic Program: Bachelor of Technology in Computer Science and Engineering
Course Code: CS6.201
L-T-P: 1-0-3
Credits: 2
(L= Lecture hours, T=Tutorial hours, P=Practical hours)

1. Prerequisite Course / Knowledge: Not applicable.

2. Course Outcomes (COs) (5 to 8 for a 3 or 4 credit course):

After completion of this course successfully, the students will be able to...

CO-1: Demonstrate familiarity with various OS Concepts, Shell programming, Web Technologies, Database Systems, Python Programming, software engineering principles.

CO-2: Understand the different types of tools and technologies that are suitable for solving different software problems

CO-3: Apply tools and technologies to implement simple software solutions

3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) - Course Articulation Matrix

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4. Detailed Syllabus:

Unit 1: Software and Systems overview - SHELL: OS concepts, Kernel, Memory, Shell basics, Advance Linux commands including file management and schedulers, Control flows, Regex, Awk,

Unit 2: Developing web applications - Introduction to HTML, CSS, JavaScript concepts, Datatypes, variables, operators, conditions, loops, functions, function expressions, events, form controls, data structures, java script libraries, AFrame, Three.js

Unit 3: Programming with Python – Functions, Exceptions, Error Handling, Sequences,
scoping rules, closures, higher order functions, mutability, object model and inheritance, modules and packages, variable args, decorators, usage of libraries including SOAP and REST API, Flask based server set up.

Unit 4: SDLC and Databases –
SDL concepts, Version Control Systems, Editors, Bug trackers, Basics of SQL, CRUD;

Reference Material/Books:
4. Workbook/Gitbook created by the course instructors (https://serciiit.gitbook.io/introduction-to-software-systems/)

5. Teaching-Learning Strategies in Brief (4 to 5 sentences):
The course is delivered using problem-based learning methodology. The major goal of the course is to introduce the students to various software and systems technologies and tools that can facilitate them to develop simple software systems. To achieve this goal, the course is delivered as a combination of lectures and tutorial sessions that provide students with hands-on experience in understanding the problem and implementing solutions using the corresponding software technologies and tools.

6. Assessment Methods and Weightages in Brief (4 to 5 sentences):
   Mid Exam – 15% Final
   Exam – 20%
   Assignments (3) – 25%
   Labs (4) – 20%
   Others – 20% (In-class Activities, Surprise quiz/test)

Title of the Course: Language Typology and Universals
Course Code: CSL1.204
Faculty Name: Radhika Mamidi
Name of the Academic Program: CLD
L-T-P: 3-1-0 Credits: 4
( L= Lecture hours, T= Tutorial hours, P= Practical hours)

1. Prerequisite Course / Knowledge:
   Introduction to Linguistics-1 and 2

2. Course Outcomes (COs) (5 to 8 for a 3 or 4 credit course):
   After completion of this course successfully, the students will be able to:
   
   CO-1 Analyse language at morpho-syntactic and semantic levels
   CO-2 Understand the similarities and differences between languages
CO-3 Understand language development and language loss in humans

CO-4 Understand different language families

CO-5 Build knowledge and do research and be able to build NLP applications in mother tongue

3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix

| CO1 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 | PSO4 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|------|------|
| 3   | 2   | 2   | 3   | 3   | 3   | 3   | 3   | 3   | 2   | 2    | 3    | 2    | 2    | 2    | 2    |

Note: Each Course Outcome (CO) may be mapped with one or more Program Outcomes (POs) and PSOs. Write ‘3’ in the box for ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low-level’ mapping

4. Detailed Syllabus:

**Unit 1: INTRODUCTION:** Nature of human language and its design features and comparison with animal communication systems - Duality of patterning, creativity, displacement etc; Levels of language organization- Phonological, Morphological; Grammatical and Discourse; **LANGUAGE CHANGE:** Concepts from Historical linguistics; language families and subfamilies; Comparative methods: spelling changes, types of sound changes, morphological changes, syntactic and semantic changes; Analogical change; Borrowing; the Great Vowel Shift; Grimm's law; Lexical comparisons

**Unit 2: COMPARISION AND CLASSIFICATION OF UNIVERSALS:** Historic-generic method and typological method; Language contact and convergence and areal typological study; South Asian language area and common areal features – experience subject, echo-formation, reduplication, retroflexion; Approaches to language universals: structural approach and generative approach – their assumptions about sampling, methodology and nature of linguistic elements.

**Unit 3: GREENBERG’S BASIC WORD ORDER TYPOLOGY:** Implicational universals and their role in restricting possible language types; absolute universals and tendencies; Post-Greenbergian research and reformulation
of word order typology. **CHOMSKYAN APPROACH TO LANGUAGE UNIVERSALS:** Language learnability,

poverty of stimulus and innateness hypothesis; Concepts of universal grammar; Principles and parameters –

head parameter, pro-drop parameter and X-bar theory of phrase structure.

**Unit 3: PHONOLOGICAL STRUCTURE:** Vowels and Consonants across languages; Distinctive features and phonological oppositions; Syllable types; Phonotactic constraints; Phonological Processes; Language acquisition and dissolution. Phonological universals. **MORPHOLOGICAL STRUCTURE:** Language types- Analytic, Agglutinative, Synthetic and Polysynthetic: derivational and inflectional categories and types of affixes; Morphological encoding of number, person, gender, tense, aspect and modal features, agreement and case marking; Parts of speech categories.

**Unit 4: CLAUSE STRUCTURE:** Grammatical relations – Nominative-Accusative and Ergative-Absolutive language types; Dative and other Nominative subjects; Relative clause types; Causative construction; Complement structure; Conjunctive Participles. **SEMANTIC STRUCTURE:** Case Grammar; Predicate argument structure and thematic roles and their realization; Paninian grammar and Karaka relations.

**Reference Books:**

5. Teaching-Learning Strategies in brief (4 to 5 sentences):
The teaching process is a mix of theory and activity based. The focus is on using the concepts taught in class to extend to mother tongue. Translation method to compare the languages they know will be done individually, as pairwork and in groups.

6. Assessment methods and weightages in brief (4 to 5 sentences):

<table>
<thead>
<tr>
<th>Type of Evaluation</th>
<th>Weightage (in %)</th>
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<tbody>
<tr>
<td>Assignments</td>
<td>25%</td>
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<tr>
<td>Seminar</td>
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<tr>
<td>Graded Exercises</td>
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<tr>
<td>Midsem Exam</td>
<td>15%</td>
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<tr>
<td>Endsem Exam</td>
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</table>

Title of the Course: Linear Algebra
Faculty Name: Girish Varms + Indranil Ch
Name of the Academic Program: BTech in Computer Science
Course Code: MA2.101
L-T-P: 3-1-0
Credits: 4

Prerequisite Course / Knowledge:
This is one of the first math courses and only assumes school knowledge of maths.

Course Outcomes (COs):
After completion of this course successfully, the students will be able to...

CO-1: Understanding the basic mathematical concepts like vector space, Basis, Linear Transformation, Rank Nullity Theorem, Matrix Representation of Linear Transformations, System of Equations, Determinants.

CO-2: Demonstrate familiarity with Eigenvalues, Eigenvectors, Orthogonality and Matrix Decomposition theorems.

CO-3: Synthesize proofs of theorems related to Matrices and Vector Spaces using clear mathematical and logical arguments.

CO-4: Apply principles of Spectral Decomposition and Singular Value Decompositions to real world problems in Image Compression, Principal Component Analysis etc.

CO-5: Design dimension reduction techniques with approximation guarantees using Best Fit Subspaces.

CO-6: Create mathematical models using principles of Linear Algebra and analyze them.
Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

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‘3’ for ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low-level’ mapping.

Detailed Syllabus:

**Unit 1:** Vector spaces, subspaces, Linear dependence, Span, Basis, Dimension, Finite dimension vector spaces Linear transformation, Range and Null space of linear transformation, Rank Nullity Theorem, Sylvester's Law, Matrix representation of a linear transformation for finite dimensional linear spaces, Matrix operations, change of basis, Rank of a Matrix, Range and Null Space of a matrix representing a linear transformation. Linear spaces with inner product [inner product example over space of functions: orthogonality and orthogonal functions in L_2.

**Unit 2:** System of Linear Equations, Row-echelon form, reduced row-echelon form. Gauss-Jordan elimination, Solution of linear systems using Gauss-Jordan elimination, matrix inversion by Gauss Jordan elimination, Understanding Range Space and Solution Space using Rank-Nullity Theorem.

**Unit 3:** Eigenvalues and Inner product: Eigenvalues & Eigenvectors, Norms, Inner Products and Projections, Applications like Analysis of Random Walks.

**Unit 4:** Advanced Topics: Spectral & Singular Value Decomposition Theorems, Applications of SVD and Best Fit Subspaces

**Reference Books:**

2. Finite Dimensional Vector Spaces, P. Halmos.
3. Introduction to Linear Algebra, Gilbert Strang.
4. Linear Algebra Done Wrong, Sergei Treil.

**Teaching-Learning Strategies in brief (4 to 5 sentences):**

Lectures will initially introduce the motivations, concepts, definitions along with simpler examples. This will be followed by assignments and quizzes that will make sure that the students have understood the concepts. These will be followed by deeper lectures and assignments which lead the students to the bigger questions in the area. These will also be supplemented with real world engineering problems so that they can apply the concepts learned by them.

**Assessment methods and weightages in brief (4 to 5 sentences):**

- Light In-class Quizzes: 15%
- Assignments: 15%
- Class Test 1: 10%
- Class Test 2: 10%
- Mid Exam: 20%
- End Exam: 30%

Title of the Course: Machine Data and Learning
Faculty Name: Vikram Pudi
Name of the Academic Program: B.Tech. in Computer Science and Engineering
Course Code: CS7.301
L-T-P: 3-1-0
Credits: 4
(L= Lecture hours, T=Tutorial hours, P=Practical hours)

1. Prerequisite Course /Knowledge:
   Data Structures, Computer Programming

2. Course Outcomes (COs)
   After completion of this course successfully, the students will be able to:
   CO-1. Understand basic ML concepts such as Underfitting, Overfitting and Bias-Variance tradeoff
   CO-2. Gain hands-on experience of applying these concepts to example problems
   CO-3. Understand local search techniques with focus on Genetic algorithms
   CO-4. Understand the basics of Probability and Utility theory
   CO-5. Usage of these concepts in the context of formal models such as Decision theoretic models and Bayesian networks
   CO-6. Understand Decision tree learning and notion of Information Gain

3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix

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4. **Detailed Syllabus:**

5. **Unit 1: Overview of AI and ML**

   Unit 2: Basic ML concepts including Data and generalization, Overfitting, Underfitting, Bias-variance tradeoff

   Unit 3: Local Search Techniques, Genetic Algorithms

   Unit 5: Basics of Probability and Utility Theory

   Unit 6: Decision Theory, Markov Decision Process, Modeling observation errors

   Unit 7: Decision Tree Learning, Construct decision trees from examples, Notion of information gain

   Unit 8: Bayesian networks

   References:
   
   - Python ML by Example by Yuxi (Hayden) Liu, Packt Publishing, 2017
   - Stuart Russell and Peter Norvig, Artificial Intelligence A Modern Approach, Pearson Education Inc., 2009

6. **Teaching-Learning Strategies in brief:**

   The course lectures will cover the core concepts while assignments will provide ample scope to implement and understand many of the concepts in more detail. Learning of theoretical concepts and problem solving will be enabled via quizzes, mid and final exams.

7. **Assessment methods and weightages in brief:**

   Assignments: 35 marks, Quizzes: 15 marks, Mid Exam: 20 marks, End Exam: 30 marks

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‘3’ in the box denotes ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low-level’ mapping
L-T-P: 3-1-0
(L= Lecture hours, T=Tutorial hours, P=Practical hours)
Credits: 2

1. Prerequisite Course / Knowledge: NA
2. Course Outcomes (COs) (2 credit course):
   CO1: Explain various mechanisms of structural stability of organic compounds and their reactivities
   CO2: Apply the mechanisms to describe types of reactions using stability of reaction intermediates
   CO3: Analyze the outcomes of different organic reactions using the principles of structure and stability of reactants and intermediate compounds

3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix

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4. Detailed syllabus

Concepts on structures, stabilities and reactivities

Unit 1: Reactive intermediates: Formation, structure, stability and fate of various reactive intermediates (Carbanion, carboxation, carbenes, nitrenes, benzynes, free radicals) – Reactive intermediates in biology and environment

Unit 2: Concepts of aromaticity

Unit 3: Molecular symmetry and chirality, Stereoisomerism, Classification of stereoisomerism, configuration, chiral centre, Axial chirality, planar chirality, helicity, Racemization and methods of optical resolution, Determination of configuration, Conformation of acyclic and monocyclic molecules-conformation and reactivity, Prochirality and protostereoisomerism, Stereochemistry of alkene, Chirality in molecules devoid of chiral centers, Chirooptical properties. Some reactions and their mechanisms

Unit 4: Methods for determining structures and reaction mechanisms
Unit 5: Types of reactions and their mechanisms

Radical substitution
Electrophilic addition to alkenes and alkynes – stereochemical considerations – Markonikov rule
Nucleophilic Substitution at saturated carbons (SN1, SN2 and SNi): Types, stereochemical considerations, Role of solvent
Nucleophilic addition to the Carbonyl group
Elimination reactions: Types (E1, E2 and E1cB) - stereochemical consideration, Role of solvent
Hofmann rules- Zaytsev Rules
Nucleophilic substitution at the carbonyl group
Electrophilic Aromatic Substitution: Benzene and its reaction with electrophiles- Effect of functional groups
Nucleophilic Aromatic substitution: Diazonium compounds
benzyne mechanism
Pericyclic reactions: Electrocyclic reactions, Cycloadditions, Sigmatropic rearrangements and Group transfer reactions
Important name reactions involving rearrangements
Functional group wise reactions
Conversions and Identifications.

5. Teaching-Learning Strategies in brief (4 to 5 sentences):
The objective of the course is to familiarize the CND students with basic concepts of organic reaction mechanisms. Since organic reactions are wide spread in natural biological systems as well as their applications in various industries, understanding the mechanisms is crucial. The course would provide the students with tools to analyze outcomes of organic reactions. It will further help them to learn the numerical analysis of molecular reactions later.

6. Assessment methods and weightages in brief (4 to 5 sentences):
Assignments – (20%), Class Quizzes + Mid-term evaluation (40%), Final exam (40%)

Reference book
A Guidebook to Mechanism in Organic Chemistry by by Peter Sykes

Title of the Course : Program Verification
Code : CS1.303
Faculty Name : Venkatesh Choppella

1 Course structure

   Name Program Verification
   Credits 2, Lectures-Tutorials-Practicals=3-1-0 (hours/week)
   Instructor Venkatesh Choppella

2 Prerequisite courses

   1. Computer Programming
   2. Discrete Mathematics

3 Course outcomes

A student graduating from the Program Verification course should be able to perform each of the following sample tasks:

   1. **CO1:** Specify simple computational problems Use logic and functional notation to precisely specify a problem in terms of an input-output relation. This includes problems related to elementary data structures and sequential algorithms.

   2. **CO2:** Model sequential algorithms as iterative systems Model sequential algorithms for searching and sorting and basic graph algorithms as simple iterative systems.
3. **CO3: Prove sequential algorithms correct** Write down a complete proof of total correctness of sequential algorithms for searching and sorting.

4. **CO4: Use verification tools** Develop facility to use software tools (Dafny, or Z3 etc.) for expressing and verifying correctness of algorithms

### Mapping of Course Outcomes to Programme and Programme Specific Outcomes

Table 1: Mapping of Course Outcomes to programme and programme specific outcomes

<table>
<thead>
<tr>
<th>Programme Outcome (PO/PSO)</th>
<th>CO1</th>
<th>CO2</th>
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<th>CO4</th>
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<td>PO3 Design/Develop</td>
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<td>PO7 Environment &amp; Sustainability</td>
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<td>PO8 Ethics</td>
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<td>PO9 Team work</td>
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<td>P10 Communication</td>
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<td>P11 Project Mgmt &amp; Finance</td>
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<td>P12 Life learning</td>
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<td>PS03 Research &amp; Development Skills</td>
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</table>

**Potential for PG study**
5 Syllabus


Sequential Program Models: Discrete Flows, fixed points, convergence, limit maps, sequential problem solving, bounded functions and invariants. Semantics of programming constructs.


6 Texts and References

Textbooks

MLCS Mathematical Logic for Computer Science, 3rd Edition. Murdoch Ben-Ari. Springer, 2013. This is the main text for the first half of the course. Reserve copies in the library.

MICS A Mathematical Introduction to Computer Science. Kasturi Viswanath. Universities Press, 2008. This is the main text for the second half of the course. Reserve copies in the library.

Other References

LiCS Logic in Computer Science. Huth and Ryan. Cambridge University Press.

7 Teaching and Learning Strategies

Lectures will cover the theoretical foundations of program verification: propositional and first order logic and state space models of programs. Lecture material will also include working with modern theorem provers and proof assistants in order for students to give a hands-on feeling of working with logic. Question answer discussions will accompany each class. Assignments will challenge the student to master proof and modeling techniques. Summative assessments will be thought quiz, mid-semester and a final exam. Reading assignments will precede each lecture. Homework (programming) assignments will mostly involve the use of technologies related to verification of programs.

8 Assessment (Tentative)

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<th>Item</th>
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<tr>
<td>Homeworks</td>
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<td>Quiz</td>
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<tr>
<td>Mid-semester exam</td>
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</table>
Appendix: Programme and Programme Specific Out- comes

Programme Outcomes (POs)

**PO1 Engineering knowledge** Use concepts from varied disciplines including Computer Science, Electronics, Mathematics, and the Sciences, to engineer and develop systems of varying scale.

**PO2 Problem analysis** Identify, formulate and analyze complex engineering problems reaching substantial conclusions using first principles of Mathematics, Natural Sciences and Engineering Sciences.

**PO3 Design/Development of solutions** Identify and bring to fore the necessary concepts from Computer Science and arrive at creative ways to solve problems that take into account the societal, cultural, and ethical considerations.

**PO4 Conduct investigations of complex problems** Interpolate and extrapolate based on existing knowledge base and self-learning skills to investigate the dynamics of complex problems and find solutions.

**PO5 Modern tool usage** Demonstrate requisite hands-on skills to work with a variety of software packages, libraries, programming languages, and software development environment tools useful in engineering large scales systems.

**PO6 The engineer and society** Make judicious use of resources and understand the impact of technology across the societal, ethical, environmental, and economic aspects.

**PO7 Environment and sustainability** Find technological solutions by considering the environmental impact for sustainable development.

**PO8 Ethics** Practice principles of professional ethics and make informed decisions after a due impact analysis.

**PO9 Individual and teamwork** Work efficiently in individual and team-oriented projects of varying size, cultural milieu, professional accomplishments, and technological backgrounds.

**PO10 Communication** Effectively communicate and exchange ideas and solutions to any individual including peers, end-users, and other stakeholders.

**PO11 Project management and Finance** Apply the principles of project management in general and software project management in particular with focus on issues such as the life cycle, scoping, costing, and development.

**PO12 Life-long learning** Exhibit the aptitude for independent, continuous, and life-long learning required to meet their professional and career goals.
Programme Specific Outcomes (PSOs)

**PSO1** Exhibit specialized knowledge in some sub-areas of Computer Science and Engineering such as Theoretical Computer Science, Computer Systems, Artificial Intelligence, Cyber-physical Systems, Cyber-security and use this specialized knowledge base to solve advanced problems.

**PSO2** Perform gap analysis in terms of systems and technologies and prepare roadmaps for incorporating state-of-the-art technology into system analysis, design, implementation, and performance.

**PSO3** Demonstrate research and development skills needed to define, scope, develop, and market futuristic software systems and products.

**PSO4** Demonstrate knowledge and skills at the required depth and breadth to excel in post-graduate and research programs.

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**Title of the Course**: Science II

**NAME OF FACULTY**: Marimuthu Krishnan + Nita Parekh

**Name of the Academic Program**: B. Tech. (CSE)

**Course Code**: SC1.111

**Credits**: 4

**(L= Lecture hours, T= Tutorial hours, P= Practical hours)**: 3-1-0

**1. Prerequisite Course / Knowledge**: NA

**2. Course Outcomes (COs) (5 to 8 for a 3 or 4 credit course):**

The course is divided into two halves:

First Half: Electromagnetism

Second Half: Introduction to Biology

**Outcomes of the Second Half (Introduction to Biology):**

After completion of this course successfully, the students will be able to

**CO-1**: Familiarize themselves with basic terms and terminology in biology, various biological entities and their function, DNA, RNA, proteins, and enzymes, cell and its functionality,

**CO-2**: appreciate that biology is very quantitative and how sequence analysis using algorithms can help in understanding the evolution, function of genes and proteins

**CO-3**: carry out a mini-project to learn how to go from sequence to structure, function and disease association

**3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix**
### Detailed Syllabus:

**Syllabus of the Second Half (Introduction to Biology):**

**Unit 1:** Introduction: Classification of Living Organisms, Origin of Life and Evolution, Biomolecules – Nucleotides, Amino Acids, Proteins, Enzymes

**Unit 2:** Cell Biology: Structure and Function - Prokaryotic and Eukaryotic Cells, Cell Cycle – Cell division – Mitosis, Meiosis, DNA Replication, Transition, Translation – Central dogma, DNA amplification, sequencing, cloning, restriction enzymes

**Unit 3:** Genetics: Mendelian Genetics – Genetic Disorders, Mendelian Inheritance Principles, Non-Mendelian Inheritance, Clinical Perspective

**Unit 4:** Macromolecules: DNA, Proteins – Structure, Function, Analysis, Carbohydrates – Features, Structure, Metabolism, Kreb cycle

**Unit 5:** Biological data analysis: Biological Data – sequence, structure, expression, etc., Sequence Data Analysis – alignment, database search, phylogeny, Applications

**Reference Books:**

2. Lehninger Principles of Biochemistry by David L. Nelson and Michael M. Cox
3. Reading the Story in DNA: A Beginners Guide to Molecular Evolution by Lindell Bromham
5. Teaching-Learning Strategies in brief (4 to 5 sentences):

The objective of the course is to give the CSE students a flavour of biological sciences. To familiarize the students with available web-based resources (databases and tools) for biological sequence analysis and extract meaningful information. Whenever possible, after a theory lecture to follow up with analysis of real sequence data. Give the student small programming tasks in biological data analysis to be able to appreciate the role of computing in biological data analysis.

6. Assessment methods and weightages in brief (4 to 5 sentences):

Assignments – (10%), Class Quizzes + Mid-term evaluation (20%), Final exam (20%)

Title of the Course: Statistical Mechanics
Name of the Faculty: Harjinder Singh
Name of the Academic Program: B Tech (CND)
Course Code: SCI 205

L-T-P: 2(90mins)-1-0 Credits: 2 (L= Lecture hours, T=Tutorial hours, P=Practical hours)

1. Prerequisite Course / Knowledge: Thermodynamics, elementary classical and quantum mechanics

2. Course Outcomes (COs) (5 to 8 for a 3 or 4 credit course):
   After completion of this course successfully, the students will be able to
   CO-1 State principles of ensemble theory applied to statistical physics
   CO-2 Apply statistical mechanics to investigate natural systems
   CO-3 Apply scientific methodology to problems in allied disciplines.

3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix

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<tr>
<th></th>
<th>PO1</th>
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Note: Each Course Outcome (CO) may be mapped with one or more Program Outcomes (POs) and PSOs. Write ‘3’ in the box for ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low-level’ mapping

4. Detailed Syllabus:
Unit 1: 1. The purpose of statistics: Bridging the micro and the macro, random walk, binomial distribution and the Gaussian limit: 1L
2. Ensemble, micro-canonical, canonical and grand canonical; Partition function, Lagrange multiplier technique to obtain the Boltzmann distribution: 2L
Unit 2: 3. Statistical expressions for thermodynamic functions for monatomic, diatomic and polyatomic perfect gases, equilibrium constant using partition function: 2L
4. Classical statistical mechanics, Liouville equation, Equipartition of energy: 1L
Unit 3: 5. Identical particles, Quantum statistics - Fermi-Dirac and Bose-Einstein statistics: 2L
6. Special topics (Real gases, Liquids, Lattice dynamics, Ising spins, etc.): 3L
Reference Books:
3. F. Reif (2017), Fundamentals of Statistical and thermal Physics, (Berkeley Physics, vol. 5), McGraw Hill Education, NY

5. Teaching-Learning Strategies in brief (4 to 5 sentences):
Teaching currently is online. Along with prepared slides, tools are used to write material extempore and draw pictures to explain the material.
Assignments are open for discussion before submission, though submission must be original.
Class exercises are used for effective learning.
Instructor is available 24X7 for discussions over the net either by a meeting or over email. This interactive process has helped the students to develop clarity on the learning material.

6. Assessment methods and weightages in brief (4 to 5 sentences):

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Weightage</th>
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<tbody>
<tr>
<td>Quiz</td>
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<td>Final Exam</td>
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<tr>
<td>Assignments (4)</td>
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Course Title : The Making of Contemporary India
Faculty Name : Nazia Akhtar
Name of the Program : Computing and Human Sciences (CHD)
Course Code : HS4.102
Credits : 4 credits
L-T-P: : 36 hours (24 classes)
Semester, Year : Spring 2022
Pre-Requisites : CHD Core

Course Outcomes :
On successful completion of this course, students will be able to

1. identify and explain major political, social, and economic trends and milestones that have made India what it is today;
2. compare and assess major frameworks and methods that scholars have used to study India;
3. apply the essential conceptual foundations taught in this course to other courses that offer in-depth study of related topics and themes; and
4. develop a critical vocabulary and perspective that will contribute to the growth of their individual research voice and expertise at the confluence of computing and human sciences.

**Course Topics:**

1. **Colonial Background:** This part of the course will give an overview of the main features of colonial rule and of India's independence movement. It will also cover some of the more important social and economic trends which started in the late 19th and early 20th century.
2. **Independence, Partition, Constitution of the new Nation-State:** This part will focus on moment of independence and the making of the Constitution.
3. **Overview of 1950s to 2000s:** This part of the course will bring out how India's polity and society passed through transition and faced new challenges. Each decade will be studied to identify the major landmarks of independent India's political, social, economic, and development journey.
4. **Cross-cutting themes:** In the last part of the course, a select few long term processes like literacy and education, infant mortality and sex-ratios, migration and urbanization, travel and communication, etc. would be taken up for study.

**Preferred Text Books:**

1. Sugata Bose, Ayesha Jalal: *Modern South Asia*
2. Michael Mann: *South Asia’s Modern History: Thematic Perspectives*
3. Paul Brass: *The Politics of India since Independence*
4. Pranab Bardhan: *The Political Economy of Development in India*

**Reference Books:**

1. Sumit Sarkar: *Modern Times*
2. Stuart Corbridge, John Harris, Craig Jeffrey: *India Today – Economy, Politics, Society*
3. Rajeev Bhargava: *Politics and Ethics of the Indian Constitution*
4. Francine R. Frankel: *India’s Political Economy 1947-2004*
5. Niraja Gopal Jayal, Pratap Bhanu Mehta: *The Oxford Companion to Politics in India*
6. Satish Deshpande: *Contemporary India: A Sociological View*
8. Devesh Kapur, Pratap Bhanu Mehta: *Public Institutions in India: Performance and Design*
9. Amartya Sen: *The Country of First Boys, and other essays*
10. Kanti P. Bajpai, Harsh V. Pant: *India’s Foreign Policy: A Reader*
11. M. N. Srinivas: *Social Change in Modern India*
12. Ravi Agrawal: *India Connected: How the Smartphone is Transforming the World’s Largest Democracy*

**Grading Plan:**

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<tr>
<th>Type of Evaluation</th>
<th>Weightage (in %)</th>
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<tbody>
<tr>
<td>Assignments (four)</td>
<td>15% x 4 = 60%</td>
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Teaching-Learning Strategies in brief:
The teaching-learning strategy in this course will consist of lectures based on set readings, which students are expected to complete in advance of the class. These lectures will incorporate prompts for classroom discussion and activities based on the readings to enable active learning and critical thinking. This learning will be further consolidated through assessments that will be designed to test and develop the student’s knowledge and skills, especially interpretative reading and writing.
4. Detailed Syllabus:
Unit 1: 1. Thermodynamic space, system and surroundings, variable, function, Thermodynamic process and energy transaction: Work, Heat; Walls: Diathermal, Adiabatic, (im)permeable 1L
2. Properties of Gases: Perfect and real 1L
3. Zeroth law and temperature, first law and internal energy, enthalpy, thermochemistry, Hess’s law 1L
4. Expansion Work, Isothermal and Adiabatic Changes, Heat capacity 1L
Unit 2: 5. Second law and equivalence of different ways of stating it, Clausius inequality The Joule-Thomson Effect, Entropy, Heat Engine, Refrigerator, Carnot Cycle 2L
6. Helmholtz and Gibbs Free Energies, thermodynamic equation of state, criteria for spontaneity, chemical potential, variation with temperature and pressure, Maxwell relations 2L
7. Fugacity and activity 1L
Unit 3: 8. Thermodynamics of mixing, Phase Diagrams and Phase Transitions 2L
9. Chemical equilibrium, Equilibrium constant and standard free energy 1L
10: Equilibrium electrochemistry
Reference Books:

5. Teaching-Learning Strategies in brief (4 to 5 sentences):
Teaching currently is online. Along with prepared slides, tools are used to write material extempore and draw pictures to explain the material.

Class exercises are used to ensure effective learning.
Assignments are open for discussion before submission, though submission must be original. Instructor is available 24X7 for discussions over the net either by a meeting or over email. This interactive process has helped the students to develop clarity on the learning material.

6. Assessment methods and weightages in brief (4 to 5 sentences):

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<th>Component</th>
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Title of the Course: Thinking and Knowing in the Human Sciences – I
Faculty Name: Don Dcruz + Sushmita Banerjee
Course code: HS0.201
Name of the Academic Program: CHD
L-T-P: 3-1-0
Credits: 4

1. Prerequisite Course / Knowledge: Nil
2. Course Outcomes (COs)

After completion of this course successfully students will be able to:

CO1: Understand the basics of philosophical discourse and develop interpretative skills
CO2: Demonstrate knowledge of conceptual challenges involved in philosophical analysis
CO3: Discuss philosophical questions about the nature of thought, knowledge and understanding
CO4: Look at the ways in which literary practices imagine and express our relation to the world.
CO5: Survey sets of concepts and intellectual assumptions that constitute historical, cultural, textual, and critical methods of literary analyses
CO6: Consider specific moments of intersection between “meta-inquiry” and questions of representation.

3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix

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‘3’ in the box denotes ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low'-level’ mapping

4. Detailed Syllabus:

Section A: Philosophy

Unit I – Philosophical tools (5 hours): conceptual distinctions, argument analysis, definition, evidence, belief, knowledge, justification, confirmation, and inference to best explanation.

Unit II – Knowledge and its limits (6.5 hours): kinds of knowledge and its sources, the problem of induction, scepticism about our senses regarding the external world, and skepticism about reflection regarding the internal world.

Unit III – Cognition and its nature (6.5 hours): dualism and the mind-body problem, functionalism and the computational account of thinking, physicalism and qualia, subjective experience and the hard problem of consciousness.

Reference books:

Section B: Literature

PREFERRED TEXT BOOKS FOR SECTION B


   Morrison Toni. *Beloved.* 1987


REFERENCE BOOKS FOR SECTION B


5. Teaching-Learning Strategies in brief:

Section A: Philosophy – the general teaching strategy employed is the use of conceptual puzzles to introduce course topics. Lectures make use of this strategy to impress upon students the need to critically reflect on problems and the relevance of doing a careful, philosophical investigation of those issues. Students are taught effective reasoning skills to engage with abstract ideas without spoon feeding them any settled philosophical truths. They are trained to think for themselves in a clear and organized manner and encouraged to ask meaningful questions that enrich debates about what we take for granted in thinking and knowing about the world and ourselves.

Section B: Literature – Plays, novels and poetry have given their authors and their readers an opportunity to consider what it is to be human. This course looks at some the ways in which literary practices imagine and express our relation to the world. The module will survey sets of concepts and intellectual assumptions that constitute historical, cultural, textual, and critical methods of literary analyses. We shall look at specific texts to see how the field of literary studies has evolved to reformulate its primary concerns and moved beyond canon formation to questions of epistemology and subjectivity.

Students are expected to read six full texts in the course of the module.
6. Assessment methods and weightages in brief:

**Section A: Philosophy** – questions are carefully designed to make students reflect critically on what they read. Students are assessed for abilities like logically dissecting issues, questioning assumptions, clarifying distinctions, and bringing out nuances. In assignments and exams, students are expected to demonstrate these abilities by presenting their views clearly, assessing competing positions systematically, anticipating possible objections to a reasoned conclusion and composing cogent responses to those objections. The assessment components and their weightages are as follows. Assignments: 35%, Essay 10%, and class participation: 10%.

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<tr>
<th>Type of Evaluation</th>
<th>Weightage (in %)</th>
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<tbody>
<tr>
<td>In-Class assignments (Due every week)</td>
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<tr>
<td>Term Paper 1</td>
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<td>Term Paper 2</td>
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<td>Participation</td>
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**Section A: Literature**

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<td>In-Class assignments (Due every week)</td>
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<td>Participation</td>
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**Title of the Course**: Value Education II  
**Course Code**: OC3.102  
**Faculty Name**: Radhika Mamidi  
**L-T-P**: 12-6-0  
**Credits**: 2  
(L= Lecture hours, T=Tutorial hours, P=Practical hours)

**Name of the Academic Program**: B. Tech. in ECE, BTech in CSE

1. **Prerequisite Course / Knowledge**: NIL

2. **Course Outcomes (COs)** (5 to 8 for a 3 or 4 credit course):

   After completion of this course successfully, the students will be able to:
   
   CO-1: Apply the basic framework of universal human values to understand oneself  
   CO-2: Understand the relation of self with family, society and nature  
   CO-3: Understand the concept of living in harmony at all levels  
   CO-4: Right understanding of relationships and Right utilization of physical facilities  
   CO-5: Help students realise the long-term goal of being happy and prosperous

3. **Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)** – Course Articulation Matrix

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Note: Each Course Outcome (CO) may be mapped with one or more Program Outcomes (POs) and PSOs. Write ‘3’ in the box for ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low’-level' mapping

4. Detailed Syllabus:
   Unit 1: Revisiting goal in life - short term and long term goals; Basic aspirations - Happiness and Prosperity; Role of education and human conduct; Self-exploration; Developing a holistic view
   Unit 2: Self-reflection and reflecting on relationships; understanding value-based life
   Unit 3: Living in harmony at 4 levels: self-self, self-family, self-society, self-nature
   Unit 4: Harmony in Society; Broadening one's perceptions;
   Unit 5: Nature and Sustainability; Our role in protecting Nature;

Reference Books:

5. Teaching-Learning Strategies in brief (4 to 5 sentences):
   This is a discussed based course. The instructor shares information on a topic and guides the discussion in the class by asking the right questions. By keeping the objectives in mind, the instructor adopts different techniques including smaller group discussions, role-play/skit, use of video clips/films or images to analyse and some activities to keep the students engaged in class throughout. Talks by experts who made a difference are also organised for the batch.

6. Assessment methods and weightages in brief (4 to 5 sentences):
   This is a Pass/Fail course. The assessment methods include submissions of assignments and term papers. Critical thinking is expected from watching relevant short films or by reading assigned books. The classroom participation is also taken into consideration for evaluation. There are a few community-based activities and projects also. Participation in them is also important.

Title of the Course : Advanced Algorithms
Course Code : CS1.406
Faculty Name : Suryajith Ch
L-T-P : 3-1-0
Credits : 4
Prerequisite Course / Knowledge:
Should have taken Introduction to Algorithms, and Formal Languages, or equivalent courses

Course Outcomes (COs):

After completion of this course successfully, the students will be able to.

CO-1: Demonstrate familiarity with using randomness in computing

CO-2: Apply principles of randomized algorithm design and analyze them for correctness and efficiency

CO-3: Synthesize randomized algorithms with either zero-error or one-sided error for a variety of problems

CO-4: Explain the significance of parallelism to modern day computing and problem-solving needs

CO-5: Apply principles and paradigms of parallel algorithm design and analyze parallel algorithms for correctness and efficiency

CO-6: Create efficient parallel algorithms for a variety of semi-numerical problems and problems on graphs

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

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Each Course Outcome (CO) may be mapped with one or more Program Outcomes (POs). Write '3' in the box for 'High-level' mapping, 2 for 'Medium-level' mapping, 1 for 'Low-level' mapping

Mapping with PSOs, where applicable.

Detailed Syllabus:
Unit 1: Randomness in computing: Tail inequalities and applications, fingerprinting, proofs of existence, expander graphs

Unit 2: randomized rounding, approximate counting

Unit 3: Parallelism in computing: Models of PRAM, Basic algorithms for prefix, search, sort, merge,

Unit 4: Parallel algorithms for lists, graphs, and symmetry breaking

Reference Books:

2. J. JaJa (1992), Introduction to Parallel Algorithms, Addison-Wesley, USA.

Teaching-Learning Strategies in brief (4 to 5 sentences):

The course lectures will include activities that promote the understanding of the lecture content by using small examples that students work out during the class itself and promote active and participatory learning. A good part of the lecture will involve problem solving and finding solutions to problems rather than expositing known material. In class tests that are held periodically are useful as summative assessments. Homework assignments are designed to reiterate the material covered in class lectures and also solve problems that are based on simple extensions of concepts described in the lectures.

Assessment methods and weightages in brief (4 to 5 sentences):

- Homeworks: 20%
- In-class Objective Tests: 20%
- Quiz 1: 15%
- Quiz 2: 15%
- End Exam: 30%
1. **Prerequisite:** Mechanics of Materials

2. **Course Outcomes**

<table>
<thead>
<tr>
<th>CO</th>
<th>Description</th>
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<tbody>
<tr>
<td>CO 1</td>
<td>Integration of buckling phenomenon with design</td>
</tr>
<tr>
<td>CO 2</td>
<td>Learn preliminary design prior to full computational analysis</td>
</tr>
<tr>
<td>CO 3</td>
<td>Learn the basic principles of composite structures</td>
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<tr>
<td>CO 4</td>
<td>Understand the basics of structural mechanics and design.</td>
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<tr>
<td>CO 5</td>
<td>Understand the underlying principles of code-based design.</td>
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<tr>
<td>CO 6</td>
<td>Learn methods useful for checking the output from more complex methods</td>
</tr>
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</table>

3. **Course Topics**

<table>
<thead>
<tr>
<th>Topic</th>
<th>Description</th>
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<tbody>
<tr>
<td>Flexure</td>
<td>von Mises yield criterion, Elastic section modulus, Plastic section modulus, Moment curvature relation, Unsymmetrical bending, Shear strength, Bending strength, Bending moment capacity in the presence of shear forces</td>
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<tr>
<td>Torsion</td>
<td>Saint-Venant torsion theory, Prandtl stress function, Membrane analogy, Lateral torsional buckling, Elastic critical buckling moment</td>
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<tr>
<td>Columns and Trusses</td>
<td>Basic strut buckling, Elastic critical buckling force, Inelastic buckling, Residual stresses, Beam Columns, amplification factors, Beam-column design equation, Beam column with lateral torsional buckling, Web buckling, Simple Trusses, Buckling of compression members, Slender trusses, Slender trusses subjected to compression and bending</td>
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<tr>
<td>Arches</td>
<td>Buckling of arches, In-plane buckling, Out-of-plane buckling, Parabolic arch, Elastic critical buckling load, Equivalent strut method, Elastic critical buckling load by Timoshenko method</td>
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<td>Thin-Walled Structures</td>
<td>Unstiffened plates in compression, Shear buckling of unstiffened plates, Unstiffened plates in compression and shear, Stiffened plates in compression, Stiffened plates in shear, Stiffened panels subjected to shear and compression, Stiffened plates with lateral loads, Stiffened panels in shear, compression, and bending</td>
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<tr>
<td>Composite Structures</td>
<td>Shear studs, Effective width, Serviceability limit state design, ULS bending strength, Elastic design of shear studs, Plastic design of shear studs</td>
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</table>

4. **Preferred Text Books:**
   - Cook, R., D., Advanced Mechanics of Materials
   - Spiegel, P. E., Applied Structural Steel Design

5. **Reference Books:**
   - Boresi, A. P., Advanced Mechanics of Materials
   - McCormac, J. C., Structural Steel Design

6. **Grading Plan**

<table>
<thead>
<tr>
<th>Type of Evaluation</th>
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<td>Assignments</td>
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7. Mapping of Course Outcomes to Program Objectives

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8. Teaching-Learning Strategies

Lectures in class room, weekly tutorials on problem solving, active learning by students.

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**Title of the Course**: Advanced Optimization: Theory and Applications  
**Course Code**: CS1.501  
**Faculty Name**: Pawan Kumar  
**L-T-P**: 3-1-0.  
**Credits**: 4  
(L= Lecture hours, T=Tutorial hours, P=Practical hours)

1. **Prerequisite Course / Knowledge:**  
Linear Algebra, Calculus
2. Course Outcomes (COs)

After completion of this course successfully, the students will be able to –

CO-1. Learn basic mathematics tools of convex sets, functions, optimization methods.
CO-2. Learn advanced theory on nonlinear optimization, non smooth, and min-max optimization.
CO-3: Learn to prove convergence estimates and complexity of the algorithms rigorously.
CO-4. Learn to code advanced optimization solvers efficiently using Python.
CO-5. Demonstrate expertise in applying optimization methods in computer science such as data science and machine learning.

3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix

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4. Detailed Syllabus:

Unit 1: Review of convexity, duality, and classical theory and algorithms for convex optimization (6 hours)

Unit 2: Nonlinear and non-smooth optimization, projected gradient methods, accelerated gradient methods, sub-gradient projection methods, adaptive methods, second order methods, dual methods, solvers for min-max, alternating minimization, EM algorithm, convergence estimates (12 hours)

Unit 3: Applications of advanced optimization: sparse recovery, low rank matrix recovery, recommender systems, extreme classification, generative adversarial methods(6 hours)

- A project related to the above syllabus will be done by students.

References:
Title of the Course: Advanced Structural Analysis
Name of the Faculty: Dr. P. Pravin Kumar Venkat Rao
Name of the Academic Program: M.Tech in CASE
Course Code: CE1.603
L-T-P: 3-1-0
Credits: 4

1. Prerequisite Course/Knowledge: Basic Structural Analysis

2. Course Outcomes (COs):

After completion of this course successfully, the students will be able to:

CO1: Develop the stiffness matrix for prismatic members and have a sound knowledge of matrix computations.

CO2: Analyze determinate and indeterminate plane and space truss/frame system.

CO3: Derive the collapse load factors for a given structure.

CO4: Understand how standard software packages (routinely used for frame analysis in design offices) operate.

3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix

Note: Each Course Outcome (CO) may be mapped with one or more Program Outcomes (POs) and PSOs. Write ‘3’ in the box for ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low-level’ mapping.

4. Detailed Syllabus:

Unit 1: Types of structures, Linear and non-linear analysis, type of elements, type of connections, Degree of freedom, Review of analysis of indeterminate structures, Degree of static and kinematic indeterminacy. Introduction to stiffness and flexibility approach.

Unit 2: Stiffness matrix for spring, Bar, torsion, Beam (including 3D), Frame, and Grid
elements, Displacement vectors, Local and Global co-ordinate system, Transformation matrices, Global stiffness matrix and load vectors, Assembly of structure stiffness matrix with structural load vector, Effect of sinking and rotation of a support.

**Unit 3:** Analysis of spring and bar assembly, Analysis of plane truss, space truss, plane frame, planegrid and spaceframmessubjectedtojointloads, Analysis of structures for axial load, Frame with inclined members, Analysis for member loading (Self, Temperature & Imposed), Inclined supports, Lack of fit, Initial joint displacements, Effect of headeformation, Inclined rollers supports.

**Unit 4:** Elastic and plastic behaviour of steel, Plastic hinge, Fundamental conditions for plastic analysis, Combination of mechanisms, Theorems of plasticity, Mechanism method, Static method, uniformly distributed loads, Continuous beams and frames, Collapse load analysis for prismatic and non-prismatic sections.

**Reference Books:**


5. **Teaching-Learning Strategies in Brief (4 to 5 sentences):**

In this course, the main objective is to enable the student to have a good grasp of all the fundamental issues in these advanced topics in structural analysis, besides enjoying the learning process, developing analytical, and intuitive skills.

6. **Assessment methods and weightages in brief (4 to 5 sentences):**

Assignments and Quizzes - 40% Mid Semester Exam - 25% End Semester Exam - 35%
### Title of the Course
Advances in Robotics and Control

### Course Code
EC4.501

### Faculty Name
Spandan Roy

### L-T-P
3-1-0

### Credits
4

Prerequisite Course / Knowledge:
Should have taken courses Systems Thinking / Introduction to Robotics & Control/ Robotics: Dynamics and Control

### Course Outcomes (COs):

After completion of this course successfully, the students will be able to..

**CO-1:** Demonstrate familiarity with Euler-Lagrange dynamics

**CO-2:** Apply principles of computed torque method for controller development of a robotic system

**CO-3:** Understanding the concepts of Lyapunov theory for stability analysis

**CO-4:** Apply principles of Lyapunov theory for controller design

**CO-5:** Design inverse dynamics based robust controller to address uncertainty in robot dynamics

**CO-6:** Design adaptive-robust controller for robotic systems to address unmodelled dynamics

### Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

<table>
<thead>
<tr>
<th>CO</th>
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Each Course Outcome (CO) may be mapped with one or more Program Outcomes (POs). Write '3' in the box for 'High-level' mapping, '2' for 'Medium-level' mapping, '1' for 'Low-level' mapping

Mapping with PSOs, where applicable.

### Detailed Syllabus:

**Unit 1:** Introduction to robotic systems and control
Unit 2: Stability analysis and design

Unit 3: Robust control design via inverse dynamics and switching gain

Unit 4: Model reference adaptive control and robust adaptation against uncertainties

Reference Books:
2) Nonlinear Systems by Hassan Khalil, Prentice Hall.
3) Applied Nonlinear Control by Slotine and Lee, Prentice Hall.

Teaching-Learning Strategies in brief (4 to 5 sentences):
The course lectures will include activities that promote the understanding of the lecture content by using examples that students work out during the class itself and promote active and participatory learning. A good part of the lecture will involve problem solving and finding solutions to problems rather than expositing known material. Homework assignments are designed to reiterate the material covered in class lectures and apply them in robotic systems via simulation. The course project will help to read, understand and implement relevant scientific publications.

Assessment methods and weightages in brief (4 to 5 sentences):
- Assignments: 20%
- Project: 20%
- Quiz 1: 15%
- Quiz 2: 15%
- End Exam: 30%

Course Title: Applied Electromagnetics
TYPE-WHEN: Elective, Spring
Course Code: EC2.405
FACULTY NAME: K R Sarma
PRE-REQUISITE: None

OBJECTIVE: Understand the fundamentals of dynamic electromagnetic fields and devices and systems used in communication, RF electronics, medical security, and defense applications.

COURSE TOPICS:

Dynamic Electromagnetic (EM) fields. Governing relationships, Maxwell's equations, Boundary conditions at interface of media.

Propagation of EM fields in unbounded media: Dielectrics, Conductors, anisotropic media. Applications using ferrites, liquid crystals.
Propagation of EM fields in bounded media in one, two and three dimensions using conductors or dielectrics as boundaries. Transmission lines, Dielectric waveguides, metallic waveguides. Applications - Fibre, coaxial cable, waveguides, resonators, inductors, capacitors, filters

Guided Radiation of EM energy in free space. Antennas: Wire antennas, apertures and reflectors arrays applications in radars, diathermy, communication: terrestrial and satellite, microwave imaging, heating, cooking, drying, biological effects

PREFERRED TEXTBOOKS:

Ulaby and Ravai0li Applied Electromagnetics 7 ed Pearson

GRADING PLAN (Last Year):

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OUTCOME: Theory and applications of systems and components based on electromagnetic theory used in communication and electronics in RF, Microwave and Visible spectral bands

Title of the Course : Behavioral Research: Statistical Methods
Course Code : CS9.422
Faculty Name : Vishnu Sreekumar + Vinoo Alluri
L-T-P : 3-1-0
Credits : 4
(L= Lecture hours, T= Tutorial hours, P=Practical hours)

Prerequisite Course / Knowledge:

None

Course Outcomes (COs):

After completion of this course successfully, the students will be able to

CO-1: develop an understanding of various experimental designs
CO-2: recognize and employ appropriate statistical packages to analyze data
CO-3: apply appropriate parametric and non-parametric analyses techniques
CO-4: perform exploratory data analysis and examine intrinsic relationships between variables
CO-5: reflect and draw appropriate inferences post analyses
CO-6: create custom code by adapting exploratory and confirmatory analyses techniques

3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix

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4. Detailed Syllabus:

Module 1: Introduction to Experimental Design; Foundations of Inferential Statistics

Experimental Design: Literature review, Hypothesis Testing, Type I and II errors, Hypothesis-based vs Exploratory Research, Types of variables and levels of Measurements, Different types of experimental designs: Between-subject and within-subject factors in an experiment; Factorial designs, Simple repeated measures design, Randomized blocks design, Latin square type designs, Foundations of Inferential Statistics, Standardized Distributions, Probability.

Module 2: Parametric tests of difference and association

Parametric tests of difference: Multivariate Analysis, Linear Models (GLM) and Mixed models; Multivariate Regression Techniques, Multi-level tests (ANOVA), MANOVA, ANCOVA, MANCOVA. Main effects and interaction.

Module 3: Non-parametric tests of difference and association

Nonparametric tests of association – chi-square test, Mann Whitney U test, Binomial Sign test, Wilcoxon’s T test,

Related and Unrelated t tests; correlation, regression; Power Analysis

Module 4: Multivariate Methods

Multidimensional Scaling, Data Reliability, Tests of Normality and Data Transformation, Outliers, Collinearity in

Data, Data Summarization vs Data Reduction Techniques: Exploratory Factor Analysis, Principal Component Analysis, Multiple Comparison problems
Module 5: Special Topics
Behavioral time-series analysis, Structural Equation Modelling.

Reference Material:
Lecture slides and supplementary reading materials (journal articles, books/book chapters, online resources) will be uploaded on the course page on Moodle.

5. Teaching-Learning Strategies in brief:
Students will be introduced to the different statistical methods employed in the analysis of behavioral data. The material will be delivered as a combination of lectures and practical sessions. In the practical sessions, students will be provided with data and code snippets to help them practice the concepts taught in the lectures. They will also receive regular problem sets/assignments which will comprise the majority of the course evaluation. We will primarily rely on R for statistical analysis but may also use other tools as deemed appropriate for the material being covered.

6. Assessment methods and weightages in brief:
In-class problem sets = 30%
Take-home assignments and problem sets = 50%
Final Project = 20%

Title of the Course: Business Fundamentals #1
Fundamentals of Management for Entrepreneurship
Faculty Name: Priyatej K
Course Code: PD2.321
Program: M.Tech I Year I Semester – Product Design and Management*
L-T-P: 3-1-0
(Credits: 2)

1. Prerequisite Course /Knowledge:
No prerequisites are required


OBJECTIVE OF THE COURSE
The course focuses on the basic concepts of business management and development including opportunity recognition; experimentation and testing of a new business idea; strategy, business model development, and business planning; financing; and planning and management of growth and change. This course provides a process perspective on business development. The course aims at generating an in-depth understanding of planning and management of growth and change at the root level of business development in the Finnish business context. The course provides basic tools and frameworks for analyzing business development and growth management cases in practice.

DETAILS OF THE COURSE SYLLABUS
- Introduction to principles of Management and entrepreneurship
- Basics of business model development and business planning
- Legal aspects of new venture creation and IPR
- Entrepreneurial Marketing
- Human resource management
- Introduction to entrepreneurial finance and Accounting
- Supervisory Skills for Business Leadership
- Negotiation and Conflict Resolution
- Business Ethics

**Title of the Course**: Business Fundamentals # 2

**Fundamentals of Management for Entrepreneurship**

**Faculty Name**: Priyatej K

**Course Code**: PD2.421

**Program**: MTech I Year I Semester – Product Design and Management*

**L-T-P**: 3-1-0

(L= Lecture hours, T= Tutorial hours, P= Practical hours)

**Credits**: 2

1. Prerequisite Course / Knowledge:
Should have taken Business Fundamentals # 1 – PD2.121 course
Semester, Year: 1st Sem – Year 1 (Spring, 2022).

**OBJECTIVE OF THE COURSE**
The course focuses on the basic concepts of business management and development including
opportunity recognition; experimentation and testing of a new business idea; strategy, business
model development, and business planning; financing; and planning and management of
growth and change. This course provides a process perspective to new business development.
The course aims at generating an in-depth understanding of planning and management of
growth and change at the root level of business development in the Finnish business context.
The course provides basic tools and frameworks for analyzing business development and
growth management cases in practice.

**DETAILS OF THE COURSE SYLLABUS**

- Strategic Management for New Business
  - Introduction to entrepreneurial finance and Accounting
  - Supervisory Skills for Business Leadership
  - Negotiation and Conflict Resolution
  - Business Ethics

**Title of the Course**: Cognitive Neuroscience

**Course Code**: CS9.430

**Faculty Instructor**: Kavita Vemuri

**L-T-P**: 3-0-1
1. **Prerequisite Course / Knowledge:**
   1. Intro topsychology
   2. CognitiveScience

2. **Course Outcomes (COs) (5 to 8 for a 3 or 4 credit course):**
   A student introduced to the concepts in the course will be able to:
   - CO-1: Neuroanatomy
   - CO-2: Brain & Behavior – perceptual systems
   - CO-3: Techniques for brain imaging
   - CO-4: Brain signal analysis
   - CO-5: Clinical case studies
   - CO-6: Cognitive process – memory, decision making, empathy, learning
   - CO-7: Ethics of Neuroscience findings

3. **Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix**

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3. **Detailed Syllabus:**

   **OBJECTIVE**
   Understand the mechanisms of the brain in sensory & higher order cognitive processing.

   The course will examine how modern cognitive neuroscientists explore the neural underpinnings of sensory information – vision, sound, touch, taste & smell, the neural processing supporting visual/auditory attention, areas of the brain attributed to motion & depth perception and action; higher order cognitive processes like language processing, memory, empathy/emotion, the theory of intelligence, and decision making. The topics will be introduced after a brief review of neuroanatomy &
evolution. The latest research from clinical & non-clinical studies will be presented to the class. Brain imaging techniques like functional magnetic resonance imaging (fMRI) and electroencephalogram (EEG) will be introduced along with the limitations of each in making inferences about the brain functionality. Equal emphasis is on understanding analytical methods and the limitations of each. The focus will not be on memorizing biological vocabulary details but on understanding principles on the sensory perceptual & cognitive process of human brain which are necessary to design and build any technological interventions.

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

1. Neuroanatomy & evolution
2. Sensory inputs (vision, auditory, taste, touch, smell)
3. Motion & depth perception and action
4. Language
5. Memory
6. Decisionmaking
7. Emotion/empathy

Wide topics covering human intelligence and models for AI. Also clinical conditions for each topic will be covered.

Reference Books:
1. Cognitive Neuroscience by Gazzaniga
2. Required research papers.

5. Teaching-Learning Strategies in brief (4 to 5 sentences):
The inclass lectures will cover basics – developmental brain, areas, neurons, followed by discussions based on research findings. As each topic is introduced as case studies supported by videos, the learning is reinforced. Quizzes are conducted periodically to evaluate transfer of knowledge and critical thinking of the implication of each study finding.

6. Assessment methods and weightages in brief (4 to 5 sentences):

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<td>End Sem Exam</td>
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<td>Project/term paper</td>
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<td>Other Evaluation</td>
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Title of the Course : COGNITIVE SCIENCE AND AI
Course Code : CS9.432
Faculty Name : BAPI RAJU S.
L - T - P : 3-1-0
Credits : 4
Semester, Year: Spring 2022

Pre-Requisites: It is preferable that students have taken Introduction to Cognitive Science / Cognitive Neuroscience; a course with emphasis on ML, AI, Neural Networks (such as SMAI); have an aptitude for programming; and familiarity with ML and Deep Learning tools such as Scikit-learn / PyTorch / Keras / TensorFlow. Efforts will be made to run tutorials or assigned practice for course participants who do not have familiarity with the ML/DL programming tools.

Course Outcomes:
(List about 5 to 6 outcomes for a full 4 credit course)

CO-1: Learn and demonstrate understanding of how basic concepts in machine learning (ML) and deep learning (DL) are applied for problems in neuroscience and cognitive science

CO-2: Demonstrate use of ML/DL algorithms on simple problems in neuroscience and cognitive science.

CO-3: Analyze and evaluate ML/DL algorithms about their ability to unravel the functional architecture of cognition

CO-4: For a selected problem, design computational solutions and evaluate their goodness of fit to the actual empirical data from cognitive neuroscience

CO-5: Create and develop novel solutions in either direction: Cognitive Science-to-AI or AI-to-Cognitive Science and compare their strengths and limitations vis-à-vis existing solutions

Course Topics:
(Please list the order in which they will be covered, and preferably arrange these as five to six modules.)

Module 1: Introduction to cognitive science and neuroscience. A brief tour of the principles of cognitive science, cognitive architecture, principles of information processing in the brain/mind, brain anatomy and functional parcellation of the brain.

Introduction to AI, Machine Learning (ML) and Deep Learning (DL). Basic introduction to supervised, unsupervised and reinforcement learning paradigms, recent advances in ML and DL with a focus on their applications in neuroscience. Debates on the strengths and limitations of deep neural networks as models of information processing in the brain as well as models for artificial general intelligence (AGI).

Module 2: Vision. Brief tour of recent developments of application of deep neural networks (DNN) in computer vision. Introduction to human perceptual processing (with emphasis on vision) and the neural correlates of the perceptual function. The relation between the representation of information across layers (of DNN) and their match with visual cortical areas in the brain. Current knowledge of the perceptual and neural phenomena in the human visual system and the ability and lack thereof of deep neural networks in mimicking these phenomena.
**Module 3: Language.** Introduction to higher-level cognitive phenomena, including human language processing. Current understanding of the neural correlates of language processing, or the extraction of meaning from spoken or written phrases, sentences, and stories. Recent developments in applying word embedding models and transformer models for brain encoding decoding. Debates about the kind of representations learned in deep learning models and their relation to how brain represents and processes language.

**Module 4: Motor function and Skill Learning.** Principles of hierarchical motor control in the mammalian brain, in AI systems and their relationship. Application of the concepts of reinforcement learning (RL) and deep RL for motor control, relationship to neurotransmitter activity of dopamine and the cortical and subcortical systems participating in motor learning, planning and control. Skill acquisition in humans and machines. Debates about the adequacy of the RL-framework for understanding various aspects of skill acquisition such as compositionality, abstraction, curiosity, mental simulation, etc.


**Tutorials:** Special tutorials will be conducted to familiarize with fMRI experiments, neuroimaging data and preprocessing, ML/DL tools and how to set up these to complete assignments and projects.

**Preferred Text Books:** No text book is available on this topic. Apart from the general reference books, list of readings will be assigned for various topics (sample references given below).

**Reference Books:**
- Grace Lindsey (2021). Models of the Mind: How Physics, Engineering and Mathematics Have Shaped Our Understanding of the Brain. Bloomsbury Publisher (General Reading)
Example Readings/Viewings:
Jacob, RT Pramod, Harish Katti, SP Arun (2021), Qualitative similarities and
differences in visual object representations between brains and deep networks,
Nature Communications, 12, 1872.https://doi.org/10.1038/s41467-021-22078-3
Martin Schrimpf, Idan Asher Blank, Greta Tuckute, Carina Kauf, Eghbal A. Hosseini,
Nancy Kanwisher, Joshua B. Tenenbaum, Evelina Fedorenko (2021). The neural
architecture of language: Integrative modeling converges on predictive
processing. Proceedings of the National Academy of Sciences Nov 2021, 118 (45)
e2105646118; DOI: 10.1073/pnas.2105646118
Marcus, G. (2020). The Next Decade in AI: Four Steps Towards Robust Artificial
Manfred Eppe, Christian Gumbsch, Matthias Kerzel, Phuong Nguyen, Martin V.
Butz, and Stefan Wermter (2020). Hierarchical principles of embodied
Matt Botvinick (Jul 3, 2020): Neuroscience, Psychology, and AI at DeepMind | Lex
Fridman Podcast #106https://www.youtube.com/watch?v=3tO6ajvBtl0&ab_channel=LexFridman
Joshua Bengio and Gary Marcus on the best way forward for AI (Moderated by
Merel, J., Botvinick, M. & Wayne, G. Hierarchical motor control in mammals and
1761–1770. https://doi.org/10.1038/s41593-019-0520-2
Current Opinion in Behavioral Sciences, 29, 91-96.
Network for Object Recognition is most Brain-Like?. bioRxiv. 2018.
doi:https://doi.org/10.1101/407007
Pereira, F., Lou, B., Pritchett, B. et al. (2018). Toward a universal decoder of
https://doi.org/10.1038/s41467-018-03068-4
Pearl, J. (2018). Theoretical impediments to machine learning with seven sparks
doi:10.1017/S0140525X16001837
Kumaran, Dharshan, Demis Hassabis, and James L. McClelland (2016). "What
learningsystems do intelligent agents need? Complementary learning systems

E-bookLinks
GradingPlan :

(The table is only indicative)
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<th>Type of Evaluation</th>
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**Mapping of Course Outcomes to Program Objectives:** (1 – Lowest, 2—Medium, 3 – Highest, or a ‘-’ dash mark if not at all relevant). Program outcomes are posted at

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Teaching-Learning Strategies in brief (4-5 sentences):

Lectures will initially introduce the motivations and concepts, illustrated with simulation examples. This will be followed by assignments and in-class presentation of relevant papers that will ensure that the students are engaged with the methods and the debates. Deeper lectures and final project are expected to lead to a broader but more concrete understanding of the issues in Cogsci & AI. The practical (programming) assignments and the final project (with significant programming component) give hands-on experience of application of ML and DL algorithms for problems in cognitive neuroscience.

**Title of the Course** : Compilers  
**Course Code** : CS1. 403  
**Faculty Name** : Vignesh Sivaraman
1. Prerequisite Course / Knowledge:


2. Course Outcomes (COs)

After completion of this course successfully, the students will be able to:

**CO-1**: Explain the principles and practices underlying production quality compilers such as GCC and LLVM (Cognitive Level: *Understand*)

**CO-2**: Modify open source compilers such as GCC and LLVM to support new languages and processor architectures; and write custom analysis and transformation passes. (Cognitive Levels: *Apply*)

**CO-3**: Identify problems or sub-problems in real world projects which can be solved by building custom compilers and interpreters of varying scale and complexity. (Cognitive Levels: *Analyze, Evaluate and Create*)

**CO-4**: Employ software engineering principles and practices to design, develop and manage complex software engineering tasks. Examples include object oriented design and programming, choosing appropriate design patterns, good support for debugging the system with ease and, develop comprehensive test suite with good coverage. (Cognitive Levels: *Analyze, Evaluate and Create*)

**CO-5**: Use software management tools such as Git, build systems such as Make/Ant etc. Write proper software design documents and end-user manuals (Cognitive Levels: *Apply*)

3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix

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4. Detailed Syllabus

- **Unit 1: Syntax Analysis**
  - Micro and macro syntax specification using regular expressions and context free grammars
  - Lexical Analysis
  - Top-down (LL(1)) and bottom-up (LR(1), LALR(1)) parsing

- **Unit 2: Semantic Analysis and IR Generation**
  - Abstract Syntax Tree (AST) construction
  - Static and Dynamically typed language
  - Type Checking

- **Unit 3: Intermediate Representations and their Generation**
  - Intermediate representations such as three address tuples, stack code
  - AST to linear intermediate representation generation
  - Basic blocks and control flow graphs
  - Static Single Assignment Form (SSA)
  - LLVM IR case study

- **Unit 4: Machine Independent Optimizations**
  - Local and regional optimizations using value numbering optimization as a case study
  - Global optimizations like constant propagation and dead code elimination
  - Data flow analysis theory and practice. Examples include Available expressions analysis and live variable analysis.
  - Compiler phase sequencing problem

- **Unit 5: Code Generation and Register Allocation**
  - Runtime environment for C-like programming languages
  - Scope and lifetime of variables. Parameter passing mechanisms.
  - Generating machine code with virtual registers from machine independent linear intermediate representation.
  - Local and global register allocation. Mapping virtual registers to physical registers.
  - Basics of instruction scheduling

Reference Books:


5. Teaching-Learning Strategies in brief

The most important component of this course is the project in which students design a C-like imperative programming language. Write a manual for their programming language specifying syntactic and semantic rules along with example programs written in their own language. Over the course, as students are introduced to principles and practices involved in designing various compiler modules, they build the corresponding modules for their programming language. At the end of the course, students will be able to run the example programs they have written by compiling them with the compiler built by them. The target language for the compiler is usually LLVM IR.
Through the mini homeworks, theoretical ideas introduced in the class are reinforced. Students get continuous support through tutorial sessions, office hours conducted by teaching assistants and the concerned faculty.

6. Assessment methods and weightages in brief

1. Mini Homeworks (7 to 8) : 15 percent
2. Course Project
   a. Syntax Analysis: 10 percent
   b. AST Construction: 10 percent
   c. Semantic Analysis: 10 percent
   d. LLVM IR Generation: 10 percent
3. Mid Term Quiz: 15 percent
4. Final Theory Exam: 30 percent

Course Title : Comprehension of Indian Music
Course Code : HS1.206
Faculty Name : TK Saroja
Credit : 3-0-0-4

Course Description:

This course offers an overview of Indian music and its classicism. The two major styles Hindustani and Karnataka with their rich traditions glorify Indian music. The creative aspect which is the foremost feature of Indian music is what takes the art form to its zenith. Its huge variety contributes to the cultural heritage of the civilization. The logic, science, philosophy, history, emotions, imagination in Indian music gives the art its completeness. The course will cover conceptual base of Indian music and emphasize on informed comprehension of music.

Objectives:

1. Study of basics of both the styles (Hindustani and Karnataka) to know the characteristics of them. Importance of nāda in music.
2. Emphasis on the conceptual system of rāga-s and tāla-s that gives Indian music its stature.
3. Introduction to different genres of India music like the semi classical, light, folk music studying their peculiar aspects. The aspects that differentiate them from each other would be analyzed.
4. The role of language and the interwoven relationship of literature and music in musical compositions. The association of melody and rhythm that go hand in hand in the compositions with focus on the vowel elongations. Role of music in bringing out the emotions and expressions in poetry and literature.
5. The contribution of different composers who enriched the classical form of art particularly in south Indian music. A special study of the compositional style of the South Indian musical trinity Tyagaraja, Mythuswamy Dixitar and Syama Sastry.
6. The existence and the prominence of gharānā-s in Hindustani music and the musicians who represent the particular gharānā-s.
7. The indispensable place of music in other art forms like dance, theatre and also spheres like cinema, commercials etc. (medium of communication).

Course outcomes:
• Understanding the theory of Indian music which gives it the status of a śāstra and appreciation of the practice of classical music.
• Understanding the rational, creative and social elements of the art which make the art an integral part of the society.
• Ability to recognize different musical forms with a systematic approach.
• Understanding the universality of music with the knowledge of Indian music.
• Understanding the importance of music and related arts in one’s life as those that foster individual growth.

Reference Materials:

1. South Indian Music – Volumes 1 to 6 by Professor P.Sambamurthy
2. The quest for Music Divine by Suresh Chandra Dey
3. The Spiritual Heritage of Tyagaraja by C.Ramanujacharya and Prof V. Raghavan
4. Karnataka Sangita Sastra by A.S. Panchapakesa Ayyar
5. Appreciating Carnatic Music by Chitraveena N. Ravikiran
6. Nuances of Hindustani Classical Music by Hema Hirlekar
7. The Hindu Speaks on Music - compilation of 232 selective music articles by The Hindu
8. A Southern Music (The karnatic story) by T.M. Krishna
9. Hindustani Music: A tradition in transition by Deepak Raja
10. Raga Chikitsa by Suvarna Nalapat
11. Sangitha Ratnakara of Sarngadeva by Shringy RK and Premlata Sharma
12. Matanga and his work Brhaddesi edited by Prem Lalatasha
13. Videos and audios of music which practically demonstrate all the concepts of the course.

Grading:

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<td>Individual Project and viva</td>
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<td>Class participation</td>
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Course Title: Computational Social Science
Faculty Name: Ponnurangam Kumaraguru
Name of the Program: Applicable to all Programs on campus including, CSE, CLD, CHD, CND, both at UG & Masters level.
Course Code: CS9.435
Credits: 4
L - T - P: 3 - 0 - 1
(Ex: Spring, 2022)

Pre-Requisites: Any UG3, UG4, M.Tech., MS, and Ph.D. student should be able to take it

Course Outcomes:

- Co-1: Students will describe the opportunities and challenges that the digital age creates for social sciences research.
- Co-2: Students will evaluate modern social research from the perspectives of both social science and data science.
Co-3: Students will create research proposals that blend ideas from social science and data science.

Co-4: Students will be able to summarize and critique research papers in Computational Social Science.

Co-5: Students will conduct, develop, and practice the techniques needed to conduct their proposed research, through course project.

Course Topics:

(Please list the order in which they will be covered, and preferably arrange these as five to six modules.)

Module 1: Social Research

Computational Social Science 101

- What is Computational Social Science?
- Is Computational Social Science = or Computer Science + Social Science?
- Why study Computational Social Science?
- Challenges with only Computer Science or Social Science
- Does Social Media data == Computational Social Science? Class debate.

Social Science vs. Data Science

Prediction vs.

Read / Listen / Watch:


Coded Bias

- Trailer: https://youtu.be/jZl5sPsFZJQ
- Full documentary: https://www.netflix.com/title/81328723

Module 2: Modeling & Causal Inference

- Linear Regression, Model building, Hypothesis testing
- Causal Inference
- Running Experiments – Lab, Real-world

Read / Listen / Watch:


Chapter 3 of Mostly Harmless Econometrics: An Empiricist Companion

Module 3: Mass Collaborations

- **HumanComputation**
  - **GalaxyZoo**


- **Crowd-coding of political manifests**

- **Open Calls**
  - **Netflix Prize**


- **Foldit: Protein-folding game**

- **Distributed Data Collection**
  - **eBird: Bird data from birders**

Photocity


How to develop our own (including around course project) MassCollaborations?

- Opportunities
- Methods
- Challenges

Module 4: Ethics

Studies of concern

- Experiment on 700,000 Facebook users


- Tastes, Ties, and Time study on Facebook users


- Web Censorship


Crime prediction using Social data, Tracking immigrants through their phoneapps
Institutional Review Board / Ethics Committee – Expectations, Why is it necessary?
Informed consent, Privacy, Risk

Module 5: Biases in CSS Research
- Biases & inaccuracies at the source of the data
- Biases & inaccuracies during processing
- Biases in social data
- Inferences from biased data

Read / Listen / Watch:
Preferred Text Books:


Reference Books:

E-book Links:

https://www.nature.com/collections/cadaddgige/

Grading Plan:

(The table is only indicative)

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Mapping of Course Outcomes to Program Objectives: (1 – Lowest, 2—Medium, 3 – Highest, or a ‘-’ dash mark if not at all relevant).

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Teaching-Learning Strategies in brief (4-5 sentences):

Learning

- Lectures
- Reading researchpapers
- Class participation: questions, discussions
- Online discussion:

Teams Learning by doing

- Course project
- Real world issues
- Interdisciplinary approach
- Real world implementation

POTENTIAL GUEST LECTURES:

1. Prof. Mathew Salganik, Princeton University
2. (Soon to be Dr.) Ashwin Rajadesingan, University of Michigan
3. Dr. Hemank Lamba, Dataminr

Note: This course description format comes into effect from Spring 2022.

Title of the Course: Computer Graphics
Course Code: CS7.302
Name of the Academic Program: BTech in Computer Science & Engineering
L-T-P: 3-1-0
Credits: 2

1. Prerequisite Course / Knowledge:

2. Course Outcomes (COs) (5 to 8 for a 3 or 4 credit course):

After completion of this course successfully, the students will be able to.
CO-1 Introduce the 3D shape representation and modelling for Computer Graphics applications. CO-2 Introduce Graphics libraries for development of graphics applications.
CO-3 Introduce Graphics Pipeline for rendering of 3D objects.
CO-4 Explain Graphics concepts/algorithms for fast and realistic rendering of 3D objects including lighting, texture, shadow as well as using the GPU based acceleration data structures like k-d trees.

3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix

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Note: Each Course Outcome (CO) may be mapped with one or more Program Outcomes (POs) and PSOs. Write ‘3’ in the box for ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low-level’ mapping

4. Detailed Syllabus:


Reference Books:

5. Teaching-Learning Strategies in brief (4 to 5 sentences):
The course lectures will include interactive graphics content for effectively conveying the basic concepts as well as small activities to promote the understanding of the lecture content. Significant focus will be on problem solving aspect and concepts will be introduced in the context of relevant practical problems related to 3D modelling and rendering of virtual objects/world. Tutorials will further try to bridge the gap between theoretical understanding and practical aspects of problem solving. Assignments are designed to solve problems that are based on simple extensions of concepts described in the lectures.

6. Assessment methods and weightages in brief (4 to 5 sentences):
Homeworks/Assignments: 55%
Quiz 1: 7%
Quiz 2: 8%
End Exam: 30%

---

Title of the Course: Computing Tools
Name of the Faculty: Sudipta Banerjee + Avinash Sharma
Name of the Academic Program: M.Tech. in CASE, Bioinformatics (1st year, 2nd semester)
Course Code: CS0.302
L-T-P: 3-1-3
Credits: 4
Prerequisite Course / Knowledge:
1. First course on programming and problem-solving
2. Basics of Python language, to be able to use relevant libraries and toolkits

**Course Outcomes (COs):**

*After completion of this course successfully, the students will be able to:*

**CO-1.** Model and create datasets.

**CO-2.** Visualize and present data.

**CO-3.** Collect data from across networks and internet to store in databases

**CO-4.** Prepare and preprocess datasets to make them ready for application of various data analytics algorithms.

**CO-5.** Employ known algorithms to solve common analytics tasks in practical applications, setting their parameter values, and using relevant libraries and toolkits.

**CO-6.** Evaluate and determine the best algorithm among known algorithms for specific datasets and applications.

**Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)**

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</tbody>
</table>

‘3’ in the box denotes ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low-level’ mapping.

**Detailed Syllabus:**

**Unit 1:** Databases (Design, SQL)

**Unit 2:** Visualization (e.g. Bokeh, VTk)

**Unit 3:** Networking and data collection (e.g. requests and json modules)

**Unit 4:** Scientific Python Modules: NumPy, Matplotlib, Tkinter, SciPy

**Unit 5:** Data analytics: Preprocessing, Clustering, Classification (e.g. pandas, scikitlearn)

**Reference Books:**
1. Official documentation and online tutorials on Python, VTK, etc.
2. Python – [https://docs.python.org/3/tutorial/](https://docs.python.org/3/tutorial/)

**Teaching-Learning Strategies in brief (4 to 5 sentences):**

This is a highly practicals-oriented course. Lectures showcase handson usage of various computing tools and modules for interdisciplinary students. Theoretical concepts in database design and data analytics are also covered with a practical focus, with examples and assignments. A mini-project is given in each module. Mini projects may be done in groups of 3. Lab exams may be done as a single large problem with intermediate milestones and choice of 1 out of 3 problems to solve. Python modules specified are suggestive and may be replaced with better ones.

**Assessment methods and weightages in brief (4 to 5 sentences):**

- Mini Projects: 5x10=50%
- Labs: 10%
- Mid exams: 10+15=25%
- Lab exams: 15%

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**Title of the Course** : Data Foundation Systems – A Project-Based Elective Course  
**Course Code** : CS4.409  
**Faculty Name** : Vikram Pudi  
**Credits** : 1-1-3-4  
**Name of the Program** : Elective for B.Tech/M.Tech/MS/PhD students in  
**L - T - P** :  
(L - Lecture hours, T-Tutorial hours, P - Practical hours)  
**Semester,Year** : Spring,2022  
(Ex: Spring, 2022)  
**Pre-Requisites** : SSAD, SSDD, or background knowledge/experience in python web programming  
**CourseOutcomes** :  
After completion of this course successfully, the students will be able to:  
1. Participate in building large, deployable softwaresystems  
2. Automate dataingestion  
3. Fluently use Javascript, NodeJS and related frameworks to build interactive web-components  
4. Fluently use one or more modern Python backend webframeworks  
5. Rapidly build responsive websites with complexlayouts  
**CourseTopics** :  
1. Code and design review of large softwaresystems  
2. NodeJS  
3. Asynchronous Javascript webcomponents  
4. One or more modern python web framework (e.g. django, py4web,etc.)  
5. Responsive webpages and complexlayouts
6. Data scraping and ingestion

Preferred Text Books:

Online material:
1. Pythondocumentation
2. NodeJSdocumentation
3. HTML5/CSS and bootstrap (or similar) layouttutorial
4. Django/py4webdocumentation

Reference Books:

E-book Links:

Grading Plan:

(The table is only indicative)

<table>
<thead>
<tr>
<th>Type of Evaluation</th>
<th>Weightage (in %)</th>
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<tbody>
<tr>
<td>Quiz-1</td>
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<td>Quiz-2</td>
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<td>Assignments</td>
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<td>Project</td>
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<td>Term Paper</td>
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<tr>
<td>Other Evaluation</td>
<td>Project evaluation will be based on deliverables at intermediate deadlines, including for requirements, screenshots, database design, prototype building, etc.</td>
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<td>A: If deliverable is deployable, well-designed and efficient A: If deliverable is deployable</td>
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<td>B: If deliverable is deployable with some more effort B: If deliverable is deployable with considerably more effort.</td>
</tr>
<tr>
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<td>F: If deliverable is not deployable.</td>
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</table>

Mapping of Course Outcomes to Program Objectives: (1 – Lowest, 2—Medium, 3 – Highest, or a ‘-’ dash mark if not at all relevant)
Teaching-Learning Strategies in brief (4-5 sentences):

This is a practicals oriented course, where the students will participate in projects to collaboratively build a large-scale application, which is the data-foundation – a technology-platform to collect, create, curate, annotate, secure and deploy a library of datasets for developing solutions driven by AI and analytics in socially-relevant domains such as Healthcare, Mobility, Buildings and Systems.

Necessary background skills, languages and tools for backend and frontend programming will be taught during lectures, along with code and design reviews of large software systems.

Students will work in teams to build a deployable system. This exposure will enable students to become industry-ready with skills to innovate and build large software systems and/or startups.

According to Massimo Di Pierro, the creator of py4web: “The ability to easily build high quality web applications is of critical importance for the growth of a free and open society. This prevents the biggest players from monopolizing the flow of information.” This course is geared towards that goal.

Sample projects to choose from:
1. Datasetlibrary
2. Data ingestion from various sources
3. Data annotation plugins
4. Dataset approval workflow
5. Javascript components to handle medical images (CT/MRI/X-Ray)
applications, including distributed applications.

CO-3: Design the recovery sub-system of any given information system

CO-4. Design archival strategy for any given information system

CO-5. Develop a concurrency control algorithm for any given database system

CO-6. Develop a framework for building a large scale big data system.

3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix

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‘3’ in the box denotes ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low’-level’ mapping

4. Detailed Syllabus:

Unit 1: Introduction, Data storage, Representing data elements (9 hours)

Unit 2: Index structures, Multidimensional indexes (7.5 hours);

Unit 3: Query execution, The query compiler (9 hours)

Unit 4: Coping with system failures, Concurrency control (7.5 hours);

Unit 5: Transaction management, NoSQL and big data systems (9 hours)

- Five mini projects related to the above syllabus will be done by students in the laboratory

References:
5. **Teaching-Learning Strategies in brief:**

Lectures by integrating ICT into classroom teaching, weekly tutorials involving problem solving and active learning by students and Project-based Learning by doing 5 mini-projects in laboratory by the students

6. **Assessment methods and weightages in brief:**

Assignments in theory: 10 marks, Quizzes in theory: 10 marks, Mid Semester Examination in theory: 20 marks, End Semester Examination in Theory: 30 marks, Assessment of 5 mini projects in Laboratory: 30 marks

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**Course Code**: Design of Hydraulic Structures  
**Faculty Name**: Shaik Rehana  
**Name of the Program**: M.Tech in CASE  
**Credits**: CE5.501  
**L - T - P**: 3-1-0  
**Semester, Year**: Spring, 2022  
(Ex: Spring, 2022)

**Pre-Requisites**: Basics of fluid mechanics and hydraulics

**Course Outcomes**:  
After completion of this course successfully, the students will be able to

- Develop a detailed understanding about the design aspects of the hydraulic structures those are constructed for the purpose of storage, diversion, conveyance and distribution of water.
- Design various major hydraulic structures such as dams, reservoirs, aqueducts, weirs, canals, etc.
- Understand how basic principles of hydraulics can be used in the design of structures in terms of safety measures, etc.

**Course Topics**:  
(Please list the order in which they will be covered, and preferably arrange these as five to six modules.)  
Introduction of Hydraulics: Fluid Properties and Classification, Hydrostatics,  
Equation of Motion, Continuity Equation, Flow Measurements  
Introduction: Storage, Diversion, Conveyance and Distribution structures  
Gravity Dams: Site selection, Forces, Stability analysis, Modes of Failure  
Reservoirs: Storage Capacity of a Reservoir and Design aspects
Design of Diversion Works: Weirs and Barrages, Spillways

**Preferred Text Books:**

**Grading Plan:**
(The table is only indicative)

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<th>Type of Evaluation</th>
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<td>Other Evaluation</td>
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**Mapping of Course Outcomes to Program Objectives:** (1 – Lowest, 2—Medium, 3 – Highest, or a ‘-‘ dash mark if not at all relevant). Program outcomes are posted at
Teaching-Learning Strategies in brief (4-5 sentences):

Lectures and tutorials to solve various hydraulic structures, practice problems, assignments with real-time case studies and data. Starting from basic hydraulics to design of large structures such as Weirs, dams, canals, aqueducts, spillways, the lectures try to cover diverse topics related to safety and design aspects for the better water resources management.

Note: This course description format comes into effect from Spring 2022.

Course Title: Design Thinking – Ideate to Evaluate
Faculty Name: Raman Saxena
Course Code: PD1.401
Program: M.Tech I Year I Semester – Product Design and Management*
L-T-P: 3-1-0
Credits: 2

1. Prerequisite Course/Knowledge:
Should have taken Design Thinking PD1.301-Research to Define

Semester, Year: 1st Sem – Year 1 (Spring, 2022)

1. Objective
This course is the extension of the earlier course “Design Thinking101-Research to Define” and will introduce the knowledge and skills required for the second diamond of the overall design thinking process. This course is aimed at guiding the students to work through the Ideation & Prototyping (Diversion) and Test/Evaluate (Convergence) phases of the second diamond of the overall Design Thinking Process. This course will help the student appreciating the criticality and value of generating lots of ideas, early prototyping and user testing/validation of the ideas at the early stage of design development for delivering solution which has higher fit between the products and the user needs and businessmodel.

This course is core knowledge/skill and will also serves as a foundation for further learning for any student irrespective of their specific domain such as product design, product management, user experience design, service design, software & IT, technology design and business.

1. Detailed Syllabus:
1. REVIST THE PREVIOUS LEARNINGS AND ACTIONABLE BRIEF (Week 1 - Lecture 1 &2)
   • Revise the understandings and learnings of the earlier course.
   • Revisit and deliberate on the actionable brief and tweaking the same if needed.
   • The process of divergence and convergence.

2. IDEATION (DIVERGENCE) PHASE (Week 2 - Lecture 3 &4)
   • Power and Value of Ideation process
   • Process and techniques of Ideation to generate many ideas.
   • Case study- Mainframe- Design for next generation.

3. PROTOTYPING (DIVERGENCE) PHASE (Week 3 - Lecture 5 &6)
   • Why prototyping?
   • Types of Prototypes – Low fidelity & high fidelity
   • Creation of prototypes.
   • Case study of Embrace – The Baby Warmer and deliberation/discussion.

4. USER TESTING AND VALIDATION (Week 4 - Lecture 7 &8)
   • Why Test?
   • Types of user testing and evaluation.
   • Process of user testing/validation using prototypes.
   • Use case of user testing/validation (TBD)

2. PROJECT WORK- IDEA GENERATION FOR THE PROJECT WORK (Week 5 & 6 -Hand on idea generation)
   • This week will be dedicated to generation of ideas against the actionable brief. The students will require to work on generating more and more ideas and lecture hours will be used for work in progress presentation by the students, discussions and feedback.

3. PROJECT WORK - PROTOTYPE CREATION AND TESTING (Week 6- Hands-on User testing)
   • Students will require to developing several prototypes based on the ideas generated during the ideation phase and validate the ideas for shortlisting,

4. PROJECT WORK – TWEAKING IDEAS AND FINALISING THE SOLUTION (Week 7- Project Completion)
   • Tweaking the ideas and further development of the same.
   • Final presentation of the work.

Reference Books:
1. Case: Design Thinking and Innovation at Apple, Stefan T. & Barbara F. (HBS9-609-066)
3. Case: Mainframe design for new Generation
5. Book: Change by Design by Tim Brown
6. Book: Design Thinking for Creativity and Business Innovation Series by Idris Mootee
7. Book: Design Thinking: A Culture of Innovation by Sean Koh
8. Book: Design Thinking, by Nigel Cross
9. Book: The Design of Everyday Things by Donald A. Norman

4. Teaching-Learning Strategies in brief (4 to 5 sentences):
   • The Course will divide into lectures (around 10 nos.) and hands-on work including assignments, classroom exercises, home assignment, and project.
The course will also include fieldwork, hands-on activities, learning by doing, to practice the learning from the lectures. It will also introduce and discuss a couple of case studies including cases related to the new product development and ICT domain.

It is supported by the design thinking and research approaches of various design, technology and business schools including Stanford, NID, IIM Bangalore etc. and also prestigious design consulting’s including IDEO, FROG Design, Nokia Research, Nokia Design and Siemens etc. to bring both academic and industrial flavor in the content and learning.

Other than attending the lectures and doing classroom exercises & assignments, students need to spend 4 hours per week on home/field assignments.

5. **Assessment methods and weightages in brief (4 to 5 sentences):**

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<td>5.</td>
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**Course Title:** Design Thinking – Ideate to Evaluate

**Course Code:** PD1.401

**Program:** M.Tech I Year I Semester – Product Design and Management*

**L-T-P:** 3-1-0

*(L= Lecture hours, T=Tutorial hours, P=Practical hours) Credits: 2

**2. Prerequisite Course /Knowledge:**

Should have taken Design Thinking PD1.301-Research to Define

**Semester, Year:** 1st Sem – Year 1 (Spring, 2022)

(March-April)

**3. Objective**

This course is the extension of the earlier course “Design Thinking101-Research to Define” and will introduce the knowledge and skills required for the second diamond of the overall design thinking process. This course is aimed at guiding the students to work through the Ideation & Prototyping (Diversion) and Test/Evaluate (Convergence) phases of the second diamond of the overall Design Thinking Process. This course will help the student appreciating the criticality and value of generating lots of ideas, early prototyping and user testing/validation of the ideas at the early stage of design development for delivering solution which has higher fit between the products and the
user needs and business model.
This course is core knowledge/skill and will also serve as a foundation for further learning for any student irrespective of their specific domain such as product design, product management, user experience design, service design, software & IT, technology design and business.

4. Detailed Syllabus:

1. REVISIT THE PREVIOUS LEARNINGS AND ACTIONABLE BRIEF (Week 1 - Lecture 1 & 2)
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6. Teaching-Learning Strategies in brief (4 to 5 sentences):

- The Course will divide into lectures (around 10 nos.) and hands-on work including assignments, classroom exercises, home assignment, and project.
- The course will also include fieldwork, hand on activities, learning by doing, to practice the learning from the lectures.
- It will also introduce and discuss couple of case studies including cases related to the new product development and ICT domain.
- It is supported by the design thinking and research approaches of various design, technology and business schools including Stanford, NID, IIM Bangalore etc. and also prestigious design consulting’s including IDEO, FROG Design, Nokia Research, Nokia Design and Siemens etc. to bring both academic and industrial flavor in the content and learning.
- Other than attending the lectures and doing classroom exercises & assignments, students need to spend 4 hours per week on home/field assignments.

7. Assessment methods and weightages in brief (4 to 5 sentences):

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Course Title: Design Thinking – Research to Define
Faculty Name: Raman Saxena
Course Code: PD1.301
Program: M.Tech I Year I Semester – Product Design and Management*
L-T-P: 3+1+0
Credits: 2
(L= Lecture hours, T=Tutorial hours, P=Practical)

1. Prerequisite Course/Knowledge:
No prerequisites are required
Semester, Year: 1st Sem – Year 1 (Spring, 2022)
(Jan – Feb)
2. **Objective**

The overall goal of this design thinking course is to help you design better solutions, products, services, systems, processes, strategies, and experiences. This course is aimed at guiding you through the Design Thinking Process and will help you developing a solid understanding of the overall process, phases and methods in design thinking. Introduce the concept of Human-centred approach, empathy, collaboration, co-creation and product-user & product-market fit. It will provide the theory and operational skills to follow Human (User)-Centred approach and how to implement this knowledge in your professional work life. This course is core knowledge/skill and will also serves as a foundation for further learning for any student irrespective of their specific domain such as product design, product management, user experience design, service design, software & IT, technology design and business.

3. **Detailed Syllabus:**

1. **UNLEARNING (Week 1 - Lecture 1 & 2)**
   Initial part of the course will emphasize on unlearning and to cultivate a knack for design thinking, and creative problem solving among the students that will work as a good foundation before introducing them to detailed process, methods and tools of DESIGN THINKING.

2. **UNDERSTANDING DESIGN AND DESIGN DOMAIN (Week 2 - Lecture 3 & 4)**
   - Understanding Design
   - Role & Functions of design and designers.
   - Design Elements – (Function, Ergonomics & Aesthetics) + Desirability, Feasibility & Viability

3. **INTRODUCTION TO DESIGN THINKING (Week 3 - Lecture 5 & 6)**
   - What is Design Thinking?
   - Why Design Thinking?

4. Design Thinking approach in new product development & innovative solutions

5. **DESIGN THINKING PROCESS (Week 4 - Lecture 7 & 8)**
   - Design Thinking Process – human-focused, empathy, research, ideation and prototype-driven, innovative design approach.
   - Introduce/Initiate Design Thinking Pilot Project which is built into course structure and will run parallel to the course content in the DT Part 1 and will conclude in DT Part 2.

6. **DISCOVERY PHASE (Week 5 - Lecture 9 & 10)**
   - What is Discovery and Validation phase and why?
   - Understanding User Context? – Why & How to Empathies?
   - Understanding the User Needs and Goals through empathy by observing their behaviour and drawing conclusions based on qualitative information
   - Understanding the Business Goals
   - Tools and Methods and Deliverables

7. **DEFINE PHASE (Week 6 - Lecture 11 & 12)**
• Analysis and Synthesis of Data and Information.
• Driving Insights (both user and business) and solution directions
• Tools and Deliverables of the Define phase

8. DRIVING ACTIONABLE BRIEF (Week 7 - Lecture 13 & 14)
• Through the process of analysis and synthesis, identifying user-business insights, arriving at an actionable brief in form of HMW statement.
• Debriefing and briefing on upcoming course “Design Thinking 101 – Research to Define”

Reference Books:
1. Case: Design Thinking and Innovation at Apple, Stefan T. & Barbara F. (HBS9-609-066)
2. Case: Defining Innovative Mobile Strategies: How Design Thinking Offers an Effective Way to Address the “Wicked Problem” of Enterprise Mobility by SAP
4. Book: Design Thinking by Tim Brown (HBR – R0806E)
5. Book: Innovation Through Design by Bill Moggridge

4. Teaching-Learning Strategies in brief (4 to 5 sentences):
• The Course will divide into lectures (around 12 nos.) and hands-on work including assignments, classroom exercises and homework.
• The course will also include fieldwork, hands-on activities, learning by doing, to practice the learning from the lectures.
• I will also introduce and discuss couple of case studies including cases related to the new product development and ICT domain.
• It is supported by the design thinking and research approaches of various design, technology and business schools including Stanford, NID, IIM Bangalore etc. and also prestigious design consulting’s including IDEO, FROG Design, Nokia Research, Nokia Design and Siemens etc. to bring both academic and industrial flavor in the content and learning.
• Other than attending the lectures and doing classroom exercises & assignments, students need to spend 4 hours per week on home/field assignments.

5. Assessment methods and weightages in brief (4 to 5 sentences):

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1. Prerequisite Course / Knowledge:

Knowledge of Calculus

2. Course Outcomes (COs)

After completion of this course successfully, the students will be able to develop

CO-1 Competence in classifying differential equations as to ordinary, partial, linear, non-linear, order and degree, and to construct differential equations under given conditions

CO-2. Competence in solving first order differential equations employing the techniques of variables separable, homogeneous coefficient, or exact equations.

CO-3 Competence in solving applied problems which are linear/nonlinear in form with particular focus on the modelling aspect.

CO-4. Competence in solving linear differential equations employing the techniques of integrating factors, substitution, variation of parameters and reduction of order

CO-5. Skills to use the series method of solving Differential equations as well as the Frobenius method

CO-6. Skills to solve systems of differential equations, including learning to model specific physical problems related to systems

3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix

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‘3’ in the box denotes ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low-level’ mapping

4. Detailed Syllabus:

Unit 1: Linear Differential Equations; Method of Integrating Factors, Separable Differential Equations, Modeling with First-Order Differential Equations (9 hours)

Unit 2: Autonomous Differential Equations and Population Dynamics, Exact Differential Equations and Integrating Factors, Numerical Approximations: Euler’s Method (7.5 hours);

Unit 3: Homogeneous Differential Equations with Constant Coefficients Solutions of Linear Homogeneous Equations; the Wronskian, Complex Roots of the Characteristic Equation Repeated Roots; Reduction of Order, Nonhomogeneous Equations; Method of Undetermined Coefficients Variation of Parameters (9 hours)

Unit 4: Series Solutions Near an Ordinary Point, Part I, Series Solutions Near an Ordinary Point, Part II Euler Equations; Regular Singular Points, Series Solutions Near a Regular Singular Point, Part I, Series Solutions Near a Regular Singular Point, Part II (9 hours);

Unit 5: Systems of Linear Algebraic Equations; Linear Independence, Eigenvalues, Eigenvectors, Basic Theory of Systems of First-Order Linear Equations, Homogeneous Linear Systems with Constant Coefficients, Complex-Valued Eigenvalues (7.5 hours)

- A project related to the above syllabus will be done by students to be submitted by the end of the semester.

References:

- Boyce di-Prima, Elementary Differential Equations and Boundary Value Problems (John Wiley and sons)
- Differential equations, dynamical systems and an Introduction to Chaos, Hirsch, M.W., Smale and Devaney (Elsevier)
- Differential Equations, S.L. Ross (John Wiley and sons)
- George F. Simmons, Differential Equations with Applications and Historical Notes

5. Teaching-Learning Strategies in brief:

Lectures in the classroom teaching, weekly tutorials involving problem solving and active learning by students and Project-based Learning

6. Assessment methods and weightages in brief:

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<th>Assignment Type</th>
<th>Weightage</th>
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<td>Assignments in theory</td>
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<td>Quizzes in theory</td>
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<td>Mid Semester Examination in theory</td>
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<td>End Semester Examination in Theory</td>
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<td>Assessment project</td>
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Title of the Course : Digital Signal Analysis
Faculty Name: Anil Kumar V
Course Code: CS7.303
L-T-P: 2-1-0
Credits: 2

Typical Course Design Name of the Academic Program: B. Tech. in CSE

Prerequisite Course / Knowledge:

No prerequisite as it is a core course for CLD program.

Course Outcomes (COs):

After completion of this course successfully, the students will be able to..

CO-1: Introduce the fundamentals of digital signal representation and processing to undergraduate students of CLD/CS/CSD.

CO-2: Introduce the advantage of a transformed domain representation.

CO-3: Application of basic signal processing to speech signals.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

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Each Course Outcome (CO) may be mapped with one or more Program Outcomes (POs). Write ‘3’ in the box for ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low-level’ mapping mapping with PSOs, where applicable.

Detailed Syllabus:

Unit 1: Basics of Fourier series and transform, sampling and quantisation, different types of signals and systems.

Unit 2: Z-transform, FIR and IIR systems. Introduction to digital filter design.

Unit 3: Application of concepts using speech signals.

Reference Books:

1. Digital signal processing by John G. Proakis and Dimitris K Manolakis.
2. Digital signal processing by Alan V. Oppenheim and Ronald W. Schafer.
3. Introduction to Digital Speech Processing by Lawrence R. Rabiner and Ronald W. Schafer, now Publishers Inc. Hanover, USA, 2007

Teaching-Learning Strategies in brief (4 to 5 sentences):

It is a mathematical oriented signal processing course, so regular problem solving
assignments are given to understand the concepts. Surprise class tests are conducted based on assignments to test the seriousness in assignment solving. As a part of teaching practical examples like speech signal is used for demonstration of mathematical concepts learned.

**Assessment methods and weightages in brief (4 to 5 sentences):**

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<th>Assessment</th>
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<td>Assignments</td>
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<td>Quiz</td>
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<td>End exam</td>
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**Title of the Course:** Digital VLSI Design  
**Course Code:** EC2.408  
**Faculty Name:** Zia Abbas  
**L-T-P:** 3-1-0  
**Credits:** 4

**Prerequisite Course / Knowledge:**  
Basic knowledge of digital design.

**Course Outcomes (COs):**

*After completion of this course successfully, the students will be able to.*

**CO-1:** Understand the background that drive to the development of state-of-the-art VLSI digital circuits, the importance of low power, high-performance and power-delay optimal designs, state of the art design issues in digital circuits, understand the CMOS digital IC design process.

**CO-2:** Design and Synthesis of Verilog/VHDL codes, test benches to meet specifications, to synthesise Verilog/VHDL onto hardware using required EDA tools.

**CO-3:** design and analyze CMOS circuits using both analytically and SPICE tools, derive analytical circuit equations to estimate performances (e.g., power) of a VLSI design. Able to identify the impact of Process, Voltage and Temperature on circuit’s performance.

**CO-4:** Analyze the design flow to design complex CMOS digital circuit using required CAD tools. Create a cell library to be used in other designs.

**CO-5:** Create a low-power digital design, estimate static and dynamic power dissipation in CMOS circuits. Impact of CMOS technology scaling. Low power design methodologies.

**CO-6:** Design of high-performance circuits, and power-delay optimal designs.

**Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)**

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Each Course Outcome (CO) may be mapped with one or more Program Outcomes (POs). Write '3' in the box for 'High-level' mapping, '2' for 'Medium-level' mapping, '1' for 'Low-level' mapping.

Mapping with PSOs, where applicable.

Detailed Syllabus:

**Unit 1:** Introduction to digital design, Digital design metrics (Performance, Power, Functionality, Robustness, etc.) and their discussion in general, why low power, why high performance, Power-delay optimal designs, why technology scaling, issues in state-of-the-art digital designs i.e., making modern digital circuits, corner-based nanoscale design, statistical circuit design.

**Unit 2:** Combinational IC design, Sequential IC design, Role of CAD tools, RTL design, Logic Synthesis, Logic Simulations, Static Timing Analysis.

MOs Capacitor, Electrical Characteristics of MOs Transistors, Threshold Voltage, Transconductance($g_m$), Body Effect, Channel-Length Modulation, MOs Transistors Switch, MOs Inverter, Switching Characteristics, Driving Large Capacitive Loads, CMOS Realization, Switching Characteristics, CMOS NAND, NOR and other basic combinational/sequential circuits, CMOS Complex circuits, CMOS technology scaling, CMOS Gate sizing-logical effort, Complementary CMOS, Pass transistor logic, Dynamic CMOS design, Transmission gate, Layout basics, Floor Planning, Introduction to FinFET technology.

**Unit 3:** Digital Design - From Power perspective: Introduction, Dynamic power dissipation (Short-Circuit and Switching), Dynamic Power in the Complex Gate, Switching Activity, Switching Activity of Static CMOS Gates, Transition Probability in Dynamic Gates, Power Dissipation due to Charge Sharing, Static i.e. Leakage Power Dissipation (leakage mechanism): p–n Junction Reverse-Biased Current, Band-to-Band Tunneling Current, Tunneling through and into gate oxide, Injection of hot carriers from substrate to gate oxide, GIDL, Punch-through, Subthreshold Leakage Current including DIBL. Impact of technology scaling on leakage currents/power, need for technology scaling, factors effecting the leakage current especially in scaled technology nodes (input pattern dependency, stacking effect, loading effect, etc.), Impact of process, temperature and supply voltage variations on leakage currents. Internal node voltage impact.

**Unit 4:** Digital Design - From Performance (i.e., delay) perspective: Computing the Capacitances, Propagation delays, Factors affecting the propagation delays, Mathematical formulation of the delays in CMOS circuits, Technology scaling impact on propagation delays, Mean and variance of the delays in a gate, Impact of process variations on delays in CMOS circuits, Impact of operating (temperature and supply voltage) variations on delays.

FinFET technology will also be discussed in parallel. Such delay/leakage estimation techniques will also be applied to FinFET circuits.

**Reference Books:**

Teaching-Learning Strategies in brief (4 to 5 sentences):

The course will start with the background that drives us to the development of state-of-the-art digital VLSI designs, then fundamental and core topics of the course will be discussed in detail broadly at logic and transistors level with hands-on with related CAD tools. Circuit simulations, layout, RTL coding, synthesis, etc. will be highly encouraged throughout the course. The broad approach of the course is to discuss the digital VLSI design from three perspectives; power, performance, and power-delay optimal designs to understand the different design approaches. Students will be exposed to state-of-the-art scaled technology node to better understand the issues related to scaled nodes. Regular assignments will be given to reinforce the concepts. Weekly tutorials will involve students in active learning by applying the lecture discussion. Quizzes will be designed to test student's understandings on the discussed concepts. Projects will be carried out in groups, thereby developing the students' abilities to work in teams.

Assessment methods and weightages in brief (4 to 5 sentences):

- Home Assignments: 20%
- Quiz: 10%
- Mid Semester Exam: 15%
- End Semester Exam: 30%
- Project: 25%

Title of the Course: Disaster Management
Course Code: CE8.401
Faculty Name: Sunitha Palissery
L-T-P: 3-1-1
Credits: 4

Prerequisite Course / Knowledge:
General awareness about disasters, computer programming skills, and electronic hardware knowledge to develop tools and aids to assist effective disaster management.

Course Outcomes (COs):

After completion of this course successfully, the students will be able to:

CO-1. Develop awareness about natural and man-made disasters and help contribute holistically towards a disaster resilient community.

CO-2. Employ the core area skills in developing disaster management tools and sensors.

CO-3. Illustrate problem solving skills for various disaster scenarios and work towards a research-based disaster management for the country.

CO-4: Develop critical thinking to help policy making in disaster management activities.

CO-5. Analyze ethical and effective disaster management practices and related e-governance.
3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix

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'3' in the box denotes ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low-level’ mapping.

4. Detailed Syllabus:
Unit 1: Disaster Management Cycle- Mitigation, Preparedness, Response, Rehabilitation, Reconstruction, Recovery, Resilience, Capacity Building (9 hours);
Unit 2: Institutional Arrangements-NDMA, SDMA, DDMA, FEMA (7 hours);
Unit 3: Management of Natural and Man-made- Case Studies- Flood, Drought, Earthquakes, Cyclones, Tsunami, Landslides, Avalanche, Forest Fire, Air Pollution, Terrorist attacks, Nuclear Disaster, Chemical Disaster (12 hours);
Unit 4: Role of Information and Communications Technologies in Disaster Management Mitigation, Preparedness, Response, Recovery-Early Warning Systems, Mobile Communications, Information Dissemination (7 hours);
Unit 5: Disaster Risk Analysis-Mapping, Modelling, Risk Analysis, Introduction to Risk Modelling & Analysis using softwares, hands-on training (QGIS) (7 hours)

References:
5. Federal Emergency Management Agency (FEMA), Guidelines, FEMA, USA
6. Kanda, M., (2017), Disaster Management in India Evolution of Institutional Arrangements and Operational Strategies, Centre for Good Governance, Hyderabad, India
7. Malhotra, S., (2005), Natural Disaster Management, Avishkar
5. Teaching-Learning Strategies in brief:
Lectures by integrating ICT into classroom teaching, tutorials involving simulation modelling, analysing GIS data for predicting disasters, critical and active learning, and project-based learning by doing term projects which involve hands-on use of computer programming skills and software/hardware tools applications.

6. Assessment methods and weightages in brief:
Assignments in theory: 20 marks, Quizzes in theory: 10 marks, Mid Semester Examination in theory: 20 marks, End Semester Examination in Theory: 30 marks, Term-project: 20 marks

<table>
<thead>
<tr>
<th>Title of the Course</th>
<th>Distributed Data Systems</th>
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</thead>
<tbody>
<tr>
<td>Name of the Academic Program</td>
<td>B.Tech. in Computer Science and Engineering</td>
</tr>
<tr>
<td>Course Code</td>
<td>CS4.403</td>
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<td>Credits</td>
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<tr>
<td>(L= Lecture hours, T=Tutorial hours, P=Practical hours)</td>
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</tbody>
</table>

1. Prerequisite Course / Knowledge:
Data Systems

2. Course Outcomes (COs)
After completion of this course successfully, the students will be able to –

CO-1. Comprehend distributed database and distributed database system.
CO-2. Design a fragmentation and allocation schema for a set of applications.
CO-3: Learn and apply distributed query processing and optimization techniques.
CO-4. Demonstrate distributed query execution on a distributed database system.
CO-5. Learn and comprehend distributed transaction principles and algorithms.
CO-6. Demonstrate the apply above concepts for a columnar and cloud data system.

3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix

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‘3’ in the box denotes ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low’-level’ mapping

4. Detailed Syllabus:
Unit 1: Distributed database, Distributed database architecture (3 hours)
Unit 2: Distributed database design – fragmentation and allocation (6 hours)
Unit 3: Distributed query processing, optimization and execution (8 hours)
Unit 4: Distributed transaction management, concurrency control, recovery, commit protocols (5 hours)
Unit 5: Columnar stores and cloud data systems (2 hours)
- Four projects related to the above syllabus will be done by students. Implementation heavy about 3,000 lines of code project.

References:

5. Teaching-Learning Strategies in brief:
Lectures by integrating ICT into classroom teaching, weekly tutorials involving problem solving and active learning by students and Project-based Learning by doing four mini-projects.

6. Assessment methods and weightages in brief:
Assignments in theory: 10 marks, Mid Semester Examination in theory: 15 marks, End Semester Examination in Theory: 30 marks, Assessment of four projects: 45 marks

Title of the Course: Distributed Systems
Course Code: CS3.401
Faculty Name: Lini Thomas
L-T-P: 3-1-0
Credits: 4

1. Prerequisite Course / Knowledge:
An understanding of operating systems, networks, and algorithms

2. Course Outcomes (COs):
After completion of this course successfully, the students will be able to..

CO-1: Explain the challenges faced by distributed systems in terms of lack of global time, synchrony, faults, programming support, etc.

CO-2: Employ standard distributed programming frameworks to write distributed programs for problem solving
CO-3: Explain the properties and design principles of various real-world and practical distributed systems

CO-4: Interpret the impact of faults in distributed systems in the context of important problems such as distributed agreement, distributed consensus, and distributed transaction processing.

CO-5: Analyze distributed algorithms for graphs with respect to correctness, round complexity, and message complexity.

CO-6: Analyze the limitations of distributed systems and assess the operational scope of large-scale distributed systems.

3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix

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Note: ‘3’ in the box for ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low’-level’ mapping

4. Detailed Syllabus:

- **Unit 1**
  - Introduction
  - Communication models
  - Time and Synchronization
  - Practice: MPI/Map-Reduce

- **Unit 2**
  - Distributed file systems
  - Consensus, Agreement, Locking
  - Practice: GFS, Chubby

- **Unit 3**
  - Distributed Database systems
  - Practice: NoSQL, MongoDB
• Unit 4
  • Limitations of distributed computing
  • Self-Stabilization
  • CAP Theorem

• Unit 5
  • Distributed algorithms for graphs
  • Advanced Topics such as Blockchain, Distributed Storage, and Distributed Program Verification

Reference Books:


3. Other significant papers from conferences such as OSDI, USENIX, NSDI, for material that is not part of textbooks

5. Teaching-Learning Strategies in brief:

Lectures of the class use the active learning methodology and allow students to learn concepts thoroughly in class along with practising small examples. Homeworks assigned as part of the course are useful to impart knowledge of using practical distributed programming tools and libraries. To promote team work, some of the homeworks are done in a team of two students. The overall learning from the course is enhanced by doing a substantial practice-based project – usually in a team of two students. The course will also have a summative assessment in the form of a final/end-semester exam.

6. Assessment methods and weightages in brief:

- In-class Quiz Exams (Cumulative over several): 15%
- Homeworks: 20%
- Project: 25%
- End Semester Examination: 40%

Title of the Course : Earthquake Engineering
Course Code : CE1.601
Faculty Name : Pradeep Kumar R
L-T-P : 3-1-0
Credits : 4

1. Prerequisite Course / Knowledge:

B.Tech in Civil Engineering subjects i.e., Engineering Mechanics, Reinforced Concrete Design, Structural Analysis, Structural dynamics

2. Course Outcomes (COs) (5 to 8 for a 3 or 4 credit course):

After completion of this course successfully, the students will be able to..

CO-1 Use the understanding of the earthquake engineering for structural design;
CO-2 Write computer programs, to understand earthquake behaviour;
CO-3 Analyse and design the structure using commercially available software
CO-4  Apply the knowledge of code provisions for design of buildings and structures

CO-5  Appreciate the challenges in construction industry and get equipped to address some of the challenges

3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix

Pl. insert the mapping table

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Note: ‘3’ in the box for ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low’-level’ mapping

4. Detailed Syllabus:

Unit 1: Earthquake Hazard on Buildings: Plate tectonics, Origin of earthquakes, types of faults and seismic waves, measurement of earthquakes, magnitude and intensity, characteristics of earthquake ground motion

Unit 2: Earthquake Behavior and Analysis of Buildings: Behavior of MRFs, behavior of SWs, Earthquake Analysis of Buildings, methods of Analysis

Unit 3: Earthquake Resistant Design and Detailing of Buildings: IS 1893-2016, concept of earthquake resistant design, seismic code Provisions for design of buildings, earthquake Resistant Detailing of Buildings, IS 13920-2016

Unit 4: Earthquake Safety Assessment of Building: Pre-earthquake safety assessment, post-earthquake evaluation of structures & Retrofitting

Unit 5: Earthquake Strengthening of Buildings and Special Topics: Methods of Retrofitting, Methods of Strengthening, Special topics, non-engineered constructions

Reference Books:
5. **Teaching-Learning Strategies in brief** (4 to 5 sentences):

A lecture on a theory concept will be preceded by its practical relevance, appreciation of field level challenges and immediately followed by on-hands-practice using manual approach as well as using appropriate scientific software. Student will be encouraged to come up with issues and how the theory and hands-on experience is helping them. Student is also encouraged to do homework and assignments individually and mini-projects as a group task.

6. **Assessment methods and weightages in brief** (4 to 5 sentences):

The course will rely heavily on looking at problem solving capability of student and hence the assessment is divided as follows i.e.,

- a) 20% weightage is given to individual assignments for checking the concepts taught in the class,
- b) 20% weightage is for group projects for checking software application
- c) 30% is quizzes & Mid exam for checking the application of concept and,
- d) 30% for end-sem exam is for overall assessment.

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**Title of the Course**: Exploring Masculinities  
**Faculty Name**: Vindhya Undurti  
**Name of the Program**: Humanities Elective  
**Course Code**: HSO.209  
**Credits**: 2 credits  
**L · T · P**: 18 Lecture hours (12 classes)  
**Semester, Year**: Spring 2022

**Pre-Requisites**: Introduction to Human Sciences, Ethics 1 (Basics)

**Course Description**: This course explores the construction and meaning of masculinities and examines in particular the linkages between the social construction of masculinities and power and violence. The course will provide an overview of the key discussions and perspectives from different disciplines such as psychology, sociology, and gender studies, on the connections between the construction of masculinities, their intersections with markers such as class, ethnicity, caste, sexual orientation, and the many forms of power and violence. While the theoretical understanding of masculinities and their connections with power and violence will form the bedrock of the course, a distinctive feature will be the experiential component – the opportunity the course aims to provide for students to reflect and imagine the possibility of ethical masculinities that is transformative, based on ideals of mutuality, care and respect, and awareness of gendered vulnerabilities. This course will thus enable students to be familiar with the key concepts in relation to the social construction of masculinities in different disciplines, unravel the links between masculinities and
violence, and to facilitate engagement, through self-reflection of behaviors, norms and values, with the transformative potential of ethical masculinities.

**Course Outcomes**

On successful completion of this course, students will be able to

1. Explain how masculinities are socially constructed
2. Understand the connections between harmful masculinities and perpetration of violence
3. Critically reflect on their own individual behavior, socialization patterns and identity development in order to contextualize the understanding of masculinities in the ‘personal’.

**Course Topics**

Module I:
- Introduction: Origins of scholarly interest and research in masculinities
- How are power, violence and the social construction of masculinities connected?

Module II:
- Gender stereotypes, construction of male identity: An intersectional approach
- Social psychology of sexism: hostile and benevolent sexism and links with violence perpetration

Module III:
- Ethical masculinities

**Readings:*

https://sk.sagepub.com/books/masculinities-and-violence/n11.xml


**Grading Plan**

<table>
<thead>
<tr>
<th>Type of Evaluation</th>
<th>Weightage (in %)</th>
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<tbody>
<tr>
<td>Quiz-1 (3-5 questions; answers of 200-300 words)</td>
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<tr>
<td>Assignment 1/Reflective piece (1000-word essay)</td>
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<td>Quiz-2 (3-5 questions; answers of 200-300 words)</td>
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<td>Assignment 2 (1000-word essay)</td>
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**Mapping of Course Outcomes to Program Objectives:**
Teaching-Learning Strategies in brief (4-5 sentences):
The teaching-learning strategy will consist of a combination of powerpoint-based lectures, and discussions on the selected readings. In addition, there will be classroom activities designed to encourage students to take an experiential stance and critically reflect on their own socialization patterns and construction of identities for a critical appraisal of the concepts learnt in class. The participatory methodology of pedagogy will be supplemented with assessments aimed to test comprehension of students’ knowledge, as well as their abilities of critical reflection, interpretative reading and structured writing.

Title of the Course: Flexible Electronics
Course Code: EC2.502
Faculty Name: Aftab Hussain
L-T-P: 3-1-0
Credits: 4
(L= Lecture hours, T=Tutorial hours, P=Practical hours)
1. Prerequisite Course / Knowledge:
Understanding of basic concepts of Physics and Chemistry taught up to the 10+2 level
2. Course Outcomes (COs) (5 to 8 for a 3 or 4 credit course):

- CO-1: Describe the physical reason for flexibility in various material systems.
- CO-2: Explain the various processes, such as lithography, etching, deposition etc., that are involved in silicon semiconductor fabrication.
- CO-3: Compare the fabrication and functioning of flexible electronic systems with their rigid counterparts.
- CO-4: Employ various microfabrication techniques to obtain flexible electronic systems.
- CO-5: Choose the correct approach for designing and fabricating a fully flexible system including, flexible memory, processor, display, power source and so on.
- CO-6: Create a report of the various advances in the state-of-the-art of a specific topic in flexible electronic systems.

3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix
Note: Each Course Outcome (CO) may be mapped with one or more Program Outcomes (POs) and PSOs.
Write ‘3’ in the box for ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low-level’ mapping

4. Detailed Syllabus:
Unit 1: Physics of silicon electronics, silicon band structure, flexible materials
Unit 2: VLSI fabrication: silicon wafer, deposition, lithography, etching
Unit 3: Flexible electronic systems, flexible PCBs, interconnects, flexible silicon processes
Unit 4: Flexible displays, flexible TFTs, OLEDs, flexible memory
Unit 5: Flexible energy harvesters, photovoltaics, flexible interconnects

Reference Books:
2. Mario Caironi, Yong-Young Noh, Large Area and Flexible Electronics, Wiley VCH, 2015
3. Takao Someya, Stretchable Electronics, Wiley VCH, 2013

5. Teaching-Learning Strategies in brief (4 to 5 sentences):
The course instruction is delivered through lectures slides explained by the instructor. The slides include theoretical concepts with examples of real-world applications of flexible electronic systems to foster student understanding and interest. Assignments are designed to encourage students to critically think about the concepts discussed in the class and to learn to independently solve problems. The students are asked to create a literature survey report detailing the advances in the state-of-the-art of one of the topics in flexible electronic systems.

6. Assessment methods and weightages in brief (4 to 5 sentences):
Continuous valuations:
Assignments – 20%
MCQ Quizzes – 20%

Comprehensive exams:
End semester exam – 35%
Term-paper report – 25%
Title of the Course: Green Buildings
Course Code: CEG422
L-T-P: 3-1-0.
Credits: 4

Name of the Academic Program: MS. in IT in Building Science

(L= Lecture hours, T=Tutorial hours, P=Practical hours)

**Prerequisite Course / Knowledge:**
Building Services

**Course Outcomes (COs)**
After completion of this course successfully, the students will be able to:

CO-1. Understand the concepts of green buildings and be able to apply them in real building projects

CO-2. Apply the green building concepts to evaluate projects for rating systems such as LEED, GRIHA, IGBC

CO-3. Design buildings using various green concepts

CO-4. Understand the inter-relationship between various aspects of buildings and do integrated design for overall building performance

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**Detailed Syllabus:**

1. Conventional building impacts
2. Introduction to Green Buildings
3. Impacts of building construction, operation, and disposal
4. The green building process and assessment
5. Ecological design
6. Sustainable sites and landscaping
7. Energy efficiency in buildings
8. Renewable energy
9. Water conservation
10. Sustainable and alternative materials
11. Indoor environmental quality
12. Construction Operations and Building Commissioning
13. Certification Systems
14. Sustainable Operations
15. Economic issues and future directions in green buildings
Analysing a building such as school, hospital for their performance from the perspective of a green building rating system

Redesigning the same building for improved performance

References:

4. Green Building Fundamentals (2nd Edition), Mike Montoya, Pearson Education
5. Fundamentals of Integrated Design for Sustainable Building, Marian Keeler, Bill Burke, John Wiley and Sons
6. IGBC reference guide
7. GRIHA manual

Teaching-Learning Strategies in brief:

Project work: Each student will evaluate an aspect of the IIIT campus from the point of view of a rating system and will submit his/her assessment and recommendations.

Site Visits: Site visit(s) to building(s)/campus(es) in Hyderabad which are designed or operated in a sustainable manner.

Students will have to submit their individual site visit reports.

Assessment methods and weightages in brief:

Mid-term exams = 25%

Studio work=50%

End semester Exam=25%

Name of the Program : Hydroinformatics
Faculty Name : Shaik Rehana
Course Code : CS9.433
Credits : 4
L - T - P : 3-1-0
(L - Lecture hours, T - Tutorial hours, P - Practical hours)
Semester, Year : Spring, 2022
(Ex: Spring, 2022)

Pre-Requisites : NIL

Course Outcomes :
After completion of this course successfully, the students will be able to
CO-1: Handle various types of hydrological, climate data sources obtained from models, experimental, remote sensing and geographic information system based.

CO-2: Process various dimensions of data from open sources and acquiring data driven information using statistical methods

CO-3: Employ computer science skills in processing the hydroclimatic information

CO-4: Employ statistical and machine learning algorithms for predicting hydroclimatic processes

CO-5: Develop critical thinking to help in processing data from various sources to solve water related issues using computational algorithms and technologies

CO-6: To improve the problem-solving skills for solving water and climate related problems

Course Topics:
Acquisition and Processing of Hydroinformatics Data: Automated data collection, data storage, file formats and standards, web-based data distribution, access and processing, geographic information system; digital image processing, digital elevation modeling.

Technologies in Hydroinformatics: Regression, Stochastic Models, Optimization, Data Driven Models.

Application of Hydroinformatics: Operation, management and decision making, development of decision support systems for water, agriculture, energy, climate and environment.

Preferred Text Books:

- Introduction to Geographic Information Systems by Kang-Tsung Chang
- Geographical information systems and science by Paul A. Longley, Michael F. Goodchild, David J. Maguire, and David W. Rhind
- Lo, C. P., and Albert K. W. Yeung., Concepts and techniques of geographic information systems by C P Lo and Albert K W Yeung

Grading Plan:
(The table is only indicative)

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<tr>
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<td>Project</td>
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Other Evaluation: Nil

Mapping of Course Outcomes to Program Objectives: (1 – Lowest, 2—Medium, 3 – Highest, or a ‘-’ dash mark if not at all relevant). Program outcomes are posted at

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Teaching-Learning Strategies in brief (4-5 sentences):

Lectures and tutorials to analyze, process, visualize and map various water and climate related information. Hands on sessions and assignments with real-time case studies and data to process and understand hydroinformatics with the use of computer programming skills.

Note: This course description format comes into effect from Spring 2022.

Title of the Course: ICTs for Development
Faculty Name: Nimmi Rangaswamy
Course Code: CS9.431
L-T-P: 4-0-0
Credits: 4

Prerequisite Course / Knowledge: UG3 and above – no other prerequisite knowledge

2. Course Outcomes (COs)- After completion of this course successfully, the students will be able to do the following:

CO-1. Develop a holistic definition and the role of information and communication technology [ICTS] in socio-economic development.
CO-2. Learn critical theoretical theories of development and ICTD from a global perspective

CO-3: Grasping context aware concepts and application of ICTD in India

CO-4. Deep analysis of ICTD case studies in India and the global South

CO-5. Develop a research project applying foundational learnings from the course

3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix

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‘3’ in the box denotes ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low’-level’ mapping

Course Structure in Detail

Overview of Course

OBJECTIVES

To introduce the idea of channeling the potential of Information and Communication Technology [ICTs] for socio-economic development to students of Engineering and Computational Humanities

To debate the notion of development as a sociological concept, with a particular focus on India, and discuss impacts of the development process on society as a multi-faceted phenomenon

To focus upon and formulate the idea of social media, as a component of ICTs, and the role they play in shaping the contours of social and everyday life

COURSE TOPICS/CONTENT/OUTLINE

Information and Communications Technology for Development is a growing area of research and community of scholars studying the role of technology in international development. Students in this course will study contemporary debates, issues and field projects that engage with information and communication technologies [ICTs] in the service of socio-economic progress and human development. This means a range of things: it could refer to the scope of technology
in alleviating poverty, in impacting low-resource settings, in designing and engineering relevant technologies to close digital literacy gaps in specific populations.

Topics that will be covered as part of the course are the following. These are broad umbrella categories which contain sub-topics

**Introduction to the idea of Development:**

Studying development is essentially a multidisciplinary exercise rooted in a range of technical and social-science research. By combining a variety of subject areas, the course will engage deeply with some of the complex problems associated with developing economies especially unstable infrastructures, scarce resources, and social disadvantages. We will discuss A Sen, K Galbraith among others

**Globalization and Development**

The course will specifically look at globalization as a socio-economic disruptor having far-fetched implications for not only wealth generation for a country but also bringing cultural transformations. We will discuss several historical trajectories of globalization in specific country contexts. We will include works of J Sachs, W Easterly

**Technology and Development**

The course will introduce a variety of social environments across resource and economic constraints that are targets for socio-economic development either through a top down model of deploying ICTs or through a more market driven and organic social processes. These can range from building low-cost technologies to studying user-driven innovations of ICTs to fit contexts of use. We will cover certain domain areas, using relevant theoretical models and practical outcomes, within ICTs and Development, like, education, healthcare, livelihoods, entertainment, and governance. Students will develop a critical lens to evaluate the processes and impacts and gain a well-rounded and practical perspective on issues of assessment and successes of development projects. Introducing Information and communication technologies as harbingers of social change

Under this topic we will debate and discuss the nature and contours of new channels of information, social networking the rise of social media and online content generation. Questions posed by these digital artifacts evaluate the inherently democratizing, process of owning, using, and networking with new media technologies. With the help of case studies, with a focus on India, we will articulate the implications of new and digital media in everyday life. We will focus on the sociology of new media technologies, with a specific aim to anchor them within select theoretical debates and in specific geographic contexts.

**Social Media as a Developmental tool**

Research had pointed to the rich field of utilization of new media tools for leisure and social networking as well as the unique affordances they spawn in the arena of self-expression and acquiring socio-digital identities. For example, the pre-pay mobile internet made web surfing an affordable and engaging activity even in the down markets and resource poor social ecologies of urban India. The course will critically evaluate the impacts of media technologies in the development discourse of a nation. The topic will include case-studies from the global North and South centering on social segments in resource-poor and emerging market settings.
This class has no pre-requisite requirements and open to students from any background.

Students will be continuously evaluated with periodic quizzes/short tests and a course end assignment that will gauge student ability in engaging with and comprehending the course readings and classroom discussions.

**PREFERRED TEXT BOOKS:**


**REFERENCE BOOKS:**


**GRADING PLAN:**

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<td>Class Participation &amp; Attendance</td>
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**OUTCOME:**
Students will be able to identify and apply a developmental lens in a variety of and diverse socio-economic contexts. The course will provide a strong grounding in developing a sociological perspective of digital media and their impact in the evolution of a digital society as a part of parcel of socio-economic development. One of the critical question the course will attempt to unpack is how technology seeks to address the needs and aspirations of people who increasingly consuming technologies and services despite are living in low resourced eco systems.

**Course Title**: Indian Grammatical Tradition  
**Course Code**: CL5.404  
**CREDITS**: 2  
**TYPE-WHEN**: Spring 2021  
**FACULTY NAME**: Dipti Misra Sharma

1. **Prerequisite Course / Knowledge**:  
Basic concepts of linguistics and basic understanding of computational modeling of language

2. **Course Outcomes (COs)** (5 to 8 for a 3 or 4 credit course):  
After completion of this course successfully, the students will be able to

- **CO-1**: Develop an understanding of the basic concepts of Panini’s grammar  
- **CO-2**: Apply concepts from Indian grammatical traditions to modern languages  
- **CO-3**: Get familiar with the Universal Dependency Grammar (UDG) scheme and be able to compare it with Paninian Dependency Grammar (PDG).  
- **CO-4**: Develop and understanding of how language encodes and conveys meaning.  
- **CO-5**: Computationally model modern languages based on PDG.

3. **Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix**

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Note: Each Course Outcome (CO) may be mapped with one or more Program Outcomes (POs) and PSOs. Write ‘3’ in the box for ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low’-level mapping.

4. **Detailed Syllabus:**

**Unit 1:** Pāṇini's grammar – Basic properties, organization – components and levels

**Unit 2:** Basic concepts

i) Morphology – prakriti and pratyaya vibhag (subanta and tinganta),

ii) Syntax and semantics – vibhakti and karaka, samas, saamarthy

**Unit 3:** Concepts of

i) Tatparya and Vivaksha

ii) sphota, pravitti nimitta

iii) aakaaMkshaa, yogyataa, sannidhi

**Unit 4:** Relation between phrase structure grammar and dependency grammar

**Unit 5:** Modelling a computational grammar based on Panini's grammar

**Reference Books:**


3. Akshar Bharati et al - NLP, A Paninian Perspective

5. **Teaching-Learning Strategies in brief (4 to 5 sentences):**

The course will be taught through lectures in an interactive manner. The students will also be asked to read papers/book chapters and present in class for further discussion. The students will also be given projects to work on which will involve annotating corpora and developing models for different levels of linguistic analysis.

6. **Assessment methods and weightages in brief (4 to 5 sentences):**

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Course Title: Information Security Audit and Assurance
Faculty Name: Shatrunjay Rawat
Name of the Program: M.Tech CSIS and other programmes
Course Code: CS8.402
Credits: 4
(L - Lecture hours, T - Tutorial hours, P - Practical hours)

Semester, Year: Spring, 2022
Pre-Requisites: Computer Networks and Operating Systems

Course Outcomes:
CO-1 Demonstrate understanding of security needs and issues of IT infrastructure
CO-2 Have basic skills on security audit of IT systems, do risk assessment and work out risk mitigation strategies
CO-3 Understand information security and privacy related laws, and their implication on IT systems
CO-4 Understand standards related to information security and develop security policies and procedures for an organisation.
CO-5 Understand functioning of security products, and design a reliable and secure IT infrastructure
CO-6 Respond to IT and other disasters in appropriate manner

Course Topics:
Unit 1: Introduction to information security, various aspects of information security; Review of TCP/IP, basic components of computer networks; Security products such as Firewall, IDS/IPS, VPN Concentrator, Content Screening Gateways, PKI, etc
Unit 2: Audit of various networking protocols/infrastructure from information security perspective – IP*, TCP/UDP, HTTP*, SMTP, OSPF/BGP/PIM, Ethernet/WiFi, switches/routers, etc.; Security audit of various Operating Systems
Unit 3: Information security standards – ISMS (ISO 27000 family), HIPAA, GDPR, etc; Security audit practices; Preparing security policies and procedures for organisations
Unit 4: Business Continuity Management, Disaster Recovery/Management; Designing security ready IT infrastructure
Unit 5: Information security related laws – Indian IT Act, IPR and privacy laws, various court judgements; Security Guidelines of various regulators (RBI, TRAI, IRDAI, etc); CERT and other information security organisations/bodies/industry associations.

Preferred Text Books:
No single text books. Required study material will be shared/identified as course progresses.

Reference Books:
Some references are listed below
1. RFCs of networking protocols
2. Various acts/laws - India IT Act, IPR and Privacy Laws, Court Judgements
3. Information security standards - ISO 27000 family, HIPPA, GDPR
4. Research papers

E-book Links:

Grading Plan:

Based on class participation, presentations, assignments, security audits, Mid/End Sem exams, Simulation exercise, etc. Tentative marks distribution for grading is as follows:

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<td>Assignments</td>
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<td>End Semester Examination</td>
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Mapping of Course Outcomes to Program Objectives:
(1 – Lowest, 2—Medium, 3 – Highest, or a ‘-’ dash mark if not at all relevant).

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Teaching-Learning Strategies in brief:

Course will be primarily driven by classroom discussions, readings, surveys, exploratory practical assignments. It will involve a lot of critical thinking and active learning by the students to solve practical problems. Students will be asked to make presentations on topics assigned to them for exploration/experiment.

Title of the Course : Internals of Application Servers
Course Code       : CS3.404
FACULTY NAME      : Ramesh Loganathan
Credits           : 3-1-0-4
TYPE-WHEN         : Spring 2022
OBJECTIVE: Understand Distributed Application Platforms through a project-based system building course structure. Key aspects of distributed applications will be introduced, and a contemporary application platform will be built as part of the course project.

COURSE TOPICS:
Understand essence of middle wares and distributed object technology.
Typical distributed platforms' server Technology and Architecture
App Server architecture.
Lifecycle of an application- development, packaging, and deployment thru monitoring in production.
Clustering and High Availability
Distributed app platform Communication models
Contemporary application platforms.
Project problems Discussions
Project architecture & design reviews
Guest lectures from Industry
(Projects built in previous years- JMS Server. Distributed web services platform (SOA). MiroServices Platforms. Ai on the Edge. Fog computing (IOT) platform)

PREFERRED TEXTBOOKS:
*REFERENCE BOOKS:

GRADING: Class quiz, Labs, and course project

OUTCOME: A systems level understanding of distributed application platforms through building a contemporary platform.

REMARKS:

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Title of the Course : Introduction to UAV Design
Faculty Name : Harikumar Kandath
Course Code : EC4.402
Name of the Academic Program : B.Tech in Electronics and Communication Engineering
L-T-P : 3-1-0
Credits : 4
(L= Lecture hours, T=Tutorial hours, P=Practical hours)

1. Prerequisite Course/Knowledge:
   Basics of Linear Algebra, Laplace transform and Vector calculus.

2. Course Outcomes (COs) (5 to 8 for a 3 or 4 credit course):
   After completion of this course successfully, the students will be able to..
   
   **CO-1** Determine the design specifications of the Unmanned Aerial Vehicle (UAV) used for a particular application.
   
   **CO-2** Explain the various design phases involved in the UAV design.
   
   **CO-3** Perform the conceptual design and preliminary design for multi-rotor, fixed-wing and hybrid UAVs.
   
   **CO-4** Perform the stability and flight performance analysis for the designed UAV.
   
   **CO-5** Able to manufacture a prototype UAV.
Perform the flight simulation and flight testing of the prototype UAV and verify its stability and performance characteristics.

3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix

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Note: Each Course Outcome (CO) may be mapped with one or more Program Outcomes (POs) and PSOs.

Write ‘3’ in the box for ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low-level’ mapping

4. Detailed Syllabus:
   Unit 1: Types of UAVs -- Multi-rotors, fixed wing (FWUAV), Hybrid VTOLs
   Unit 2: Multi-rotor design -- Concept of operation (CONOPS), design specifications, different reference frames, axis conventions, forces and moments, sizing and assembly, sensors and control.
   Unit 3: FWUAV flight mechanics and control -- wing, fuselage, stabilizer and control surfaces, propulsion system, forces (lift, drag, thrust, side force), moments (roll, pitch, yaw), trim conditions, longitudinal static stability, lateral and directional stability, PID control through successive loop closure.
   Unit 4: FWUAV design -- Concept of operation (CONOPS), design specifications, preliminary sizing, airfoil selection, wing planform selection, control surface sizing, stabilizer sizing, selection of propulsion system (battery, motor/engine, propeller), stability and performance analysis, design trade-offs.
   Unit 5: Different configurations (tilt-rotor, tailsitter), transition dynamics, design specifications, sizing, stability and control.

Reference Books:
3. R.W. Beard and T.M. McClain, Small Unmanned Aircraft: Theory and Practice, first edition,
5. Teaching-Learning Strategies in brief (4 to 5 sentences):
Weekly lectures based on the course syllabus and based on the latest design technologies available in the literature and other industrial resources. Tutorials covering the use of software for UAV design and performance analysis. Detailed student assignment for practicing the different elements of the conceptual design phase. Open book exam followed by detailed project submission including simulation studies, prototype development and flight testing.

6. Assessment methods and weightages in brief (4 to 5 sentences):

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<thead>
<tr>
<th>Type of Evaluation</th>
<th>Weightage (in %)</th>
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<tbody>
<tr>
<td>Quizzes</td>
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<tr>
<td>Assignments</td>
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<tr>
<td>Project</td>
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</table>

Title of the Course: Introduction to Algorithm Engineering
Faculty Name: Kishore Kothapalli
Course Code: CS1.305
Credits: 2
L-T-P: (L - Lecture hours, T - Tutorial hours, P - Practical hours)
Semester, Year: Spring 2022
Pre-Requisites: first course on algorithms, programming, computer architecture/organization

Course Outcomes:

(list about 5 to 6 outcomes for a full 4 credit course)
The action verbs to be used for writing the course outcomes can be found on slide 22 in the following presentation. You may remove this line and the following link after the course outcomes are formulated.
https://iiitaphyd-my.sharepoint.com/:b/r/personal/dyacad_iiit_ac_in/Documents/NBA-2020-21/Reference%20Documents/Curriculum%20Design%20in%20NBA%20Framework%20and%20Course%20Design%20for%20All%20Faculty%20IIIT%20Hyderabad%202021.pdf?csf=1&web=1&e=387W1k

At the end of the course, a student will be able to:
CO – 1: Demonstrate familiarity and scope of algorithm engineering
CO – 2: Explain the significance of algorithm engineering and analyze the practical performance of algorithms in connection to the nature of input
CO–3: Apply algorithm engineering principle to implement a variety of graph and semi-numerical algorithms
Course Topics:
(please list the order in which they will be covered, and preferably arrange these as five to six modules.)
1. Introduction to algorithm engineering, its scope, and its importance – 1
2. Cache-Aware Design: Algorithms and Techniques - 1
4. A Primer on Parallel Algorithms – 3
5. Graph connectivity – 2
6. Eccentricity and Diameter – 2
7. Centrality Measures on Graphs – 2

Preferred Text Books:
Reference Books: Reference papers that are used for some of the course topics will be posted as they are discussed in class.
E-book Links: Book being developed by the instructor available at http://cstar.iiit.ac.in/~kkishore/pgae.pdf

Grading Plan: Since the course is a half-course, we will have one quiz evaluation and one finalevaluation.

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<tr>
<th>Type of Evaluation</th>
<th>Weightage (in %)</th>
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<td>Quiz-1</td>
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<td>Mid Sem Exam</td>
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<td>Quiz-2</td>
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<td>End Sem Exam</td>
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For Office Use Only (starts on a new page)

Mapping of Course Outcomes to Program Objectives: (1 – Lowest, 2—Medium, 3 – Highest, or a ‘-’ dash mark if not at all relevant). Program outcomes are posted at

https://iiitaphyd-my.sharepoint.com/:w:/r/personal/dyacad_iiit_ac_in/Documents/NBA-2020-21/Course%20Content/IIIT-CSE-ECE.docx?d=w111f0effcaea41b3a4d1e8a3fbc6332d&csf=1&web=1&e=z1

Khby
Teaching-Learning Strategies in brief (4-5 sentences):

The course will have hands-on exercises that help students understand the mechanisms available for algorithm engineering. The course project also equips them to explore an existing algorithm and a problem in depth and gain useful practical knowledge. The material used in the course is not part of standard textbook as yet, so lecture slides and reference papers will be made available for reading.

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Note: This course description format comes into effect from Spring 2022.
Preferred Text Books:

Reference Books:

E-book Links:

Grading Plan:
(The table is only indicative)

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<th>Type of Evaluation</th>
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<td>End Sem Exam</td>
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<td>Term Paper</td>
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Mapping of Course Outcomes to Program Objectives: (1 – Lowest, 2—Medium, 3 – Highest, or a ‘-’ dash mark if not at all relevant). Program outcomes are posted at

| PO 1 | PO 2 | PO 03 | PO 04 | PO 05 | PO 06 | PO 07 | PO 08 | PO 09 | PO1 0 | PO1 1 | PO1 2 | PS 01 | PS 02 | PS 03 | PS 04 |
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| CO2  | 3    | 1     | 2     | 3     | 1     | 3     | 3     | 1     | 1     | 1     | 1     | 2     | 2     | 2     | 3     | 2     |
| CO3  | 2    | 1     | 2     | 2     | 1     | 3     | 2     | 2     | 1     | 1     | 1     | 2     | 1     | 2     | 3     | 1     |
| CO4  | 1    | 1     | 1     | 1     | 1     | 1     | 1     | 1     | 2     | 3     | 1     | 2     | 1     | 1     | 1     | 1     |

Teaching-Learning Strategies in brief (4-5 sentences):
The IBC course is primarily lecture and discussion-based learning course. Students will be introduced to undergraduate-level introductory topics and issues in brain and cognition. Reading material will be assigned. Students will be required to engage in discussions, and to write a term paper on related topics. Students will be encouraged to relate the theory topics to everyday experiences and will be asked to evaluate the event/phenomenon/ processes critically and scientifically. They will be encouraged to interact with various research teams in Cognitive Science Lab to familiarize themselves with the research projects so that they can start thinking about a future lab to conduct their research work.
Title of the Course: Introduction to Game Theory
Course Code: CS1.408
Faculty Name: Sujit Gujr
L-T-P: 3-1-4
Credits: 4
(L= Lecture hours, T=Tutorial hours, P=Practical hours)

1. Prerequisite Course / Knowledge:
Basic Knowledge in Linear Algebra, Probability Theory and comfortable in basic maths

2. Course Outcomes (COs) (5 to 8 for a 3 or 4 credit course):
After completion of this course successfully, the students will be able to
CO-1 understand how to define a game and strategies in a game
CO-2 demonstrate familiarity with different solution concepts in game theory
CO-3 write algorithms to solve many game theoretic problems
CO-4 understand the concept of mechanism design (incentive engineering)
CO-5 analyze given autonomous system for any strategic behavior of the agents
CO-6 design mechanism for autonomous agent systems to make them game theoretically sound
CO-7 design agents to partecipate in auction-based competition

3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix

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4. Detailed Syllabus:

(b) Mini-max Theorem, Nash Theorem, Shapley's Theorem for core and algorithmic aspects of these theorems.
(c) Game with incomplete information, introduction to mechanism design, revelation principle, voting schemes.
(d) Application of the above concepts will be illustrated with use cases in wireless communication, e-Commerce, social networking, crowdsourcing and, cloud management.

Reference Books:
1. “Game Theory and Mechanism Design” by Y Narahari.
2. “Game Theory: Analysis of Conflict”, by Roger B. Myerson.

5. Teaching-Learning Strategies in brief (4 to 5 sentences):
The course is designed mix of theory and practice. The theory part is planned to be taught with posing questions to the students to make them think how intelligent agents should behave in the given situation. The students are evaluated regularly with quizzes. To expose students to deep research aspects there are reading assignments. To enable learning practical aspects, there are programming assignment and tournament where they write their strategic agents. The assignments are done in teams to enable peer learning. To further enhance the knowledge further, the reading assignments are peer-evaluated.

6. Assessment methods and weightages in brief (4 to 5 sentences):

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<th>Type of Evaluation</th>
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<td>Course Participation</td>
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<td>Project (Competition)</td>
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Title of the Course: Introduction to Information Security
Faculty Name: Ashok Kumar Das
Name of the Academic Program: B.Tech. In CSE / M.Tech. in CSE/CSIS
Course Code: CS8.401
L-T-P: 3-1-0
1. Prerequisite Course / Knowledge:

Discrete Structures, Programming Languages

2. Course Outcomes (COs) (5 to 8 for a 3 or 4 credit course):

After completion of this course successfully, the students will be able to

CO-1: Effective security related problems solving

CO-2: Critical thinking skills

CO-3: Practical demonstration of security protocols

CO-4: Blockchain technology and its security aspects

CO-5: Design and analysis of Internet of Things (IoT)-related security protocols

3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix

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Note: Each Course Outcome (CO) may be mapped with one or more Program Outcomes (POs) and PSOs. Write ‘3’ in the box for ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low’-level’ mapping

4. Detailed Syllabus:

- **Unit 1**: Basics of Cryptography: Cryptographic goals and objectives; Types of attacks, passive and active attacks; Introduction to Number Theory; Complexity Theoretic Connections; Overview of symmetric and public key cryptography
• **Unit 2:** Basics of System Security: Overview of intrusion detection: Types of intruders, intrusion detection and prevention mechanisms; Overview of software vulnerabilities: Overview of phishing, Buffer Overflow (BOF), heap overflow, and SQL injection attacks

• **Unit 3:** Basics of Network Security: Overview of encrypting communication channels

• **Unit 4:** Introduction to Internet of Things (IoT) security: IoT architecture; various IoT applications; security requirements, security attacks, threat model for the IoT ecosystem; taxonomy of security protocols

• **Unit 5:** Introduction to Blockchain technology: Various applications of Blockchain of Things (BCoT); centralized versus decentralized models; types of blockchain; brief overview of various consensus algorithms; block formation and addition in a blockchain

**Reference Books:**


**5. Teaching-Learning Strategies in brief (4 to 5 sentences):**

* Design of efficient and secure symmetric/public key cryptosystems

* Design of efficient intrusion detection systems

* Understanding various system related attacks and their remedies

* Understanding security aspects of IoT-related applications

* Understanding Blockchain technology and its usage in various real-life applications

**6. Assessment methods and weightages in brief (4 to 5 sentences):**

- In-Class Tests: 20%
- Assignments: 20%
- Mid Semester Examination: 20%
- End Semester Examination: 40%

---

**Course Title:** Introduction to NLP  
**Faculty Name:** Manish Shrivastava  
**Name of the Program:** B.Tech. in Computer Science and Engineering  
**Course Code:** CS7.401  
**Credits:** 4  
**L - T - P:** 3-1-0  
(L - Lecture hours, T-Tutorial hours, P - Practical hours)
Semester, Year: Spring, 2022
(Ex: Spring, 2022)

Pre-Requisites: None

Course Outcomes:
After completion of this course successfully, the students will be able to –

CO-1. Demonstrate the knowledge of stages and fundamental building blocks of NLP
CO-2. Apply NLP machine learning algorithms for classification, representation, and parsing
CO-3. Demonstrate the knowledge of Dense vector representation for NLP
CO-4. Explain the concepts behind distributed semantics
CO-5. Discuss the approaches to global and contextual semantic representation
CO-6. Apply the above concepts for fundamental NLP tasks.

Course Topics:

Unit 1: Stages of NLP: from lexical to semantic. Fundamental Language processing: Tokenization, Language modeling, Text classification,

Unit 2: Morphology, POS Tagging, Chunking, Discriminative vs generative modes, HMM and CRF

Unit 3: Syntax parsing: Constituency and Dependency, PCFG, projectivity Arc-eager

Unit 4: Distributed semantics: SVD, Word2Vec, RNN, LSTM,

Unit 5: Contextual Distributed semantics: ElMO, BERT


Reference Books:

E-book Links:

Grading Plan:
(The table is only indicative)

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Mapping of Course Outcomes to Program Objectives: (1 – Lowest, 2—Medium, 3 – Highest, or a ‘-’ dash mark if not at all relevant). Program outcomes are posted at

https://iiitaphyd-my.sharepoint.com/:w:/r/personal/dyacad_iiit_ac_in/Documents/NBA-2020-21/Course%20Content/IIIT-CSE-ECE.docx?d=w111f0ebbca41b3a4d1e8a3fbc6332d&csf=1&web=1&e=z1Khby

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Teaching-Learning Strategies in brief (4-5 sentences):
Lectures by integrating ICT into classroom teaching, weekly tutorials involving problem solving and active learning by students and Project-based Learning by doing four assignments and a project. Evaluation based on personal viva to judge deeper understanding.

Note: This course description format comes into effect from Spring 2022.

Title of the Course : Introduction to Particle Physics
Course Code : SC1.42
Faculty Name : Subhadip Mitra
L-T-P : 3+1+0.
Credits : 4
(L= Lecture hours, T=Tutorial hours, P=Practical hours)

1. Prerequisite Course / Knowledge:
Some exposure to Quantum Mechanics & basic Mathematics (i.e., some linear algebra & complex analysis, basic group theory etc.) and most importantly, interest about the subject.

2. Course Outcomes (COs):
After completing this course successfully, the students will be able to
CO-1 Describe the particle content of the Standard Model.
Discover the various types of interactions among the elementary particles/antiparticles and the role of various symmetries and classify the particles according to their quantum numbers.

Discover the representation of elementary processes with Feynman diagrams.

Recognize the relativistic generalization of Quantum Mechanics through the Klein-Gordon and Dirac equations and outline the basic workings of Quantum Electrodynamics.

Apply their knowledge and calculate simple processes (like two-body decay or two-going-to-two scattering, etc.).

3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix

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Note: Each Course Outcome (CO) may be mapped with one or more Program Outcomes (POs) and PSOs. Write ‘3’ in the box for ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low-level’ mapping

4. Detailed Syllabus:

Unit 1: *Introduction*: developments throughout the 19th century as the backdrop. From abstract atoms to the Large Hadron Collider, Elementary particles and forces, the Standard Model.

Unit 2: *Relativistic kinematics and Symmetries of nature*: the SU(2) & SU(3) groups and their connections with the elementary particles, discrete symmetries, antiparticles.

Unit 3: *The Klein Gordon equation* & the basics of the perturbation theory.

Unit 4: *Core Concepts*: Electrodynamics of spin-less particles, Feynman diagrams and rules, Dirac equation, Quantum Electrodynamics

Unit 5: *Advanced Topics*: Parton model and a little QCD, collider physics – a (very) quick tour, introduction to HEP computing – Monte Carlo tools, some basic simulations, challenges in modern particle physics, role of modern computing

Reference Books:
2. F Halzen and A D Martin, Quarks and Leptons, John Wiley & Sons.
4. 

5. Teaching-Learning Strategies in brief:
This is an introductory (elective) course on Particle Physics designed to give the students who have no prior exposure to Quantum Field Theory a broad overview and some taste of the exciting world of Particle Physics. The approach would be somewhat intuitive. The design is for students
with diverse backgrounds. The focus would be on concepts, simple explanations, and intuition building.

6. **Assessment methods and weights in brief:**
   Assignments + Quizzes - (30%),
   Mid-term evaluation - (30%),
   Final exam - (40%)

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**Title of the Course**: Introduction to Philosophy of Technology
**Faculty Name**: Ashwin Jayanti
**Course Code**: HSS318
**Name of the Academic Programs**: B.Tech. in CSE, B.Tech in ECE
**L-T-P**: 3-0-0
**CREDITS**: 4

(L = Lecture hours, T = Tutorial hours, P = Practical hours)

1. **Prerequisite Course /Knowledge:**
   None

2. **Course Outcomes (COs):**
   After completion of this course successfully, the students will be able to:
   
   **CO-1**: Identify and recognize various conceptions of technology implicit in arguments for/against technology
   **CO-2**: Classify and describe various theories and interpretations of technological change through history
   **CO-3**: Compare analytical and continental approaches to technology and its relation to science and examine the limitations and advantages of both approach
   **CO-4**: Evaluate and assess the moral significance of technical artefacts within particular social contexts
   **CO-5**: Develop and synthesize philosophical frameworks with which to understand and assess the impact of contemporary technologies to society at large

3. **Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) -- Course Articulation Matrix**

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4. **Detailed Syllabus:**

   **Unit I** – Introduction: What is Philosophy of Technology? Engineering and Humanities
Philosophies of Technology; Classical and Contemporary Philosophy of Technology

Unit II: Encountering Technological Artefacts – Conceptual history of ‘technology’; What is ‘technology’? Continental and Analytic Perspectives

Unit III: Epistemological Aspects to Technologies – Science, Technology, and Engineering; Philosophy of science and philosophy of technology; Knowing-how and knowing-that

Unit IV: Moral Status of Technologies – Norms, Values, and Technologies; Debates Concerning Moral Significance of Artefacts; Role of Design in Moral Status

Unit V: Philosophical Debates in Artificial Intelligence –Philosophical background to Artificial Intelligence; Philosophical and ethical issues within Artificial Intelligence

REFERENCE BOOKS:


5. Teaching-Learning Strategies in Brief

This course aims at reading, critically evaluating, and thinking through contemporary debates in philosophy of technology. For this purposes, the main strategy is to share the readings and resource material beforehand for the students to acquaint themselves with the topics and use the class time to discuss and evaluate the implications of the various positions respective to each topic. Continuous assessment methods will be employed to make sure the students have acquired the requisite conceptual understanding to explicate and argue for their position with greater nuance and logical rigor.

6. Assessment Methods and Weightages in Brief

Continuous assessment in the form of written assignments will carry the major weightage of the evaluation, with the rest of the weightage assigned to class participation in the ensuing discussions. The assigned weightage is as follows: Assignments: 60 marks, class participation: 10 marks, Mid semester exam: 10 marks, End semester exam: 20 marks.
Prerequisite Course / Knowledge:

Knowledge of Advanced Linear Algebra, Quantum Mechanics, Classical information Theory

Course Outcomes (COs):

After completion of this course successfully, the students will be able to..

CO-1. Understand the basic idea of Qubits (Quantum States), Pure and Mixed States, Quantum Measurements, Entanglement, Quantum Gates and the idea of extension of Entropy from Classical to Quantum. Learning Dirac Algebra to solve problems of Quantum Computing and Information

CO-2. Demonstrate familiarity with process like Quantum Measurement, Information processing tasks like Teleportation, Superdense Coding, Entanglement Swapping, s Quantum Circuits.

CO-3: Synthesize proofs of theorems related to Quantum Entropy using the mathematical and logical arguments.

CO-4. Design Quantum Circuits with Universal Gates,

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

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‘3’ in the box denotes ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low’-level’ mapping

Detailed Syllabus:

Unit 1. Introduction and Overview: Transition from Classical to Quantum (2L)

Unit 3. Quantum Entropy and Entanglement: Quantum Entropy, EPR Paradox, Schmidt Decomposition. (2L)

Unit 4. Basic Quantum Information Processing Protocols: Teleportation, Super Dense Coding, Entanglement Swapping. (2L)

Unit 5 Quantum Computation: Introduction to quantum computing, Pauli Gates, Hadamard Gates, Universal Gates, Quantum algorithms. (2L)

Reference Books:


Teaching-Learning Strategies in brief (4 to 5 sentences):

First of all there will be lectures which will introduce the motivations, concepts, definitions along with simpler examples. After that there are going to be assignments and quizzes that will make sure that the students have understood the concepts. These will be followed by deeper lectures and assignments as the area is interdisciplinary and new. These will also be supplemented with innovative problems so that they can apply the concepts learned by them.

Assessment methods and weightages in brief (4 to 5 sentences):

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Course Title: A linguistic introduction to Sanskrit
Faculty Name: Peter M. Scharf
Name of the Program: HSS
Course Code: HS1.207
Credits: 4
L - T - P: L2, P1
(Semester, Year: Spring, 2022)

(Ex: Spring, 2022)
Pre-Requisites: None

Course Outcomes:

Read simple Sanskrit containing the common grammatical forms covered, with the help of a dictionary.
Understand the difference between script and phonetics.
Understand sound change laws.
Understand morphological analysis and synthesis. Understand syntactic structures.


Course Topics:

The course surveys basic Sanskrit grammar in a linguistically explicit manner accompanied by traditional oral practice and exercises consisting of readings adapted from ancient Indian narratives.

Week Topic
Week 1 Ch. 1, Introduction to Sanskrit language and literature; Ch. 2, The Sounds of Sanskrit, and Ch. 3, Devanagari script
Week 2 Ch. 4, Sandhi
Week 3 Ch. 5, Verbs: present and past indicative active and middle of verbs of classes 1, 4, 6, and 10
Week 4 Ch. 6, Nouns: masculine and neuter-a-stem
Week 5 Ch. 7, Nouns: feminine long a-stem; a-stem adjectives
Week 6 Ch. 8, Imperative and optative moods; a-stem verbs
Week 7 Ch. 9, Mono and polysyllabic fem. long i/u-stem nominals
Week 8 Ch. 10, Present stem of verbs of classes 5, 8, and 9
Week 9 Ch. 11, i/u-stem nominals
Week 10 Ch. 12, Vocalic-r-stem nominals
Week 11 Ch. 12, Present stem of verbs of classes 2, 3, and 7
Week 12 Ch. 12, continued
Week 13 Ch. 13, Consonant stem nominals

Preferred Text Books: शब्दोब्राह्मण: सांस्कृतिक इntroducuon to Sanskrit

Reference Books: None
E-book Links: None

Grading Plan:

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Teaching-Learning Strategies in brief (4-5 sentences):

Lectures introduce new material for intellectual understanding. Memorization internalizes basic information so that it is easily available for application. Exercises apply intellectual understanding and basic information and solidify understanding.

I will introduce new concepts and material once a week and engage students in oral/aural practice in a second meeting. Each meeting will include time to answer questions. Students will regularly do homework using an on-line interactive intelligent exercise platform that provides immediate feedback and supplies links to information to assist students in learning.

Because learning a language involves the cumulative acquisition of knowledge and skills, regular attendance and keeping up with assignments will be essential.

Note: This course description format comes into effect from Spring 2022.

Name of the Program: Linear partial differential equations and variational calculus
Faculty Name: Samyadeb Bhattacharya
Course Code: MA4.303
Credits: 4
L - T - P:
( L - Lecture hours, T-Tutorial hours, P - Practical hours)

Semester, Year: Spring
(Ex: Spring, 2022)

Pre-Requisites: Basic knowledge of ordinary differential equations

Course Outcomes:

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a) Getting students equipped with skills to solve practical physical problems.
b) Basic ideas on partial differentiation, state functions, path functions etc.
c) Introductory ideas on thermodynamics, wave propagation and heat conduction in connection to partial differential equations.
d) Solid idea on the basics of partial differential equations and their uses.
e) Basic idea about constructing boundary value problems.

Course Topics:
1. Basic concepts and definitions.
3. Linear operators.
5. First order quasi-linear equations and method of characteristics.
7. Classification of second order linear equations.
8. Method of separation of variables.
9. Introduction to eigenvalue problems.
10. Introduction to boundary value problems.

Preferred Text Books: K.T. Tang, Mathematical methods Engineers and scientists 3.

Reference Books: Tyn Myint-U and Lokenath Debnath, Linear partial differential equations for scientists and engineers. (other references will be given during the course)

E-book Links: Will be shared during the course

Grading Plan:
(The table is only indicative)

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<th>Type of Evaluation</th>
<th>Weightage (in %)</th>
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<td>Term Paper</td>
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<td>Other Evaluation</td>
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Mapping of Course Outcomes to Program Objectives: (1 – Lowest, 2—Medium, 3 – Highest, or a ‘-’ dash mark if not at all relevant). Program outcomes are posted at

https://iiitaphyd-my.sharepoint.com/:w:/r/personal/dyacad_iiit_ac_in/Documents/NBA-2020-21/Course%20Content/IIIT-CSE-ECE.docx?d=w111f0effcaea41b3a4d1e6e8a3fbc6332d&csf=1&web=1&e=zy1Khby

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Teaching-Learning Strategies in brief (4-5 sentences):
In this course, the main objective is to help the student understand the fundamental aspects of partial differential equations and their usage in practical problems. The course is of two aspects. First is the technical and mathematical aspect, which will be taught meticulously. Second is that of physical and practical, where student will be taught to construct a physical problem.

Note: This course description format comes into effect from Spring 2022.

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Faculty Name</th>
<th>Name of the Program</th>
<th>Course Code</th>
<th>Credits</th>
<th>L - T – P</th>
<th>Semester, Year</th>
<th>Pre-Requisites</th>
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<tbody>
<tr>
<td>Literature and the Ethics of telling a Story</td>
<td>Sushmita Banerji</td>
<td>Humanities Elective</td>
<td>HS0.210</td>
<td>2 credits</td>
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<td>Spring 2022</td>
<td>Introduction to Human Sciences, Ethics 2 (Basics)</td>
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Course Description:

Theodore Adorno famously said, “to write poetry after Auschwitz is barbaric.” He was clearly not talking about the act of writing poetry but rather the tension between ethics and aesthetics inherent in an act of artistic production that reproduces the cultural values of the society that generated the mass murder of Jews during WWII. How then does a writer presume to represent/re-present collective acts of extreme brutality while also not validating the culture that produces these violences? This course shall look at key pieces of literature emerging from periods of extreme violence and orchestrated genocide in the 20th and 21st century to examine and interrogate models of
remembering, testimony and representation. Readings shall include writings on the Holocaust, the Partition of India and Pakistan, and regional Indian Literatures.

**Course Outcomes:**
On successful completion of this course, students will be able to

1. Examine key ethical concepts and explain how they work or fail in the historical of war and genocide.
2. Examine prominent writers have dealt with fundamental ethical questions, moral dilemmas and personal failures and successes in key pieces of writing.
3. Synthesize their knowledge of theories and concepts in ethics to critically examine the world they live in and the cultural production they encounter and produce.

**Course Topics:**

Unit I: Introduction
Ethics in the World
Literature and its dimensions, What is the value of representation?

Unit II:
Ethical Questions and World War II Literature
Ethics of Suffering

Unit III:
Indian Literatures of Strife

**Preferred Text Books:**


**Reference Books:**


**Assessments:**

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<td>Term Paper 2</td>
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**Teaching-Learning Strategies:**

Students are expected to read prescribed texts in the course of the semester, watch any video lectures made available, and view films when required. This class is based on close reading of the texts prescribed and relies heavily on student participation and discussion.

This class shall deal with material students might disagree with. All informed disagreements, opinions, and discussions are encouraged. It shall however be the instructor’s right to shut down any disrespectful behaviour.

**Mapping of Course Outcomes to Program Objectives:**

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**Title of the Course**: Literature, History, and Belonging in Hyderabad  
**Course Code**: HS1.203  
**Faculty Name**: Nazia Akhtar  
**Name of the Program**: Humanities Elective  
**Credits**: 4  
**L - T - P**: 36 hours (24 classes)  
**Semester, Year**: Spring 2022  
**Pre-Requisites**: Introduction to Human Sciences
**Course Outcomes**

On successful completion of this course, students will be able to

1. discuss Hyderabad’s literary history and understand the role of literature in studying and knowing history;
2. explain the complexities of Hyderabad’s history and society and larger questions of identity and belonging;
3. apply important techniques of textual analysis and their experience in writing an argumentative essay in other academic and professional contexts; and
4. devise a thoughtful and informed critical voice that will enable them to meaningfully situate culture and cultural productions in the world around them.

**Course Topics**

1. (i) Introduction: Historical and Socio-Political Context
   (ii) The People’s Poetry: Dakhni poetry and culture
2. Ghazal Poetry at the Asaf Jahi Court
3. Progressive Writing: Poetry and Novels
4. Women’s Writing: Prose and Poetry
5. Writing from the Margins: Contemporary Contexts
6. “Every City is a Story”: New Narratives of Globalization

**Preferred Text Books**

Chapters and excerpts from the following books will form the textbook for this course.

3. Ian Bedford – *The Last Candles of the Night* (2014; novel)
6. Mercy Margaret, Shahjahana – selected poetry
7. G. Shyamala – selections from *Father May Be an Elephant and Mother Only a Small Basket But ...* (2012; short stories)

**Reference Books**


E-book Links : 

Grading Plan :

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<th>Type of Evaluation</th>
<th>Weightage (in %)</th>
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Mapping of Course Outcomes to Program Objectives:

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Teaching-Learning Strategies in brief:
The teaching-learning strategy in this course will consist of lectures based on set readings, which students are expected to complete in advance of the class. These lectures will incorporate prompts for classroom discussion and activities based on the readings to enable active learning and critical thinking. This learning will be further consolidated through assessments that will be designed to test and develop the student's knowledge and skills, especially interpretative reading and writing.

Title of the course : Machine Learning for Natural Sciences
Course Code : SC4.411
Faculty Name : Nita Parekh + Prabhakar B + Girish Varma
L-T-P : 4-0-0
Credits : 4
(L= Lecture hours, T=Tutorial hours, P=Practical hours)

Prerequisite Course / Knowledge:
Probability & Statistics, Linear Algebra, Statistical Models in AI

Course Outcomes (COs):
After completion of this course successfully, the students will be able to...
CO-1: Learn and demonstrate understanding the basic concepts in machine learning
CO-2: Demonstrate use of machine learning algorithms on simple problems
CO-3: For a selected problem, apply the understanding of the principles, to formulate a problem statement
CO-4: Build Models based on requirements of the problem statement
CO-5: Analyze the constructed models for their usefulness, find deficiencies and identify possible improvements.
Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

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‘3’ for ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low-level’ mapping.

Detailed Syllabus:

Unit 1: Overview: Types of problems: regression, classification. Types of machine learning: (a) supervised, (b) unsupervised, (c) semi-supervised and (d) reinforcement learning

Unit 2: Problem specific issues:
(a) representation: how to decide on a model that can solve the problem at hand?
(b) evaluation: Construction of a loss function to evaluate the
(c) Optimization: methods to use to iteratively improve the model from a starting guess?

Unit 3: Review of prominent current literature in ML as applied to natural sciences

Unit 4: Project discussion and implementation: Selection of a problem in natural sciences and developing a solution using ML techniques

Reference Books:
1. “Probabilistic Machine Learning”, Kevin Murphy, MIT Press 2022
2. Other material (websites, technical articles) will be given to the students, based on need.

Teaching-Learning Strategies in brief (4 to 5 sentences):
Lectures will initially introduce the motivations, concepts, definitions along with simpler examples. This will be followed by assignments and quizzes that will make sure that the students have understood the concepts. These will be followed by deeper lectures and assignments which lead the students to the bigger questions in the area. These will also be supplemented with real world engineering problems so that they can apply the concepts learned by them.

Assessment methods and weightages in brief (4 to 5 sentences):
- Light In-class Quizes: 15%
- Assignments: 15%
- Mini Project: 20%
- Major Project: 50%

Title of the Course: Mechatronics System Design
Faculty Name: Nagamanikandan + Harikumar K
L-T-P: 3+1+0
Credits: 4
(L= Lecture hours, T=Tutorial hours, P=Practical hours)
1. Prerequisite Course /Knowledge:
Basic programming (Python, C++), Linear Algebra, Numerical methods, Basic microcontroller knowledge.

2. Course Outcomes (COs):
After completion of this course successfully, the students will be able to:
- CO-1 Describe important elements of mechatronics system
- CO-2 Apply the previous knowledge of microcontroller programming for controlling multidisciplinary mechatronic systems.
- CO-3 Describe and design basic mechanical elements and their feedback control.
- CO-4 Synthesize and analyze a range of mechanisms.
- CO-5 Design and execute a multidisciplinary project based on the given specifications as part of a team.

3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix

<table>
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<th>CO1</th>
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4. Detailed Syllabus:
Unit 1: Sensors and Actuators:
- Sensors for robotics application - position, speed, acceleration, orientation, range.
- Actuators - general characteristics, motors, control valves.

Unit 2: Computer based feedback control:
- Sampled data control, sampling and hold, PID control implementation, stability, bilinear transformation.

Unit 3: Introduction to mechanical elements and transformations, basic concepts of kinematics and dynamics.

Unit 4: Design and analysis of mechanisms.

Unit 5: Programming and hardware experiments.

Reference Books:
6. User manual of microcontroller and data sheets of sensors and actuators
5. **Teaching-Learning Strategies in brief**:

This course aims to teach the students about designing and developing a mechatronics system by providing them with essential hardware and software. Part of the class is devoted to a learn-by-doing lesson where the students will learn theory and get hands-on experience with various aspects of the mechatronics system. The goal for the students is to design, build, and debug the electromechanical system for a given task as a part of the course project.

6. **Assessment methods and weightages in brief**:

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<tr>
<th>Assessment</th>
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<tr>
<td>Mid semester exam</td>
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<tr>
<td>Assignments</td>
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<td>Project</td>
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<td>Project demonstration</td>
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<td>Final report</td>
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**Title of the Course**: Minds, Machines, and Intelligence

**Course Code**: HS0.205

**Faculty Name**: Don Dcruz

**Credits**: 4

**Pre-Requisite**: None

**Objective**: Recent advances both in the fields of AI and cognitive science have initiated vigorous debates about data intensive machine learning models invading crucial aspects of society and how developments in unraveling the workings of the human brain puts technology on a path to realize robust artificial general intelligence. The course will critically explore our conceptual grasp of notions like thinking, rationality, and intelligence from a philosophical standpoint. The aim is to locate the known shortcomings of current AI with respect to what we understand about human cognition within debates in epistemology, philosophy of science and ethics. To achieve this, the course journeys through some fundamental philosophical questions like ‘Can machines really think in the way humans do, and can they have conscious experiences like thoughts, desires and emotions?’, ‘Is machine intelligence and human intelligence comparable or are they fundamentally different?’, and ‘Can machines be held morally responsible for their decisions and can it learn what is right and wrong?’ The goal is to equip students with some intellectual tools to successfully navigate the coming age of intelligent systems.

**Course Topics**:

**Module I: Philosophical preliminaries**
- Topic 1: Techniques and devices: argument analysis, logical tools, inference to the best explanation, conceptual distinctions, thought experiment, belief, knowledge, evidence, justification, confirmation, explanation, theory, model.

**Module II: Metaphysics**
- Topic 2: The nature of cognition: Turing, Searle, qualia and consciousness. Topic 3: Computation and the philosophy of cognitive science

**Module III: Epistemology**
- Topic 4: Nature of deep learning’s success and standard criticisms, contemporary
version of the rationalist vs empiricist debate, relevant history of philosophy (Locke, Berkeley, Hume and Kant).

Topic 5: Epistemological issues in AI: adversarial examples and knowledge, epistemic opacity of deep learning models and interpretability, explanation vs prediction in philosophy of science, use of deep learning models in science.

Module IV: Ethics

Topic 6: The problem of encoding normative principles, virtuous machines, artificial moral agents, conditions for responsibility, conceiving singularity and its risks.

READINGS: The complete set of topic-wise readings, including all reference books and papers, will be made available once the course begins. Given below are the books and articles, selections from which form which form the core readings for the lectures.


Oxford University Press.


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<tr>
<td>Assignments (max 700 words each)</td>
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<td>Paper 2 (max 3500 words)</td>
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<tr>
<td>Peer reviews of paper 2</td>
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OUTCOME: Students learn to think about general conceptual issues in AI and cognitive science by doing philosophical analysis. This enables them to reflect critically about developments in a field where hype and hyperboles can overshadow insightful philosophical debates that have the potential to foster foundational progress. Students will cultivate the ability to reason out the nuances involved in complex notions like cognition, rationality, and intelligence. Since this will be a mostly writing-driven course, students develop the skill to write clear and well thought out expositions on conceptual matters.

REMARKS: Students are expected to do the assigned readings, which usually does not take more than 2 hours, before the lecture so as to engage effectively in class discussions. To do well in this course, students need to read argumentative text, think on what they have understood and what they have not, dissect arguments and demonstrate inferences clearly in writing. You must explain why you think what you think in a rational manner without committing fallacies. Detailed instructions about evaluation components will be provided once the course begins.

Title of the Course: Molecular Modeling and Simulations
Name of the Faculty: U Deva Priyakumar
Name of the Academic Program: BTech & BTech+MS dual degree programs
Course Code: SC2.316
L-T-P: 3-1-0
Credits: 4

( L= Lecture hours, T=Tutorial hours, P=Practical hours)

1. Prerequisite Course / Knowledge:
None
2. Course Outcomes (COs):

After completion of this course successfully, the students will be able to

CO-1: Describe the different aspects of molecular modeling techniques

CO-2: Describe the fundamental methods of quantum chemistry, molecular mechanics, molecular dynamics in the context of modelling molecular systems

CO-3: Examine properties of molecules using quantum chemical methods

CO-4: Evaluate the dynamic characteristics of biomolecules such as protein, DNA and RNA using molecular dynamics simulations.

3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix

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Note: Each Course Outcome (CO) may be mapped with one or more Program Outcomes (POs) and PSOs. Write ‘3’ in the box for ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low’-level’ mapping

4. Detailed Syllabus:

Unit 1: Potential energy surface: Concepts of minima, transition states and higher order saddle points. Optimization methods: gradient descent, conjugate gradient and Newton-Raphson methods
### Unit 2: Basics of Quantum mechanics
- Particle in a box
- Hydrogen atom problem
- Two-body problem
- Molecular orbital theory

### Unit 3: Practicals of quantum chemistry
- Optimization of molecules
- Understanding of the different components of the outputs
- Calculation of properties like the IR spectrum

### Unit 4: Molecular mechanics
- Force field equations
- Additive forcefields
- Polarizable and machine learning forcefields

### Unit 5: Molecular dynamics simulations
- Integrating Newton’s laws of motion with force derived from force fields
- Replica exchange simulations
- Umbrella sampling simulations

### Unit 6: Practicals of molecular dynamics
- Set up necessary requirements for MD simulations
- Perform short simulations
- Calculation of thermodynamic properties

### Reference Books:
1. Molecular Modeling by Andrew Leach
2. Molecular Modeling and Simulations by Tamar Schlick

### 5. Teaching-Learning Strategies in brief (4 to 5 sentences):
The course aims to enable students to model a given chemical or biological molecular process. Lectures followed by practicals on the same aspects will be done in tandem. A bird’s eye view will be followed where the emphasis is more on the philosophical understanding of the methods than elaborate derivations of all concepts. The evaluations will be continuous and will test the students’ understanding of concepts and their implementations in performing a given task.

### 6. Assessment methods and weightages in brief (4 to 5 sentences):
- Assignments - 20%
- Quiz - 30%
- Exams - 50%

---

**Title Of the Course**: Multivariate Analysis  
**Course Code**: MA4.405  
**Faculty Name**: Venkateshwarlu M  
**L—T—F**: 3+1+0  
**Credits**: 4

1. **Prerequisite**: Basic statistics, Matrix analysis, Calculus
2. **Course Outcomes**

<table>
<thead>
<tr>
<th>CO</th>
<th>Description</th>
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<tbody>
<tr>
<td>CO 1</td>
<td>Understand the intricacies of simultaneous analysis of several variables</td>
</tr>
<tr>
<td>CO 2</td>
<td>Understand the theoretical foundation for multivariate analysis</td>
</tr>
<tr>
<td>CO 3</td>
<td>Cover several areas of applications</td>
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</table>
3. **Course Articulation Matrix**

<table>
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<tr>
<th>Course outcomes</th>
<th>Program Outcomes</th>
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4. **Detailed Syllabus**

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<tr>
<th>Unit</th>
<th>Course Content</th>
<th>Hours</th>
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<tbody>
<tr>
<td>Unit 1</td>
<td>Random variables, vectors, and matrices. Partitioning, Linear functions. Mahalanobis distance</td>
<td>3 hours</td>
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<tr>
<td>Unit 2</td>
<td>Multivariate Normal, properties, estimation of parameters, Maximum likelihood method, Wishart distribution</td>
<td>3 hours</td>
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<td>Unit 3</td>
<td>Hotelling T-square tests, likelihood ratio test, Union-Intersection test, Confidence intervals and Tests, Tests on subvector</td>
<td>6 hours</td>
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<td>Unit 4</td>
<td>Multivariate analysis of variance, one way classification, Two-way analysis, Tests on subvector</td>
<td>6 hours</td>
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<td>Unit 5</td>
<td>Discrimination, Two groups, Several groups, Tests of hypotheses, Classification, Two groups, Several groups, Estimation of error rates</td>
<td>6 hours</td>
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<td>Unit 6</td>
<td>Multiple regression, Multivariate regression, Fixed x’s, Estimation, Hypothesis tests.</td>
<td>6 hours</td>
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<td>Unit 7</td>
<td>Canonical Correlations and variates, Properties, Tests of significance, Interpretation of canonical variates</td>
<td>6 hours</td>
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<td>Unit 8</td>
<td>Principal Components, Methods for discarding components, Interpretation, Relationship between Principal Components and Regression</td>
<td>3 hours</td>
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<tr>
<td>Unit 9</td>
<td>Basic factor model, estimation of loadings and commonalities, Determining the number of factors, Rotation of factor loadings</td>
<td>3 hours</td>
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**References:**
Title of the Course: Music, Mind, and Technology
Course Code: CS9.434
Faculty Name: Vinoo Alluri
L-T-P: 3-1-0
Credits: 4

Prerequisite Course / Knowledge: None

Course Outcomes (COs):
After completion of this course successfully, the students will be able to
CO-1 appreciate the fundamental concepts of the field of Music Cognition and Technology
CO-2 understand the role of the individual in musical experiences in relation to music
experience including music consumption, music industry, mental well-being, and critically
think about the relationship between diverse fields that comprise music cognition such as
psychology, music information retrieval, and neuroscience.
CO-3 understand the relation between physical aspects of sound and perceptual processes
including sensation and perception
CO-4 understand sound synthesis and analysis in addition to application of machine learning
to various music information retrieval tasks (eg: music genre classification, mood detection,
recommendation)
CO-5 understand music processing in the brain, and effect of individual differences thereof
(eg: musical expertise, empathy, gender). Analyze brain responses to music which includes
an interdisciplinary approach combining sound- and brain-signal processing, statistical
methods, and perceptual experimentation to analyze experimental data from human
neurological experiments
CO-6 combine knowledge gained from CO-1-4 to formulate own research idea and go about
solving it.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and
Program Specific Outcomes (PSOs) – Course Articulation Matrix
Note: Each Course Outcome (CO) may be mapped with one or more Program Outcomes (POs) and PSOs. Write ‘3’ in the box for ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low’-level’ mapping

4. Detailed Syllabus:
Unit 1: Introduction to Music cognition, Evolutionary and Biological significance of music, Embodied music cognition, evolution of the field of psychology of music
Unit 2: Music experience and Individual differences, Music Emotion
Unit 3: Auditory Processing, Sensation, Perception, Auditory stream segregation
Unit 4: Sound synthesis and analysis
Unit 5: Music information retrieval
Unit 6: Neuromusicology

Reference Material:
Lecture slides and supplementary reading materials (journal articles, review articles) will be uploaded on the course page on Moodle.

5. Teaching-Learning Strategies in brief:
Students will be introduced to the broad field of music cognition. The objective of the course is to give an appreciation of the main concepts of the field of Music Cognition and Technology. Students will learn about topics in music psychology (from perception to cognition), familiarize yourselves with music signal analysis and music information retrieval (MIR), ending with the interdisciplinary field of cognitive neurosciences of music (with a focus on functional magnetic resonance imaging (fMRI) studies). Apart from this, the course provides an overview of main areas of contemporary research of music perception and cognition such as musical preferences and personality, music and movement, music and emotion, music and mental well-being, and music processing in the brain.

By attending lectures, in addition to a few guest lectures by leading music researchers from around the world, students will be exposed to this interdisciplinary field and open questions. Students learn by working in groups to solve existing open problems in addition to creating their own research problem and addressing it to the best of their abilities.

Lectures are highly interactive as the course requires a student to actively participate and think and be creative. Students learn by doing assignments designed to achieve course outcomes and collaboratively working on a final project. The final project wherein students learn by working in teams, especially to devise a research question, identify
hypotheses, operationalize it, deploy it, collect (if necessary) and analyze data and present the results thereby promoting collaboration, which is very much needed in interdisciplinary research.

6. Assessment methods and weightages in brief:
Quiz 1 = 10%
Quiz 2 = 10%
Assignments = 30%
Final Project = 40%
Class participation = 10%

Title of the Course: Next Generation Sequence Data Analysis
NAME OF FACULTY: Nita Parekh
Course Code: SCI653
L-T-P: 3-1-0
(L= Lecture hours, T= Tutorial hours, P= Practical hours)
Credits: 4
Name of the Academic Program: CND

1. Prerequisite Course / Knowledge: Bioinformatics Course

2. Course Outcomes (COs) (5 to 8 for a 3 or 4 credit course):
After completion of this course successfully, the students will be able to

CO-1: Handle confidently different types of next generation sequencing data.

CO-2: Appreciate mathematical and algorithmic concepts for whole genome and exome assembly, both reference-based and de novo and learn to carry out the analysis on real data.

CO-3: Identify different types of variations in NGS data, viz., small sequence variations, copy number variations, insertions and deletions, inversions and translocations, and annotate the variants.

CO-4: Perform differential gene expression analysis using NGS data

CO-5: Use judiciously different tools and databases for end-to-end analysis of NGS data.

The course provides in-depth hands-on analysis of NGS data using various publicly available resources and prepares the student for his research.

3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix

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4. Detailed Syllabus:

Unit 1: Workflow of NGS data analysis, Types of reads - single-end, paired-end, mate-pairs
Sequencing technologies – Illumina, SOLiD, 454 - read lengths, accuracy, biases introduced, etc.
Applications of NGS sequencing - RNA-Seq, De novo sequencing, non-coding RNA sequencing, bisulphite sequencing, metagenomics by NGS, etc.

Unit 2: Introduction to some basic Unix/Linux/R commands, NGS Data Formats - FASTA, FASTQ, SFF, VCF, SAM/BAM, etc., Parsing NGS Files (Accessing, Querying, Comparing, etc.)

Unit 3: Algorithms in Short Read Alignments. Alignment based assembly – Bowtie, BWA, De novo assembly – de Bruijn graph. Tools for alignment-based assembly - Bowtie (genome), BWA (genome), HISSAT (transcriptome)

Unit 4: Downstream analysis of alignment-based assembly. Methods for identification of variants (genome-level), Data-preprocessing, Data pretreatment, Data analysis for Single nucleotide variations (SNVs), Structural variations (SVs) - CNVs, indels, inversions and translocations, Visualization and Annotation of variants, Differential gene expression analysis (CuffDiff) – (transcriptome-level)

Unit 5: Tools for de novo assembly - Velvet (genome), Soapdenovo (genome), Cufflinks (transcriptome). Downstream analysis of de novo assembly - Genome annotation, Enrichment analysis

Unit 6: Small RNA analysis

Reference Books:

1. Research Papers (to be uploaded on course website)
2. Algorithms for Next Generation Sequencing, Wing-Kin Sun

5. Teaching-Learning Strategies in brief (4 to 5 sentences):

The course will provide the skills to perform comprehensive genome analysis using next generation sequencing data, both at the whole-genome level (WGS) and transcriptome-level (RNAseq). A major component of the course is hands-on-sessions, wherein various publicly available resources will be used to carry out the analysis on real genome/transcriptome data to address biological problems. The course structure will be one theory lecture followed by one lab session. The course also has a project component wherein the students will carry an end-to-end genome analysis using NGS data for a biological problem and submit a term paper on some recent application of NGS data analysis.

6. Assessment methods and weightages in brief (4 to 5 sentences):
Assignment - 15%
Term paper + Project - 15%
Mid semester exams - 20%
End semester exam - 50%

Title of the Course: Nonlinear dynamics
Course Code: SC1.315
Faculty Name: Abhishek Deshpande
L-T-P: 3-1-0
Credits: 4
( L= Lecture hours, T=Tutorial hours, P=Practical hours)

1. Prerequisite Course / Knowledge:

2. Course Outcomes (COs) (5 to 8 for a 3 or 4 credit course):

After completion of this course successfully, the students will be able to

CO-1: Apply geometrical, analytical, and numerical methods for analyzing non-linear dynamics
CO-2: Calculate fixed points and determine their stability
CO-3: Analyze various types of bifurcations in one and two dimensions
CO-4: Analyze limit cycles and their stability
CO-5: Analyze chaotic dynamics
CO-6: Analyze discrete maps and period doubling
CO-7: Apply theoretical methods for analyzing nonlinear dynamics to problems in sciences and engineering.

3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix

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Note: Each Course Outcome (CO) may be mapped with one or more Program Outcomes (POs) and PSOs. Write ‘3’ in the box for ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low-level’ mapping.
4. Detailed Syllabus:
Unit 1: Overview: Capsule history of Dynamics, A dynamical view of world
Unit 2: One-Dimensional flows: Flows on the line, Bifurcations, Flows on the circle

Unit 3: Two-Dimensional Flows: Linear System, Phase Plane, Limit Cycles, Bifurcations
Unit 4: Chaos: Lorenz Equations, One-Dimensional Maps, Fractals

Reference Books:
1. Nonlinear Dynamics and Chaos: With Applications to Physics, Biology, Chemistry and Engineering by Steven Strogatz
2. Understanding Nonlinear Dynamics by Daniel Kaplan and Leon Glass

5. Teaching-Learning Strategies in brief (4 to 5 sentences):
The course lectures will involve problem solving and simulations to analyse whether system in question settles down to equilibrium, keeps repeating in cycles or does something more complicated. The emphasis will be on geometric thinking, computational and analytical methods. Interactive tools are used to enhance the understanding. Project ideas from various disciplines (both engineering and sciences) are considered for the assessment.

6. Assessment methods and weightages in brief (4 to 5 sentences):
- Quiz - 20%
- End semester exam - 30%
- Assignments - 30%
- Project - 20%

Title of the Course: Optical Remote Sensing
Course Code: CS9.436
Faculty Name: Ramachandra Prasad P
L-T-P: 3-0-1
Credits: 4

1. Prerequisite Course/Knowledge:
Basic Physics and computational knowledge.

2. Course Outcomes (COs)
After completion of this course successfully, the students will be able to
CO-1: Comprehend processes of optical remote sensing
CO-2: Describe various sensors and their image characteristics
CO-3: Extract information from satellite imagery using conventional methods
CO-4: Apply advanced computational techniques for feature extraction
CO-5: Discuss satellite imagery applications (ex. Forest, Urban, Agriculture)
CO-6: Get basics of advanced remote sensing technologies

3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix

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4. Detailed Syllabus:

Unit-1: Introduction to Remote sensing: What is remote sensing? Earth Observation Satellites and Platforms (Evolution of platforms, sensors, satellites, national and international sensors)

Unit-2: Sensor and its characteristics – Classification; Remote sensing instruments, passive-active, imaging-non imaging, OIR-Microwave, framing-scanning, mechanical-push broom; Aerial photographs-satellite image; types of resolutions and their trade off

Unit-3: Physics of Electro Magnetic Radiation (EMR) EMR properties/characteristics-wave model- particle model; Radiation laws applicable to remote sensing: EMR interaction with Atmosphere and Earth materials: EMR interactions with atmosphere, atmosphere structure, Atmosphere blinds – windows; Absorption-scattering mechanism types; EMR interactions with earth surface material-Specular- Diffuse; Albedo.

Unit-4: Data acquisition and image characteristics: Data creation at sensor level – telemetry- ground station acquisition: Old data formats (BIL, BIP, BSQ) and current; Data products: Special Products – Processing software, Image characteristics, and FCC creation-types. Additional ways of Acquiring data in Non-optical or near Optical Image processing

Unit-5: Image pre-processing: Image restoration- Atmosphere errors, correction-methods; Correcting geometric distortions – Types of errors, Spatial and pixel interpolation (types), map projections and types: Image Enhancement - Contrast and Spatial enhancement, Hue, Intensity, and Saturation transformations, Densitieslicing

Unit-6: Information extraction- Multispectral classification – Visual Interpretation-Digital classification –Unsupervised, supervised; other classifiers –Deep learning methods, Fuzzy logic, Decision tree (basic level); post classification smoothing, Groundtruth, accuracy assessment. Object-based image classification, difference between per pixel and object-based classification. PCA; Image arithmetic, Change detection methods, State of the Art – Geo-AI. Unit-7: Stereo Imagery - DEM Creation methods, examples, comparison and Application

Unit-8: Major applications of remote sensing in Vegetation / Terrestrial ecology/wildlife; Hydrology/Land use / Land cover / Agriculture; Disaster management

Unit-9: Overview of Advanced topics: Drone imagery – Ultra high resolutions (cm level
data); Hyperspectral and thermal (near optical); Microwave/Radar

References:

1. Introduction to Remote Sensing by James B.Campbell
2. Remote Sensing and Image Interpretation by Thomas M. Lillesand
3. Remote sensing Digital Image Analysis by J.A Richards and Xiuping Tia
4. Fundamental of Remote Sensing by CCRS(Online)
5. Principles of Remote Sensing by ITC(online)

5. Teaching-Learning Strategies in brief:
Teaching, discussing current approaches of information extraction, challenges and limitations with satellite data; Current research papers presentations by students on chosen topic, writing assignments, periodical evaluation of course project implemented with open data and tools; applying remote sensing satellite imagery in different domains, develop an open source tool as part of project or revise algorithms for feature extraction or for any image processing method.

6. Assessment methods and weightages in brief:
1. Assignments [written, lab and presentations] -(20%),
2. Theory [Mid exams-2 (30%) and End exam (30%)] -(60%)
3. Project [Literature survey, Preliminary and final presentation along with report] -(20%)

*PROJECT: Development of open-source tools, replication of case studies or working on new problem using open data and algorithms or any application or improvement of existing algorithms in processing and feature extraction from satellite data

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<td>FACULTY NAME</td>
<td>Dr. Naresh Manwani</td>
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<td>PRE-REQUISITE</td>
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EXPECTED BACKGROUND:

To follow this course, some level of familiarity with linear algebra (specially, vectors and matrices) is expected. In addition, student is expected to know the fundamentals of algorithms and some of the popular problems (eg. shortest path.)

OBJECTIVE:

1. To enable students to formulate and solve problems in an optimization framework.

2. To expose a set of powerful tools and techniques to the students. To demonstrate how these tools (i.e. optimization methods) can be used in practice.

3. To visualize the optimization algorithms and know the numerical and practical issues in their implementation.

4. To relate the optimization methods to applications in diverse areas.

COURSE TOPICS:
1. CO-1: Linear Programming, Geometric Interpretation, Simplex Method, Duality, primal dual method, Interior point methods, Ellipsoidal methods, Computational Issues.

2. CO-2: Integer programming, LP relaxation, Examples from combinatorial optimization. Shortest paths, network flows and matchings.


6. CO-6: Linear Equations, Solutions based Matrix Factorization, Singular Value Decomposition,

7. CO-7: Additional topics (if time permits) related to
   1. Specific Algorithms (eg. Cutting plane algorithms, Stochastic gradients)
   2. Applications in Approximate Algorithms
   3. Computational issues in large scale optimization
   4. Heuristic methods for optimization

PREFERRED TEXT BOOKS:


REFERENCE BOOKS:

1. M T Heath, "Scientific Computing", TMH (Most of First six chapters)


OUTCOME:
This course will help in sharpen the problem-solving skills of students. Students will have experience informally stating problems with the associated constraints, and solving them with computer friendly algorithms.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix

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GRADING PLAN:

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<td>Assignments</td>
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Term Paper/Project 10%
Scribe 5%

Course Title: Performance modeling of computer systems
Faculty Name: Tejas Bodas
Name of the Program: CSE and ECE
Course Code: CS3.307
Credits: 2
L-T-P: 2-0-0
Semester, Year: Spring 2022

Pre-Requisites: MA6.101 Probability and Statistics

Course Outcomes:
1. Explain and identify the role of performance modeling in different computer systems such as data networks, server farms and cloud computing platforms.
2. Apply Markov chains to model and analyze their performance metrics like response time, waiting time or job loss probability.
3. Derive expressions for the average delay or average number of jobs waiting for service in a variety of queueing systems.
4. Design and analyze the performance of multi-server queueing systems that have applications to cloud computing.
5. Analyze and understand the impact of scheduling policies like FIFO, LIFO, processor sharing and random routing on the performance of queues.
6. Identify causes for performance degradation (large latency problem) in queueing systems and offer easy scalable solutions.

Course Topics:
- Following is the tentative list of topics to be covered in this course in about 12 lectures. (Each lecture is 90 mins.)

Module 1: (2 lectures)
- Motivation to Performance modeling (Modeling = Design + analysis)
- Probability refresher
- Basics of Stochastic processes

Module 2: (2 lectures)
- Discrete time Markov chains
- Continuous time Markov chains

Module 3: Elementary Queues (2 lectures)
- M/M/1 queue
- Loss queues
- Little's law and PASTA property
Module 4: Server-farms and networks (3 lectures)
- Multi-server queues
- Network of queues
- Load balancing systems
- Applications to data centers, cloud computing and distributed systems

Module 5: Scheduling and resource allocation in computer systems (3 lectures)
- M/G/1 queues
- Performance analysis of FIFO, round-robin, processor sharing, LCFS
- SMART scheduling policies

Preferred Text Books: Performance modeling and design of computer systems (Cambridge press) by Mor Harchol-Balter (Professor, CMU)

- Reference Books: 1) Probabilistic modeling by Isi Mitrani
  2) Queueing Systems (vol 1 and 2) by Klienrock

E-book Links: NA

Grading Plan:
(The table is only indicative)

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Mapping of Course Outcomes to Program Objectives: (1 – Lowest, 2—Medium, 3 – Highest, or a ‘-’ dash mark if not at all relevant). Program outcomes are posted at

https://iiitaphyd-my.sharepoint.com/:w:/r/personal/dyacad_iit_ac_in/Documents/NBA-2020-21/Course%20Content/IIIT-CSE-ECE.docx?d=w111f0effce41b3a4d1e8a3fbc6332d&csf=1&web=1&e=ztKhby
Teaching-Learning Strategies in brief (4-5 sentences):

- The course is planned to be a fine balance between theory and practice.
- Traditionally, this course has been a theory intensive course with little emphasis on practical applications. We will however flip this around.
- We will introduce theoretical mathematical concepts on a need to know basis or as and when required.
- The emphasis will be to look at plenty of practical examples of queueing systems that we encounter not just in our daily lives but also see in advanced computing systems.
- The goal is not only to design queueing systems that offer better performance guarantees but also to be able to analyze such systems so as to fine tune or control them.
- The 12 lectures are meant to be very interactive, there would be lots of discussion and exchange of ideas on the design aspect of queueing systems.
- As for the analysis, ample practice problems and practice assignments would be provided to gain analytical expertise.

Note: This course description format comes into effect from Spring 2022.

Title of the Course: Physics of Soft Condensed Matter
Course Code: SC2.301
Faculty Name: Marimuthu Krishnan
L-T-P: 3+1+0
Credits: 4

1. Prerequisite Course / Knowledge:
Science-I and Science-II (for non-CND students); thermodynamics and basic statistical mechanics (for CND students)

2. Course Outcomes (COs) (5 to 8 for a 3 or 4 credit course):

After completion of this course successfully, the students will be able to
CO-1 Apply theoretical and numerical methods to analyze the structure and dynamics of soft condensed matter
CO-2 Analyze the time evolution of phase space probability density functions for many-body systems
CO-3 Calculate radial distribution functions and structure factors for condensed systems
CO-4 Explain density fluctuations and fluctuation dissipation theorem
CO-5 Calculate radial distribution functions and structure factors for condensed systems
CO-6 Explain fluctuation theorems for non-equilibrium systems
3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix

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<td>CO7</td>
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</tbody>
</table>

4. Detailed Syllabus:
Unit 1: Introduction to soft condensed matter
Unit 2: Phase space probability density functions (PDFs) and their time evolution, Liouville equation and Liouville theorem
Unit 3: Particle densities and distribution functions, Radial distribution function and pair correlation functions
Unit 4: Statistical properties of liquids: thermodynamics and structure, static and dynamic structure factors
Unit 5: Density fluctuations and fluctuation-dissipation theorem
Unit 6: Fluctuation theorems
Unit 7: Mechanics of biomembranes, molecular transport through nanopores, single-molecule kinetics

Reference Books:
1. Theory of Simple Liquids: With Applications to Soft Matter by I. R. McDonald and J. P. Hansen
2. Principles of Condensed Matter Physics by P. M. Chaikin and T. C. Lubensky
3. Relevant research articles will be provided as additional reading material

5. Teaching-Learning Strategies in brief (4 to 5 sentences):
Lectures will introduce the basic concepts and recent advances in soft condensed matter physics, with particular emphasis on the equilibrium and non-equilibrium properties of simple liquids, biopolymers, and macromolecular assemblies. This will be followed by lectures on theoretical tools needed to understand many-body systems and some discussion on experimental techniques commonly used to probe soft condensed matter. The course will also have hands-on sessions on computational analyses of condensed matter systems. As part of reading assignments, students will be asked to read and present some research articles on some interesting soft condensed matter systems. Class assignments and mid-term exams will be used evaluate students’ understanding of concepts covered in the course. Computational projects will be given at the end of the course, which will enable students to apply the concepts to some real-world problems.

6. Assessment methods and weightages in brief (4 to 5 sentences):
Mid-term exams (20%), Assignments (20%), Final Exam (30%), Projects (30%)

Course Title: Physics of Early Universe
Course Code: SC1.415
Name of the Faculty: Diganta Das
L-T-P: 3-1-0
Credits: 4
(L= Lecture hours, T= Tutorial hours, P= Practical hours)

1. Prerequisite Course / Knowledge:
Differentiation and integration, classical mechanics, electricity and magnetism

2. Course Outcomes (COs) (5 to 8 for a 3 or 4 credit course):
After completing this course successfully, the students will be able to
CO-1 Explain the large-scale structure of the universe and its observational components
CO-2 Demonstrate understanding of how mass, radiation distribution shapes the dynamics of the universe
CO-3 Apply their knowledge and calculate dynamical properties of few model universe
CO-4 Discover the thermal history of the early universe
CO-5 Familiarize themselves with several unsolved problems in the research of cosmology

3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix

<table>
<thead>
<tr>
<th>CO1</th>
<th>CO2</th>
<th>CO3</th>
<th>CO4</th>
<th>CO5</th>
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</thead>
<tbody>
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</tbody>
</table>

Note: Each Course Outcome (CO) may be mapped with one or more Program Outcomes (POs) and PSOs. Write ‘3’ in the box for ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low’-level’ mapping

4. Detailed Syllabus:
Unit-1: Universe Observed: Expansion. Isotropy and homogeneity. Age. Cosmic microwave background


Unit-3: Black-body radiation and the early history: Observation of CMB. Recombination and decoupling. Last scattering. Temperature fluctuations


Unit-5: Inflation: Flatness, horizon, and monopole problem. Physics of inflation
Reference Books:
1. Barbara Ryden: Introduction to Cosmology
2. Matts Roos: Introduction to Cosmology

5. Teaching-Learning Strategies in brief (4 to 5 sentences):
This is an introductory course to cosmology. The course is for students who do not have any knowledge of cosmology. It is also designed to be taught to students from diverse background of science. In each lecture session, the focus will be on building concepts and intuition about the physics. It will be followed by hands-on session where application of the concepts to simple problems will be practiced.

6. Assessment methods and weightages in brief (4 to 5 sentences):
Assignments: 30%,
Quizzes: 30%,
End Semester: 35%,
Attendance: 5%

Title of the Course: Principles of Information Security
Name of the Academic Program: B.Tech. in Computer Science and Engineering
Course Code: CSE418
Credits: 4
L-T-P: 3-1-0
(L= Lecture hours, T= Tutorial hours, P= Practical hours)

1. Prerequisite Course / Knowledge:
Basic principles of algorithms.

2. Course Outcomes (COs) (5 to 8 for a 3 or 4 credit course):

After completion of this course successfully, the students will be able to..

CO-1 Discuss mathematic concepts of cryptographic primitives
CO-2 Describe fundamental concepts and algorithms of cryptography, including encryption/decryption and hash functions
CO-3 Summarize different authentication techniques and describe programs like PGP & S/MIME
CO-4 Discuss network security principles, applications, and practices
CO-5 Analyse protocols for various system security objectives using cryptographic tools
CO-6 Evaluate the role of different security mechanisms like passwords, access control mechanisms, firewalls, etc.

3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix
<table>
<thead>
<tr>
<th>CO</th>
<th>3</th>
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</table>

Note: Each Course Outcome (CO) may be mapped with one or more Program Outcomes (POs) and PSOs. Write ‘3’ in the box for ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low’-level’ mapping.

4. Detailed Syllabus:


Reference Books:
4. Research papers

5. Teaching-Learning Strategies in brief (4 to 5 sentences):
Lectures by integrating ICT into classroom teaching; tutorials involving problem solving; being a fundamental course, it requires critical thinking and active learning by the students to solve problems.

6. Assessment methods and weightages in brief (4 to 5 sentences):

<table>
<thead>
<tr>
<th></th>
<th>Weightage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assignments</td>
<td>30 marks</td>
</tr>
<tr>
<td>Mid Semester Examination</td>
<td>30 marks</td>
</tr>
<tr>
<td>End Semester Examination</td>
<td>40 marks</td>
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</tbody>
</table>

Title of the Course: Principles of Semiconductor Devices
Course Code: EC2.409
Faculty Name: Anshu Sarje
L-T-P: 3-1-0
Credits: 3

1. Prerequisite Course / Knowledge:
AEC, EW1 & EW2

2. Course Outcomes (COs) (5 to 8 for a 3 or 4 credit course):
After completion of this course successfully, the students will be able to..

CO-1 Describe quantum mechanics basics: Heisenberg’s principle, energy band (conduction & valance bands, energy gap).
CO-2 Explain the basic physics for PN junctions, MOS, MS junctions, MOSFET & BJT
CO-3 Calculate basic semiconductor device parameters and solve problems related to design of above mentioned semiconductor devices.
CO-4 Design very simple diode & MOSFET circuits

3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix

<table>
<thead>
<tr>
<th>CO1</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
<th>PSO1</th>
<th>PSO2</th>
<th>PSO3</th>
<th>PSO4</th>
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<td>2</td>
<td>1</td>
<td>3</td>
</tr>
</tbody>
</table>
Note: Each Course Outcome (CO) may be mapped with one or more Program Outcomes (POs) and PSOs. Write ‘3’ in the box for ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low’-level mapping

4. Detailed Syllabus:
Unit 1: Semiconductor Properties
Unit 2: Quantum Mechanics and Energy Band Theory
Unit 3: Carriers in equilibrium, G-R processes
Unit 4: Carrier Transport
Unit 5: PN Junction physics
Unit 6: MOS & MOSFET
Unit 7: BJT

Reference Books:
1. Advanced Semiconductor Fundamentals by Robert Pierret
2. Semiconductor Device Fundamentals by Pierret

5. Teaching-Learning Strategies in brief (4 to 5 sentences):
Students will be applying the lecture discussion to solved examples shared with them in the class. The assignments given will reinforce the concepts. Class room learning will be done in interactive method as much as possible. Occasionally self assessment test (1 minute paper) will be given. In lab class, students will make simple circuits using simple basic components.

6. Assessment methods and weightages in brief (4 to 5 sentences):

<table>
<thead>
<tr>
<th>Type of Evaluation [3 credit-lecture]</th>
<th>Weightage (in %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mid Sem Exam 1</td>
<td>15*</td>
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<tr>
<td>Mid Sem Exam 2</td>
<td>15*</td>
</tr>
<tr>
<td>End Exam</td>
<td>25*</td>
</tr>
<tr>
<td>Assignments</td>
<td>15</td>
</tr>
<tr>
<td>Mini Project</td>
<td>25</td>
</tr>
</tbody>
</table>
Title of the Course: ProductManagement101
Faculty Name: Ramesh lognathan
CourseCode: PD2.401
Program: M.TechIYearISemester–ProductDesignandManagement*
L-T-P: 3-1-0
( L= Lecture hours, T=Tutorial hours, P=Practical hours)
Credits: 2

1. Prerequisite Course/Knowledge:

No prerequisites are required
Semester,Year: 1st Sem – Year 1 (Spring, 2022)

Course Outcomes:
Introduction to Product Management. Product management is an organizational function that guides every step of a product’s lifecycle — from development to positioning and pricing — by focusing on the product and its customers first and foremost. To build the best possible product, product managers advocate for customers within the organization and make sure the voice of the market is heard and heeded.

Course Topics:
- Product Management Strategies (Product-Market strategies)
- Defining and Building products for success in the markets.
- Evaluating product-market fit
- Develop a product mindset needed to bring viable products (or services) to the market
- Define the problem a product will solve while mapping the customer’s journey and articulate user personas
- Product roadmaps, prototyping decisions and product management techniques and practices
- Agile methods of software development and the Product Management process

Preferred Text Books: None

Reference Books:

E-book Links:

Grading Plan: Class quizzes, Lab assignments, Miniproject
(The table is only indicative)

<table>
<thead>
<tr>
<th>Type of Evaluation</th>
<th>Weightage (in %)</th>
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<tr>
<td>1 minute paper (in class) [weekly prescheduled]</td>
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<tr>
<td>ClassQuizes</td>
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<tr>
<td>Assignments</td>
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<tr>
<td>Project</td>
<td>20</td>
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<tr>
<td>EndSemExam/Termpaper</td>
<td>30</td>
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<tr>
<td>OtherEvaluation</td>
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</table>

Note: This course description format comes into effect from Spring 2022.

Course: Program Verification  
Faculty Name: Venkatesh Chopella  
Course Code: CS1.303  
Credits: 3-1-0-2

1. Course structure

   Name: Program Verification  
   Credits: 2, Lectures-Tutorials-Practicals=3-1-0 (hours/week)  
   Instructor: Venkatesh Choppella

2. Prerequisite courses

   1. Computer Programming  
   2. Discrete Mathematics

3. Course outcomes

   A student graduating from the Program Verification course should be able to perform each of the following sample tasks:

   1. CO1: Specify simple computational problems. Use logic and functional notation to precisely specify a problem in terms of an input-output relation. This includes problems related to elementary data structures and sequential algorithms.

   2. CO2: Model sequential algorithms as iterative systems. Model sequential algorithms for searching and sorting and basic graph algorithms as simple iterative systems.

   3. CO3 Prove sequential algorithms correct. Write down a complete proof of total correctness of sequential algorithms for searching and sorting.

   4. CO4: Use verification tools. Develop facility to use software tools (Dafny, or Z3 etc.) for expressing and verifying correctness of algorithms.
Table 1: Mapping of Course Outcomes to programme and programme specific outcomes

<table>
<thead>
<tr>
<th>Programme Outcome (PO/PSO)</th>
<th>CO1</th>
<th>CO2</th>
<th>CO3</th>
<th>CO4</th>
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</thead>
<tbody>
<tr>
<td>PO1 Engg. Knowledge</td>
<td>3</td>
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<td>3</td>
<td>3</td>
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<tr>
<td>PO2 Problem Analysis</td>
<td>3</td>
<td>3</td>
<td>1</td>
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<td>PO3 Design/Develop</td>
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<td>PO4 Complex Problems</td>
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<tr>
<td>PO5 Modern tool usage</td>
<td>1</td>
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<td>3</td>
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<tr>
<td>PO6 Engr. &amp; Society</td>
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<td>3</td>
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<tr>
<td>PO7 Environment &amp; Sustainability</td>
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<td>PO8 Ethics</td>
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<td>PO9 Team work</td>
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<td>2</td>
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<td>PO10 Communication</td>
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<td>PO11 Project Mgmt &amp; Finance</td>
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<tr>
<td>PO12 Life learning</td>
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<td>PS01 Specialised knowledge</td>
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<td>PS02 Roadmap for technologies</td>
<td>3</td>
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<tr>
<td>PS03 Research &amp; Development Skills</td>
<td>3</td>
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<tr>
<td>PS04 Potential for PG study</td>
<td>3</td>
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</table>
5 Syllabus


**First Order Logic:** Quantifiers, syntax of first order logic. Evaluation. Deduction Systems. Applications to program specification. Writing proofs.

**Sequential Program Models** Discrete Flows, fixed points, convergence, limit maps, sequential problem solving, bound functions and invariants. Semantics of programming constructs.


6 Texts and References

6.1 Textbooks


**MICS** *A Mathematical Introduction to Computer Science*. Kasturi Viswanath. Universities Press, 2008. This is the main text for the second half of the course. Reserve copies in the library.

6.2 Other References

**LiCS** *Logic in Computer Science*. Huth and Ryan. Cambridge University Press.

7 Teaching and Learning Strategies

Lectures will cover the theoretical foundations of program verification: propositional and first order logic and state space models of programs. Lecture material will also include working with modern theorem provers and proof assistants in order for students to give a hands-on feeling of working with logic. Question-answer discussion will accompany each class. Assignments will challenge the student to master proof and modeling techniques. Summative assessments will be through a quiz, mid-semester and a final exam. Reading assignments will precede each lecture. Homework (programming) assignments will mostly involve the use of technologies related to verification of programs.

8 Assessment (Tentative)
<table>
<thead>
<tr>
<th>Item</th>
<th>Weight (%)</th>
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<tbody>
<tr>
<td>Homeworks</td>
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<tr>
<td>Quiz</td>
<td>15</td>
</tr>
<tr>
<td>Mid-semester exam</td>
<td>20</td>
</tr>
<tr>
<td>Final exam</td>
<td>30</td>
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</tbody>
</table>

Appendix: Programme and Programme Specific Outcomes

Programme Outcomes (POs)

**PO1::Engineering knowledge** Use concepts from varied disciplines including Computer Science, Electronics, Mathematics, and the Sciences to engineer and develop systems of varying scale.

**PO2 Problem analysis** Identify, formulate and analyze complex engineering problems reaching substantial conclusions using first principles of Mathematics, Natural Sciences and Engineering Sciences.

**PO3 Design/Development of solutions** Identify and bring to fore the necessary concepts from Computer Science and arrive at creative ways to solve problems that take into account the societal, cultural, and ethical considerations.

**PO4 Conduct investigations of complex problems** Interpolate and extrapolate based on existing knowledge base and self-learning skills to investigate the dynamics of complex problems and find solutions.

**PO5 Modern tool usage** Demonstrate requisite hands-on skills to work with a variety of software packages, libraries, programming languages, and software development environment tools useful in engineering large scales systems.

**PO6 The engineer and society** Make judicious use of resources and understand the impact of technology across the societal, ethical, environmental, and economic aspects.

**PO7 Environment and sustainability** Find technological solutions by considering the environmental impact for sustainable development.

**PO8 Ethics** Practice principles of professional ethics and make informed decisions after a due impact analysis.

**PO9 Individual and teamwork** Work efficiently in individual and team-oriented projects of varying size, cultural milieu, professional accomplishments, and technological backgrounds.

**PO10 Communication** Effectively communicate and exchange ideas and solutions to any individual including peers, end-users, and other stakeholders.

**PO11 Project management and Finance** Apply the principles of project...
management in general and software project management in particular with focus on issues such as the life cycle, scoping, costing, and development.

**PO12 Life-long learning** Exhibit the aptitude for independent, continuous, and life-long learning required to meet their professional and career goals.

Programme Specific Outcomes (PSOs)

**PSO1** Exhibit specialized knowledge in some sub-areas of Computer Science and Engineering such as Theoretical Computer Science, Computer Systems, Artificial Intelligence, Cyber-physical Systems, Cyber-security and use this specialized knowledge base to solve advanced problems.

**PSO2** Perform gap analysis in terms of systems and technologies and prepare roadmaps for incorporating state-of-the-art technology into system analysis, design, implementation, and performance.

**PSO3** Demonstrate research and development skills needed to define, scope, develop, and market futuristic software systems and products.

**PSO4** Demonstrate knowledge and skills at the required depth and breadth to excel in post-graduate and research programs.

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**Course Title**: Quantum Algorithms
**Faculty Name**: Shantanav Chakraborty
**Name of the Program**: Computer Science Elective (UG3, UG4, Dual degree)
**Course Code**: Newcourse
**Credits**: 4
**L-T-P**: 3-1-0 (L-Lecture hours, T-Tutorial hours, P-Practical hours)
**Semester, Year**: Spring 2022

**Pre-Requisites**: Familiarity with basic Linear Algebra, probability theory, discrete math, algorithms
**Desirable**: Knowledge of elementary quantum mechanics.

**Course Outcomes**: After the completion of this course, the students will be able to:

**CO.1 (Understand level)** – Demonstrate familiarity with the basic postulates of quantum mechanics, quantum circuits, quantum algorithmic primitives, various basic and advanced quantum algorithms and their running times, different quantum computational models

**CO.2 (Analyze level)** – Analyze the behavior of basic and advanced quantum algorithms

**CO.3 (Evaluate level)** – Review literature on the state-of-the-art quantum algorithms

**CO.4 (Evaluate level)** – Evaluate the complexity of quantum algorithms in various computational models

**Course Topics**:
Unit 1: Introduction to quantum mechanics, qubits, quantum circuits,
Unit 2: Quantum Fourier Transform, Simon's algorithm, Quantum phase estimation, Shor's Factoring Algorithm.

Unit 3: Grover's search algorithm, Quantum amplitude amplification, Analog quantum search

Unit 4: Quantum walks, Quantum walk search, Element distinctness problem, exhaustive search algorithm, Adiabatic quantum computing

Unit 5: Hamiltonian simulation, Linear combination of unitaries, The block encoding framework

Unit 6: Quantum algorithms for solving linear systems and least squares, Quantum machine learning: reading the fine print

Preferred Text Books:
There is no required textbook for this course. Good introductory material:


These two books contain almost all the topics to be covered in Unit 1, Unit 2 and Unit 3.

Reference Books:
The following lecture notes are also recommended reading material:

- Lecture notes on Quantum Computation by John Preskill (Caltech)
- Lecture notes on Quantum Algorithms by Andrew Childs (U.Maryland)
- Lecture notes on Quantum Computation by Ronald de Wolf (CWI)

These lecture notes are updated periodically and cover some of the more recent topics on the subject (Unit 4, Unit 5, Unit 6).

A great self-learning material for beginners is “Whynowistherighttimetostudy quantum computing”, by Aram Harrow.

Additionally, we will be using various research articles throughout the course.

Grading Plan:

<table>
<thead>
<tr>
<th>Type of Evaluation</th>
<th>Weightage (in %)</th>
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</thead>
<tbody>
<tr>
<td>Assignments</td>
<td>20</td>
</tr>
<tr>
<td>Quiz</td>
<td>15</td>
</tr>
<tr>
<td>Course project</td>
<td>35</td>
</tr>
<tr>
<td>Final Exam</td>
<td>30</td>
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</tbody>
</table>

Course project details:
Students have to submit a course project where they have to work on a topic related to quantum algorithms. While a list of suggested topics will be made available, students are free to choose their own topic. Along with surveying prior art, the students are strongly encouraged to identify or propose new research directions in that area.

The students can work on their own or form small groups of 2-3 students. The course project evaluation will have the following components:
• Project proposal (5% of project grade) – to be submitted by the end of Lecture 12

• Project presentation (40% of project grade) – to be made to the class (mandatory 10 mins allocated for questions)

• Paper (55% of project grade) – to be submitted by the end of the course

### Mapping of Course Outcomes to Program Objectives:

<table>
<thead>
<tr>
<th>CO1</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
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Teaching-Learning Strategies in brief (4-5 sentences):

The lectures will facilitate inter-student and faculty-student discussions by incorporating small-class exercises. There will be homework assignments that would help the student to: engage with the essential components of the lecture and will test the student’s ability to apply key concepts learnt, and also inform the faculty of the progress being made by the students in acquiring them. Given the advanced nature of the course, there will be a significant exploratory component: students will have to submit a course project on a topic related to quantum algorithms, where the students will be encouraged to not only review existing literature on the topic but also explore the possibility of identifying new possible research directions. Project presentations will facilitate inter-student discussions and exchange of new ideas.

Note: This course description format comes into effect from Spring 2022.

---

**Course Title**: Questions of Crime and Punishment in Literature  
**Faculty Name**: Nazia Akhtar  
**Name of the Program**: Ethics 2 Sub-Elective  
**Course Code**: HS0.208  
**Credits**: 2 credits  
**L - T - P**: 18 Lecture hours (12 classes)  
**Semester, Year**: Spring 2022  
**Pre-Requisites**: Introduction to Human Sciences, Ethics 1 (Basics)

**Course Description**:

What are the ethical questions that human beings struggle with? How do we make ethical choices? For that matter, how do ethical choices present themselves to us in the first place? How do we define a moral life as individuals? The study of ethics offers ways to approach ethical
questions and lets us deliberate and think about them. Ethics have also always been an important concern of literature. Literature places human beings in a specific context and gives us a glimpse into their lives, choices, and actions, allowing us to see how these play out and what are the motivations, implications, and consequences involved. The impact and influence of creative writers, such as Fyodor Dostoevsky and Leo Tolstoy, on discussions of the big questions with which humanity grapples far exceed their specific context and milieu and remain relevant in today’s world. This course will provide students the opportunity to examine, analyse, and discuss age-old ethical and moral dilemmas through their writings.

**Course Outcomes**:  
On successful completion of this course, students will be able to

4. examine key ethical concepts and explain how they work in a given context. These skills are portable and will stand students in good stead in the study and application of ethics in broader contexts.

5. assess how one of the most prominent creative writers and thinkers in history approached fundamental ethical questions, and analyse the development of ethics in his work.

6. synthesize their knowledge of theories and concepts in ethics with the ability to think and communicate carefully about ethical questions beyond casual statements or impressions, strengthening fundamental skills in critical thinking.

**Course Topics**:  
Module I:
- Introduction: Ethics in the World
- Historical and Socio-Cultural Context

Module II:
- Ethical Questions in Crime and Punishment: ethical relativism, egoism, consequentialism, deontology, virtue ethics, feminist ethics

Module III:

**Preferred Text Books**:

**Reference Books**:

**E-book Links** : –

**Grading Plan** :

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<td>Quiz-2 (3-5 questions; answers of 200-300 words)</td>
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**Mapping of Course Outcomes to Program Objectives:**

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**Teaching-Learning Strategies in brief (4-5 sentences) :**

The teaching-learning strategy in this course will consist of lectures based on set readings, which students are expected to complete in advance of the class. These lectures will incorporate prompts for classroom discussion and activities based on the readings to enable active learning and critical thinking. This learning will be further consolidated through assessments that will be designed to test and develop the student’s knowledge and skills, especially interpretative reading and writing.

**Title of the Course** : Readings in Indian Literatures

**Course Code** : HS1.202

**Faculty Name** : Sushmita Banerji

**L-T-P** : 3-0-0

**Credits** : 4

1. **Prerequisite Course / Knowledge:**

None

2. **Course Outcomes (COs):**

After completion of this course successfully, the students will be able to
CO-1: Engage in the pleasure and challenge of the close reading of literary texts

CO-2: Look at modern Indian literatures in translation to see how individuals imagine their own, particular lives and create a sense of a shared past and a shared culture

CO-3: Explore, among other issues, how the self is constructed through reading and writing, the relationship between memory and identity,

CO-4: Interrogate claims of authenticity or truth

CO-5: Study the oscillation between interior and exterior life, and the peculiarities of individual voice.

3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix

| CO1 | CO2 | CO3 | CO4 | CO5 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 | PSO4 |
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4. Detailed Syllabus:

Unit 1: Individual and Society

Unit 2: Histories in the making

Unit 3: Troubled corners of our making

Reference Books:


Tiwari, Shubha. Ed. *Indian Fiction in English Translation*. New Delhi, Atlantic, 2005

Text Books:

*Raag Darbari* (Shrilal Shukla, 1992)

*Agnisakshi: Fire, My Witness* (Lalithambika Antharjanam, Trans. 2015)
5. Teaching-Learning Strategies:

Students are expected to read up to 8 books in the course of the semester, watch any video lectures made available, and view films when required. This class is based on close reading of the texts prescribed and relies heavily on student participation and discussion.

This class shall deal with material students might disagree with. All informed disagreements, opinions, and discussions are encouraged. It shall however be the instructor’s right to shut down any disrespectful behaviour.

6. Assessment methods and weightages:

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Title of the Course: Robotics: Planning and Navigation
Course Code: EC4.403
Faculty Name: Madhava Krishna K
L-T-P: 3-1-0
Credits: 4

Prerequisite Course / Knowledge:
Computer Programming, Data Structures and Algorithms. Knowledge of Functional Optimization is a plus.

Course Outcomes (COs):
After completion of this course successfully, the students will be able to...

**CO-1**: Demonstrate familiarity with different paradigms in robotic motion planning
**CO-2**: Analyze robotic planning algorithms in the context of navigating in an environment to accomplish a goal
**CO-3:** Explain the significance of mathematical frameworks of functional optimization as well as robot kinematics in robotic planning and navigation tasks.

**CO-4:** Apply principles of functional optimization and robot kinematics to propose analytical frameworks, algorithms for solving real world problems in robotic motion planning, navigation.

**CO-5:** Create and Simulate the algorithms using state of the art software and libraries and evaluate its performance on specified tasks

**Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)**

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Each Course Outcome (CO) may be mapped with one or more Program Outcomes (POs). Write ‘3’ in the box for ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low’-level’ mapping Mapping with PSOs, where applicable.

**Detailed Syllabus:**

**Unit 1:** Classical AI Based Planning and its Limitations

**Unit 2:** Sampling Based Kinematic Planners, Trajectory Optimization

**Unit 3:** Model Predictive Control and Velocity Obstacles for Dynamic Scenes

**Unit 4:** Uncertainty Modelling, Planning under Uncertainty

**Reference Books:**

1. Trajectory Planning for Automatic Machines and Robots by Luigi Biagiotti · Claudio Melchiorri
2. Introduction to Robotics: Mechanics and Control by John J Craig

**Teaching-Learning Strategies in brief (4 to 5 sentences):**

Classes invoke rich graphical content in the form of images, representations, videos to elucidate difficult concepts in robotic motion planning. Code walkthroughs, simulation of algorithms used to enhance understanding. Learning by doing, coding and simulation is highly promoted and encouraged. Students understand difficult mathematical concepts and abstraction by coding it using state of the art software, simulation frameworks, libraries and solvers.

**Assessment methods and weightages in brief (4 to 5 sentences):**
- Programming Assignments: 50%
- Mid Sem: 20%
- End Exam: 30%

Course Title: Science & Technology: Critical perspectives
Name of the Faculty: Harjinder Singh
Name of the Academic Program: CHD
Course Code: TBD
L-T-P: 3-1-0.
Credits: 2

1. Prerequisite Course / Knowledge: None

2. Course Outcomes (COs):

   After completing this course successfully, the students will be able to

   **CO-1**  Explain diverse perspectives on Science & Technology with an ethical scrutiny.

   **CO-2**  Demonstrate understanding of how science and technology have differential effects on different sections of society.

   **CO-3**  Apply their knowledge to critically and ethically evaluate applications of science and technology to social problems.

3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix

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Note: Each Course Outcome (CO) may be mapped with one or more Program Outcomes (POs) and PSOs. Write ‘3’ in the box for ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low-level’ mapping

4. Detailed Syllabus:
Unit-1: The problem of knowledge and science as an episteme; the nature of technology
Unit-2: Deterministic nature versus social construction of science and technology; differential effects on different sections of society
Unit-3: General critique of science - feminist critique, post-modern critique, etc.
Unit-4: Specific instances of ethical violations - abuse of science and technology, illustrations from biotechnology, technology of war, etc.

Reference Books:
   https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1084045/ (and references therein)

5. Teaching-Learning Strategies in brief:
Interactive class room teaching, multiple quizzes; encouragement for brief student presentations.

6. Assessment methods and weightages in brief:
Assignments: 30%,
Class Quizzes: 20%,
End Semester: 40%
Term Paper: 10%
A jump in grade will be awarded for an exceptional term paper. Plagiarism of any degree will invite a ‘F’ grade with no discussion.

Title of the Course: Science, Technology and Society
Faculty Name: Radhika Krishnan
Name of the Academic Program: CHDCore offered to UG2 (fourth semester of the CHD program). Also offered as an HSS Elective.
Course Code: HS7.301
L-T-P: 3-0-0
( L= Lecture hours, T=Tutorial hours, P=Practical hours)
Credits: 4

1. Prerequisite Course / Knowledge: Thinking and Knowing in the Human Sciences I and II (Core courses the CHD program) or Introduction to Sociology.

2. Course Outcomes (COs) (5 to 8 for a 3 or 4 credit course):

After completion of this course successfully, the students will be able to.

CO-1:

Students will be introduced to the discipline of science and technology studies (STS) and the questions that STS seeks to address. Students will have a working knowledge of the key methodological and theoretical frameworks within STS, as well as the key debates within STS, and the significant contributions of STS scholars.
CO-2:
Students will understand the various approaches within the broad domain of the social construction of science.

CO-3:
Students will learn about how technology shapes and in turn shaped by social, economic, political and cultural factors. They will understand various theories and methods under the broad rubric of the social construction of technology, and will be exposed to the debates between technological determinism and social construction of technology.

CO-4:
Students will be encouraged to identify values embedded in technical systems, and the potential as well as limitations of human and non-human agency. Students will have the conceptual ability to analyse various aspects of the society-technology interface.

CO-5:
CHD students will be able to think more deeply about confluence between the social sciences and the digital world of computing. This will help them think about possible research approaches and questions which they can later pursue.

3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix

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Matrix for ECE

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</table>

Note: Each Course Outcome (CO) may be mapped with one or more Program Outcomes (POs) and PSOs. Write ‘3’ in the box for ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low-level’ mapping

4. Detailed Syllabus:

Unit 1:

Structure and functioning of the scientific community (rules, norms, values). Social construction of scientific knowledge (controversies and the problem of replication, science as a negotiated process, role of interests). Strong Programme, Sociology of Scientific Knowledge, Empirical Programme of Relativism

Unit 2:
Introduction to Technology Studies: Understanding the technological visions of Jacques Ellul and Lewis Mumford.

Unit 3:


Unit 4:

Technological determinism and its debates with Social Construction of Technology: Introduction to the ideas of David Noble, Langdon Winner, Robert Heilbroner, David Harvey, Nathan Rosenberg.

Unit 5:

Digital Technologies in society: Discussion of recent research and case studies related to digital technologies.

Reference Books:


Merritt Roe Smith and Leo Marx (eds.), Does Technology Drive History: The Dilemma of Technological Determinism (Cambridge, Massachusetts and London: MIT Press, 1994).


5. Teaching–Learning Strategies in brief (4 to 5 sentences):

Students are introduced to theories and concepts through lectures. Discussions and interventions in the classroom are highly encouraged. Case studies will be used extensively to explain theoretical concepts. This course involves 2 projects (one will deal with sociology of science, and the other will involve studying digital technologies using theories and methods in
The idea behind these projects is to bring together theory and practice. In addition, students are given 4 reading-based assignments through the course, which will help them to understand the concepts in some depth.

6. Assessment methods and weightages in brief (4 to 5 sentences):

<table>
<thead>
<tr>
<th>Type of Evaluation</th>
<th>Weightage (in %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project 1</td>
<td>20%. Related to the Sociology of Science</td>
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<tr>
<td>Project 2</td>
<td>30%. Related to analysis of the society-technology interface using STS concepts and theories</td>
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<td>Assignment 1</td>
<td>12.5%. Related to Unit I</td>
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<tr>
<td>Assignment 2</td>
<td>12.5%. Related to Unit II</td>
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<tr>
<td>Assignment 3</td>
<td>12.5%. Related to Units III/IV</td>
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<tr>
<td>Assignment 4</td>
<td>12.5%. Related to Unit V</td>
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</tbody>
</table>

Title of the Course: Software Engineering
Course Code: CS6.401
Faculty Name: Raghu Reddy
L-T-P: 3-0-1
Credits: 4

1. Prerequisite Course/Knowledge:
Students must have taken Intro to Software Systems, Design and Analysis of Software Systems or Equivalent courses

2. Course Outcomes (COs) (5 to 8 for a 3 or 4 credit course):

After completion of this course successfully, the students will be able to...

CO-1: Demonstrate familiarity with various process models, design patterns, architecture patterns and the characteristics of good software architectures
CO-2: Apply principles of user interface design, sub-system design and analyze the designs for good Software Engineering principles
CO-3: Demonstrate the use of tools to quantitatively measure and refactor existing software systems
CO-4: Compare design trade-offs between different patterns and/or different implementations of the same pattern
CO-5: Design the major components and user interface for a small-scale software system using modeling approaches such as UML class diagrams, and sequence diagrams
CO-6: Critique the quality of software design and use product quality metricsto assess the quality of delivered software
3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix

<table>
<thead>
<tr>
<th>CO1</th>
<th>PO1</th>
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Note: Each Course Outcome (CO) may be mapped with one or more Program Outcomes (POs) and PSOs. Write '3' in the box for 'High-level' mapping, '2' for 'Medium-level' mapping, '1' for 'Low'-level mapping.

4. Detailed Syllabus:

**Unit 1:** Software Development Lifecycle and Importance of Architecture and Design in the Lifecycle, Process models; Modeling using UML.

**Unit 2:** Anti-patterns; Metrics and Measurement; Reverse Engineering and Refactoring.

**Unit 3:** Design Principles and Classification of Patterns
- Structural patterns: Adapter, Composite, Façade, Proxy, Decorator
- Behavioral patterns: Iterator, Observer, Mediator, Command, Memento, State, Strategy, Chain of Responsibility
- Creational patterns: Abstract Factory, Builder, Singleton, FactoryMethod

**Unit 4:** Software architecture and Architectural business cycle; Quality attributes and Tactics for achieving attributes; Architectural styles and Techniques; Designing Architectures, Case studies.

**Reference Books:**

5. Teaching Learning Strategies in Brief (4 to 5 sentences):
The course is delivered using project-based learning methodology. Topics like software subsystems modeling, design analysis, design trade-offs, language agnostic designs and component-based software development are taught and reinforced via unit level projects. The lectures emphasize the study and development of software sub-systems, comprehension and analysis of design quality attributes. The focus is on application of these concepts to concrete design problems through in-class design exercises and analysis of existing designs of currently implemented software systems. Entire class is
run in a studio mode to facilitate discussion between student teams and discuss design trade-offs among students within student teams. Students present their designs and implementations to other students who are expected to critique the designs.

6. Assessment methods and weightages in brief (4 to 5 sentences):

<table>
<thead>
<tr>
<th>Assessment Method</th>
<th>Weightage</th>
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<tbody>
<tr>
<td>Final Exam</td>
<td>22 %</td>
</tr>
<tr>
<td>Mid-term Quiz</td>
<td>12 %</td>
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<tr>
<td>Unit Questions</td>
<td>12 %</td>
</tr>
<tr>
<td>3 Unit Projects (2 * 17) + (1 * 10)</td>
<td>44 %</td>
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<tr>
<td>Other In-class Activities</td>
<td>10 %</td>
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</tbody>
</table>

Course Title: Software Programming for Performance
Faculty Name: Suresh Purini
Course Code: CS3.302
L-T-P: 3-1-0
Credits: 2
Name of the Academic Program: B-Tech in Computer Science and Engineering
(L=Lecture hours, T=Tutorial hours, P=Practical hours)

1. Prerequisite Course/Knowledge
Basics of Algorithm Analysis, Computer Architecture

2. Course Outcomes (COs)
After completion of this course successfully, the students will be able to

CO-1. Explain the algorithmic optimizations necessary to improve the performance of a software on a uniprocessor.
CO-2. Analyze cache dependent performance of algorithms
CO-3. Employ cache-aware (such as tiling)/cache oblivious (such as recursive multiplication) optimizations to improve program performance
CO-4. Analyze the software performance improvement using SIMD Array Processing and Vector Processing Architectures
CO-5. Explain different concurrency platforms such as Pthreads, Threading Building Blocks.
CO-6. Develop multicore programs using OpenMP pragmas
CO-7. Explain the basics of GPU architecture

3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix

<table>
<thead>
<tr>
<th>PO1</th>
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</table>
Note: Each Course Outcome (CO) may be mapped with one or more Program Outcomes (POs) and PSOs.

Write ‘3’ in the box for ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low-level’ mapping

4. Detailed Syllabus

Unit 1: Algorithmic optimizations – Introduction to optimization of matrix multiplication: Language dependent performance, Loop ordering, compiler optimization, loop parallelization, tiling, vectorization

Unit 2: Memory Hierarchy aware Optimizations – Review on Caches, Conflict misses, Ideal Cache Model and cache misses, Cache analysis of matrix multiplication, Tiling, Recursive Matrix Multiplication

Unit 3: Using SIMD units – Flynn’s Taxonomy, Data Parallelism, SIMD Array Processing, Vector Processing – Vector Registers, Vector Functional Units, Memory Banking, Basic Vector Code Performance, Vector Chaining, Multiple Memory Ports, Masked Vector Instructions

Unit 4: Programming Multi-cores – Shared Memory Hardware, Concurrency Platforms – Pthreads, Threading Building Blocks, OpenMP – Creating Threads, Synchronization: critical, barrier, Parallel loops, Data Sharing, Memory model

Unit 5: Acceleration using Hardware Accelerators (GPU)

Reference Books:
No specific text book, but the material would be taken from different books such as:

1) Cormen, Thomas H., et al. *Introduction to algorithms.*

5. Teaching-Learning Strategies in brief
Weekly lectures cover the topics in the syllabus. Tutorials cover how to use some tools for measuring performance of software implementations. There are couple of assignments that will provide the students experience in programming some functions and improve the performance employing the techniques learned in theory. Firstly they would learn how to improve cache performance and then exploit parallelism in code by employing multicore programming using OpenMP.

6. Assessment methods and weightages in brief
<table>
<thead>
<tr>
<th>Type of Evaluation</th>
<th>Weightage (in %)</th>
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<tr>
<td>Quizzes</td>
<td>40</td>
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<tr>
<td>Assignments</td>
<td>60</td>
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Course Title: SpatialDataScience
Faculty Name: KSRajan
Name of the Program: Open to All Programmes on Campus at UG, PG/PhD Level
Course Code: (PG-2 level course)
Credits: 4
L-T-P: 3-1-0
(L-Lecture hours, T-Tutorial hours, P-Practical hours)

Semester, Year: Spring 2022
(Ex: Spring, 2022)
Pre-Requisites: Basic understanding of Locational Data and Computing—Any UG3, UG4, M.Tech., MS, and Ph.D. students should be able to take it. Prior coursework in Spatial Informatics may help.

Course Outcomes:
- CO-1: Describe how Spatial Data Science helps uncover patterns
- CO-2: Apply Geospatial techniques to prepare the data for analysis
- CO-3: Analyze the spatial and temporal data and interpret its outcomes
- CO-4: Assessment of application of Spatial Data Science in key domain areas
- CO-5: Design research projects that help synthesize the learning into an application

Course Topics:
Module 1: Introduction to Spatial Data Science
- What is special about Spatial Data and Geo-AI?
- How Spatial and Spatio-temporal Big Data helps uncover patterns?
- Spatial Data Handling including spatial data models, data formats
- Challenges to computing approaches when applied to Spatial Data—Effects of Topology

Module 2: Geospatial Data Analysis and Modelling
- Vector Data Spatial Analysis
- Raster Data Spatial Analysis
- How to use temporal data in conjunction with spatial data
- Geo Spatial Data M

Module 3: Spatial Sciences
- Spatial Statistics including spatial auto-correlation, spatial tessellation
- Data Mining applications on Spatial Data including Spatio-temporal Data Mining
- Network Analysis and Graph Theory
- Few relevant topics from Computational Geometry
- Geovisualization

MapstoWebGIS

Module 4: Spatial Classification and Prediction
- Spatial decision trees
- Machine learning as applied to Spatial Data including Spatial-aware Neural Networks
- Hotspot Analysis
- Spatial Outliers detection

Module 5: Applications of Spatial Data Science
- Public Health—monitoring and mapping diseases, risk analysis and disease spread modeling
- Agriculture—crop growth monitoring, crop yield patterns and resource constraints
- Location based services—routing applications, ride-sharing algorithms, optimal location

Preferred Text Books:
1. Spatial Computing, By Shashi Shekar and Pamela Vold. The MIT Press. 2020
4. Selected Research Papers and Articles (will be shared with the topics taught on the course portal)

Reference Books:
1. Geographical Data Science and Spatial Data Analysis—An Introduction in R. By Lex Comber and Chris Brunsdon. SAGE Publications Ltd. 2020

E-book Links: Will be provided in class as appropriate

Grading Plan:

<table>
<thead>
<tr>
<th>Type of Evaluation</th>
<th>Weightage (in %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class Quizzes</td>
<td>15.0</td>
</tr>
<tr>
<td>Mid Sem Exams—2</td>
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</tr>
<tr>
<td>End Sem Exam</td>
<td>30.0</td>
</tr>
<tr>
<td>Paper reviews and Presentations by each Student in Class</td>
<td>10.0</td>
</tr>
<tr>
<td>Project/Term paper demonstrating the Practical applications</td>
<td>25.0</td>
</tr>
</tbody>
</table>

Mapping of Course Outcomes to Program Objectives:
Teaching-Learning Strategies in brief (4-5 sentences):

Teaching-Learning

Lectures
Guest Lectures
Reading research papers
Class participation in Q&A, discussions
OnlinediscussionsoverMST
ams

Learning by doing

Short Presentation and Discussion led by Student
Courseprojectonconceptualization
ndimplementationRealworldapplications
Multi-disciplinary approach

Note: This course description format comes into effect from Spring 2022.

Title of the Course: Stability of Structures

NAME OF FACULTY: Sunitha Palissyery

Name of the Academic Program: M. Tech in CASE

Course Code: CE1.602

L-T-P: 3-1-0

Credits: 4

1. Prerequisite Course / Knowledge: Design of RC and Steel Structures (Undergraduate course content)

2. Course Outcomes (COs):

After completion of this course successfully, the students will be able to:

CO-1. Develop knowledge and skills to mathematically formulate structural stability criteria of steel members

CO-2. Employ the computer application skills in developing structural models to perform buckling analysis and predict stability of frames

CO-3. Demonstrate problem solving skills for various instability modes and work towards a research-based approach to the stability design of steel frames

CO-4: Apply buckling and stability analysis methods, to address practical stability design problems

CO-5. Analyze ethical and effective structural design practices to preclude stability failure of steel structures and towards reasonably good behavior under extreme loading conditions
CO-6. Reorganize inter-personal skills required to manage possible negotiations with structural engineering design practitioners towards a stable steel structure

3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix

Note: Each Course Outcome (CO) may be mapped with one or more Program Outcomes (POs) and PSOs. Write ‘3’ in the box for ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low’-level mapping

4. Detailed Syllabus:

Unit 1: Basic Concepts of Stability
Bifurcation Buckling- Methods of Stability Analysis-Post-buckling Behaviour-Large Deflection Analysis

Unit 2: Buckling of Columns and Frames
Differential Equations using Equilibrium, Large Deformation Theory, Effects of Imperfections, Inelastic Buckling – Tangent and Reduced Modulus Concepts, Shanley’s theory of Inelastic Column Behaviour, Effects of Residual Stresses-Beam Columns; Modes of Buckling- Frame Stability Analysis-Non-sway and Sway Frames-Critical Load Estimation using Slope Deflection Equations

Unit 3: Torsional and Flexural-Torsional Buckling and Buckling of Plates
Thin-walled Open Cross-Sections-Columns-Beams-Beam Columns; Governing Differential Equations for Plate Buckling, Plates Subjected Loading Actions, Post-buckling Behaviour of plates

Unit 4: Introduction to Behavior of Steel Beams and Beam Columns
Limit State Design; Classification of sections; Buckling classifications; Laterally Restrained and unrestrained beams, Effective Length of Columns- AISC Alignment Charts; stability index, Design Strength

Unit 5: Design of Beam Columns
Interaction equations, Design for combined axial and bending effects; computer analysis of rigid steel frames

Reference Books:
5. **Teaching-Learning Strategies in brief (4 to 5 sentences):**

1. Lectures by integrating ICT into classroom teaching
2. Tutorials involving mathematical formulation and graphical analysis of stability problems
3. Assignments involving analysing structural data to understand buckling behaviour of steel members and frames
4. Critical and active learning through projects, and project-based learning by doing term-projects which involves computer programming and hands-on use of software tools to investigate & predict stability behaviour of members and frames.

6. **Assessment methods and weightages in brief (4 to 5 sentences):**

Assignments in theory: 20 marks, Quizzes in theory: 10 marks, Mid Semester Examination in theory: 20 marks, Term-project: 20 marks, End Semester Examination in Theory: 30 marks

<table>
<thead>
<tr>
<th>Title of the Course</th>
<th>Statistical Methods in Artificial Intelligence</th>
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<tbody>
<tr>
<td>Course Code</td>
<td>CS7.403</td>
</tr>
<tr>
<td>Faculty Name</td>
<td>Vineet Gandhi</td>
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<tr>
<td>Credits</td>
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</tbody>
</table>

( L= Lecture hours, T=Tutorial hours, P=Practical hours)

1. **Prerequisite Course / Knowledge:**

Basic probability theory

Basic Linear Algebra

Good programming skills in Python

2. **Course Outcomes (COs) (5 to 8 for a 3 or 4 credit course):**

After completion of this course successfully, the students will be able to..

CO-1: Data processing: process raw data and convert it into machine exploitable format

CO-2: Problem formulation: formulate a practical problem as a machine learning problem (classification, clustering etc.)

CO-3: Classical algorithms: In depth investigation of theory and practice of classical algorithms in supervised and unsupervised learning (e.g. SVM, Kmeans, decision trees).

CO-4 Deep Learning: Introduction to theory and practice of deep learning and recent advances

CO-5 System building: design practical systems incorporating basic machine learning

3. **Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix**
<table>
<thead>
<tr>
<th>CO1</th>
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Note: Each Course Outcome (CO) may be mapped with one or more Program Outcomes (POs) and PSOs. Write ‘3’ in the box for ‘High-level’ mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low-level’ mapping

4. Detailed Syllabus:

Unit 1: Review of basic statistics, linear algebra, probability

Unit 2: Problem formulation in ML, Decision Trees, Nearest Neighbours

Unit 3: Supervised Machine Learning (SVM, Random Forest, Boosting etc.)

Unit 4: Unsupervised Machine Learning (kmeans, recommendation, anomaly detection, PCA, LDF etc.)

Unit 5: Deep Learning

Reference Books:


5. Teaching-Learning Strategies in brief (4 to 5 sentences):

The course involves heavy theory and programming components. The strategy is to first discuss a problem statement, introduce an algorithms and work out the details of the algorithm, and then use the algorithm to solve the problem. A lot of teaching on black board to discuss theory, large assignments are given for covering practical aspects and a large project is given mid-way of the course to cover the system building aspect.

6. Assessment methods and weightages in brief (4 to 5 sentences):

Programming Assignments: 25%
Quiz1 : 10%
Quiz2 : 15%
Final exam : 25%
Course Project : 25%

Course Title : System and Network Security
Faculty Name : Dr. Ankit Gangwal
Name of the Program : MTech. in CSIS and Open Elective for B.Tech. in CSE
Course Code : CS8.403
Credits : 4
L - T - P : 3-1-0 (L - Lecture hours, T-Tutorial hours, P - Practical hours)
Semester, Year : Spring, 2022
Pre-Requisites : Data Structures and Algorithms and Principles of Information Security

Course Outcomes :

After completion of this course successfully, the students will be able to..

CO-1 Demonstrate a familiarity with concepts of computer attacks and core defense techniques

CO-2 Discuss various vulnerability testing schemes

CO-3 Apply the knowledge of cryptography to build secure and efficient communication channels

CO-4 Analyze and compare mobile platform security architecture of iOS and Android

CO-5 Design security modules against web and network attacks

CO-6 Develop a framework to test web applications’ security

Course Topics :
Unit 1: Attacks and Vulnerabilities: Exploits and defenses in control hijacking attacks; principle of least privilege, access control, and operating systems security; isolation and sandboxing; vulnerability testing using fuzzing, static, and dynamic analysis; brief overview of cryptography.

Unit 2: Web Security: Basic web security mode; web application security; web session management; goals and pitfalls for HTTPS.


Unit 4: Security of Mobile Platforms: Mobile platform security architecture; Android and iOS security models; topics in Android security.

Unit 5: Low-level Architectural Security and Misc. Topics: Processor and microarchitecture security; Intel SGX and the Specter attack; privacy, anonymity, and censorship.

Preferred Text Books :

Reference Books :
Grading Plan:

<table>
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<th>Type of Evaluation</th>
<th>Weightage (in %)</th>
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Mapping of Course Outcomes to Program Objectives:

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Teaching-Learning Strategies in brief (4-5 sentences):
The main objective of this course is to enable students to have a good understanding of the fundamental principles of computer systems and network security. It is designed to help the students understand various attack and defense techniques. The course is especially useful for students who plan to do research and/or product development in the area of system building.

Course Title: The State in Colonial India
Course Code: HS3.302
Faculty Name: Aniket Alam
Credits: 4 (four)
L - T - P: 3 - 1 - 0
(Ex: Spring, 2022)
Pre-Requisites: Introduction to Human Sciences (HS8.102)
Course Outcomes:
After completion of this course successfully students will be able to:
CO1: Describe the concept of modern State, and its emergence in colonial India
CO2: Explain range of academic theories relating to state formation, and colonialism
CO3: Analyze the different features and institutions which make-up the State in colonial India
CO4: Evaluate the Institutional and social processes which formed the State in colonial India.
CO5. Assess primary evidence using computational tools to form their own conclusions.
CO6. Develop their own theory about the positives and negatives of the colonial State.

Course Topics : The course is divided into five modules: (i) Idea of the State in India and Europe, (ii) Geography of the colonial State, (iii) Economy of the colonial State, (iv) Technologies of Governance of the colonial State, and (v) Mapping the Modern State in India.

Module 1: Definitions of the state in India over the past two millennia, and in the philosophies of Hobbes, the Enlightenment, Adam Smith and the Utilitarians, 20th Century scholars; Development of the State among Mughal, Rajput and Maratha kingdoms and in Europe.

Module 2: Study how the territory of British India was gained and how it defined the nature of the state. It will look at the land-locked nature of the sub-continent and the open sea-faces on three sides, the river valleys, mountains, deserts and forests, and the trade routes. It will study the trigonometrical survey and the cadastral surveys which fixed territory. It will look at how the frontiers, boundaries and borders, as well as the regions and provinces were formed.

Module 3: Study the economy and resources of the colonial state; how it came to manage and govern the land, its agricultural and mineral products, the forests and water resources, the manufactures and commerce. It will also study the financial foundations of the state and its accounts.

Module 4: The fourth section of the course will look at the technology of governance. These will include (a) technologies of government and administration, (b) technologies of transport and communication and (c) technologies of measurement. This module will include a study of the military, police, civil and judicial administration, the schools, colleges and universities, the medical institutions, the other institutions of state and legal systems. It will also include posts and telegraph, the railways, telephones and press. Finally, it will also discuss the various methods of measuring land, forest, wealth, populations, etc. Students will use their skill of information technology to study the manner in which these technologies worked.

Module 5: Study the ideology of the colonial state, how it saw itself as a legatee of the Mughals and yet as scientific and modern with a mission to “civilize”; how it considered its main task to be the guarantor of stability and peace, while also claiming for itself the role of protector of the poor. Students will use their skill of information technology to study the spread of the State.

Preferred Text Books :
1. Michael Mann: South Asia's Modern History: Thematic Perspectives
2. Lakshmi Subramanian: History of India: 1707 to 1857

Reference Books :
1. Sekhar Bandyopadhyay: From Plassey to Partition.
2. Romila Thapar: From Lineage to State.
5. Manu Goswami: Producing India – From Colonial Economy to National Space.
10. Marc Galanter: Law and Society in Modern India.
11. S. Gopal: British Policy in India, 1858-1905.
12. Ranajit Guha, A Rule of Property for Bengal.
20. Ian J. Kerr: Engines of Change: The Railroads that Made India.
22. Nicholas B Dirks: Castes of Mind: Colonialism and the Making of Modern India.
23. Madhav Gadgil, Ramachandra Guha: This Fissured Land.

Articles.


10. Bernard Cohn: “Representing Authority in Victorian India”.


**E-book Links**

**Grading Plan**

(The table is only indicative)

<table>
<thead>
<tr>
<th>Type of Evaluation</th>
<th>Weightage (in %)</th>
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<td>Mid SemExam</td>
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<td>Quiz-2</td>
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<tr>
<td>End Sem Exam</td>
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<td>Assignments</td>
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<td>Project</td>
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<td>Term Paper</td>
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<td>Other Evaluation</td>
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**Mapping of Course Outcomes to Program Objectives:** (1 – Lowest, 2—Medium, 3 – Highest, or a ‘-’ dash mark if not at all relevant).

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</table>
Teaching-Learning Strategies in brief (4-5 sentences):

The course will be based on classroom lectures and will require intensive reading and writing. On an average, each student will be required to read between 1,000 to 1,500 pages of books and articles and submit written work between 6,000 to 8,000 words, cumulatively.

In each class some select students will be given a small topic from the next class to read up on, and they will be expected to initiate discussions around these. Pictures, Extracts from primary sources, audio and video resources will be used to illustrate the points being taught. The assignments and project will focus on training students to develop their own ideas, and apply computer science tools, to the topics on hand.

Note: This course description format comes into effect from Spring 2022.
4. Detailed Syllabus:

**Unit I** – Introduction to applied ethics; animal rights; animal rights and equality; Argument from marginal cases, unequal value thesis

**Unit II:** Environmental ethics; biocentric ethics; distributive and corrective justice, individual moral obligations

**Unit III:** Economic Justice and inequality; Rawls-Nozick debate

**Unit IV:** Genetic engineering; genetic engineering and perfection; genetic engineering and enhancement; GMOs

**PREFERRED TEXTBOOK**

**REFERENCE BOOKS**


5. Teaching-Learning Strategies in Brief

This course aims at reading, critically evaluating, and thinking through contemporary debates in applied ethics. For this purposes, the main strategy is to share the readings and resource material beforehand for the students to acquaint themselves with the topics and use the class time to discuss and evaluate the implications of the various positions respective to each topic. Continuous assessment methods will be employed to make sure the students have acquired the requisite conceptual understanding to explicate and argue for their position with greater nuance and logical rigor.
Continuous assessment in the form of written assignments will carry the major weightage of the evaluation, with the rest of the weightage assigned to class participation in the ensuing discussions. The assigned weightage is as follows: Assignments: 90 marks, class participation: 10 marks.

<table>
<thead>
<tr>
<th>Type of Evaluation</th>
<th>Weightage (in %)</th>
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<tbody>
<tr>
<td>Class Participation</td>
<td>10</td>
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<tr>
<td>Assignments (1000 words)</td>
<td>60 (3 x 20)</td>
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<tr>
<td>Review Essay (1500 words)</td>
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Title of the Course: Time Frequency Analysis
Name of the Academic Program: B.Tech. in ECE
Course Code: EC5.402
L-T-P: 3-1-0
Credits: 4

Typical Course Design
Prerequisite Course/Knowledge:
Should have taken Signal Processing course.

Course Outcomes (COs):
After completion of this course successfully, the students will be able to.

CO-1: Demonstrate usability of joint time-frequency transforms and distributions in signal processing.

CO-2: Apply principles of time & frequency fundamentals to understand uncertainties in joint time-frequency representation.

CO-3: Developing mathematical foundation for joint time-frequency representation.

CO-4: Analyzing signals with Wavelet theory of signal processing.

CO-5: Explaining the application of advanced transforms for signal analysis.

CO-6: Designing the algorithms for modeling non-stationary signals.

Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)
EachCourseOutcome(CO)maybemappedwithoneormoreProgramOutcomes(POs).Write ‘3’in th
ebox for‘High-level’mapping, 2 for ‘Medium-level’ mapping, 1 for ‘Low’-level’ mapping

Mapping with PSOs, where applicable.

Detailed Syllabus:

**Unit 1:** Introduction to Vector Space, Basis Functions, Basis, Frames. Review of Fourier series and transform.

**Unit 2:** Fundamentals of time and frequency. Time-bandwidth product. Uncertainty principle.

**Unit 3:** STFT, Wavelet theory of signal processing, multi-resolution analysis.

**Unit 4:** Wigner Villedistribution, HHT and S-transform.

**Unit 5:** Applications in signal and image processing.

**Reference Books:**


**Teaching-Learning Strategies in brief (4 to 5 sentences):**

It is a mathematical oriented signal processing course, so regular problem solving assignments are given to understand the concepts. Surprise class tests are conducted based on assignments to test the seriousness in assignment solving. As apart of teaching, practical examples like speech and images are used for demonstration of mathematical concepts learned. Advanced concepts applications are studied by doing course projects.

**Assessment methods and weightages in brief (4 to 5 sentences):**

- Assignments – 20%
- Mid exams – 30%
- End Project – 15%
- End exam – 35%

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**Title of the Course:** Topics in Coding Theory

**Faculty Name:** Prasad Krishnan

**Name of the Academic Program:** B. Tech in Electronics and Communication Engineering
Course Code: ECE537
L-T-P: 3-1-0
Credits: 4
(L=Lecture hours, T=Tutorial hours, P=Practical hours)

1. Prerequisite Course/Knowledge:

1. Linear Algebra over field of Complex Numbers: Vector Spaces, Bases, Dimension, Subspaces, Connection between Linear Operators and Matrices, Diagonalizability of Hermitian Operators/Matrices (Mandatory)
2. Basics of Linear Algebra over Finite Fields and Linear Block Codes (Highly preferable but not mandatory)

2. Course Outcomes (COs):

After completion of this course successfully, the students will be able to:

**CO-1:** Describe the basic postulates of Quantum Mechanics (Quantum bits (qubits) to represent information, transformations on qubits via Unitary operators, Quantum Measurements

**CO-2:** Describe the effects on noise on qubits such as bit flip and phase flip errors, and the relevance of quantum error correction codes (QECCs).

**CO-3:** Demonstrate understanding of basic principles of QECCs [the role of Pauli matrices], their encoding and decoding techniques [via the Shor Code, a 1-qubit QECC that corrects bit and phase flip errors]

**CO-4:** Analyze the Calderbank Shor Steane code via the Stabilizer formalism of QECCs and understand the relationship of these to classical codes.

**CO-5:** Demonstrate ability to understand recent topics of research in QECCs and their applications in coding theory domain.

3. Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs) – Course Articulation Matrix

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4. Detailed Syllabus:

**Unit 1:** Linear Algebra Refresher (Vector spaces over C, Operators on Vector spaces, Eigen values, vectors and Diagonalization, Tensor Products), Postulates of Quantum Mechanics – Qubits, Measurements, Operators, Errors and their representation via Pauli Matrices, Basics of Quantum Circuits required for QECCs

**Unit 2:** Principles of Quantum Error Correcting Codes, Quantum Noise (bit flip, phase flip, depolarizing), Knill-Laflamme Conditions

**Unit 3:** Bit-flip & Phase-flip correcting Shor Code, Review of Classical Linear Block Codes, Bounds for QECCs

**Unit 4:** Stabilizer Formalism, encoding, decoding and the Calderbank-Shor-Steane Construction, Connection to classical codes to CSS Codes, Important QECC examples - Steane code $[[7,1,3]]$, and $[[15,1,5]]$ quantum Reed-Muller code.

**Unit 5:** Further constructions of QECCs beyond CSS codes (Topological Codes, Subsystem Codes), Applications of Quantum computation in recent problems in communication/coding theory.

Reference Books


5. Teaching-Learning Strategies in Brief (4 to 5 sentences):

   The course is on learning the basics of Quantum error correcting codes, constructions of Quantum error correction, performance analysis, and decoding. The material will be covered via lectures which are systematically prepared and delivered considering the prerequisite knowledge of the students. The tutorial sessions will be engaging the students via a number of problems that are linked to the theory sessions covered in the class. The evaluation plan of the course involves written exam, home assignments and term paper presentation. As this is a course meant for research-oriented students, 40% of the weightage is shared between home assignments and term paper presentations. The term paper presentation will involve presentation of a recent research paper individually or group-wise. The midterm and end semester exams have cumulatively 60% of the remaining weightage will examine the students’ understanding in the topics covered in the class via various problems.

6. Assessment Methods and Weightages in Brief (4 to 5 sentences):

<table>
<thead>
<tr>
<th>Type of Evaluation</th>
<th>Weightage(in%)</th>
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<tbody>
<tr>
<td>Home Assignments (Problem Sets 3-4)</td>
<td>20%</td>
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<tr>
<td>Midterm(1)</td>
<td>20%</td>
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<tr>
<td>End Semester Examination</td>
<td>40%</td>
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Title of the Course : Topics in Deep Learning
Faculty Name : Charu Sharma and Makarand Tapaswi
Name of the Program : Honors, DD, MTech, PhD
Course Code : CSE
Credits : 4
L-T-P : 3-1-0
(L-Lecture hours, T-Tutorial hours, P-Practical hours)
Semester, Year : Spring, 2022

Max. no. of students : 50

Pre-Requisites:

Mandatory: SMAI course and linear algebra.
Nicetohavebasicsofgraphtheory,computervision,andnaturallanguageprocessing.

Course Outcomes:

Recently, graph representation learning has gained prominence in the area of Deep Learning in a wide variety of tasks as there is a lot of graph data available in different forms from several domains such as social network, biological network, chemical compounds, citation network, retail network, transaction network, drug network, etc. Machine learning for graphs aims to solve various problems such as graph classification, node classification, link prediction, relation prediction, graph/node clustering, etc. This is a research-driven course that intends to describe variety of tasks, representation learning methods and its applications in the emerging field of machine learning for graphs. The aim of the course is to make students understand the theoretical and research aspects of the topics (CO1) so that they can analyze and evaluate the research ideas behind the existing methods (CO2). The students will also be able to look at the problem from different perspectives (CO3) and extend or design a method/algorithms for a real-world problem (CO4). Students can relate to the real-world problem and apply the existing methods as well (CO5).

Course Topics: Following topics are subject to minor changes.

1. Introduction, Fundamentals and Significance
   A. Introduction to ML for Graphs, Applications, Problem Definition
   B. Basics of Networks and Graphs
   C. Node and Graph Embeddings
2. Problems in Graph ML
   A. Node and Graph Classification
   B. Link Prediction and Relation Prediction
   C. Clustering and Community Detection
   D. Graph/Subgraph Matching
   E. Applications
3. Embedding Methods
   A. Heuristic Methods, Graph Kernel-based Methods
   B. Random Walk-based Methods: DeepWalk, Node2vec
   C. Graph Laplacian and Spectral Methods
   D. Applications

4. Graph Neural Networks
   A. Popular GNNs and its Variants: GCN, GraphSAGE, GIN, DGCNN, etc.
   B. Applications of GNNs

5. Knowledge Graphs
   A. KG Embeddings
   B. Applications of KG Embedding Methods

6. Other GNNs
   A. Attention Model: GAT
   B. Graph Transformers
   C. Graph Generation: Deep Generative Models

Preferred Text Books for Machine Learning and Deep Learning basics:

Christopher Bishop. Pattern Recognition and Machine Learning.

Reference Books: There is an e-book (Graph Representation Learning) that came recently by William Hamilton (link mentioned under book links). Useful links, class notes and/or references will be provided for classes.

E-book Links:


Tentative Timetable

<table>
<thead>
<tr>
<th>Wednesday</th>
<th>Saturday</th>
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<tbody>
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<td>5 Jan</td>
<td>8 Jan</td>
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<td>12 Jan</td>
<td>15 Jan</td>
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<tr>
<td>19 Jan</td>
<td>Lecture topic</td>
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<td>26 Jan</td>
<td>Holiday</td>
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<tr>
<td>2 Feb</td>
<td>Quiz 1</td>
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<td>9 Feb</td>
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<td>16 Feb</td>
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<td>23 Feb</td>
<td>26 Feb</td>
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<tr>
<td>2 Mar</td>
<td>Time to work on your projects Nomid-semexam</td>
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<td>16 Mar</td>
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<td>27Apr</td>
<td>Projectpresentations</td>
</tr>
<tr>
<td>30Apr</td>
<td>Projectpresentations</td>
</tr>
</tbody>
</table>

**Grading Plan**

The evaluation below is subject to minor changes.

<table>
<thead>
<tr>
<th>Type of Evaluation</th>
<th>Weightage (in%)</th>
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</thead>
<tbody>
<tr>
<td>Quiz 1</td>
<td>10</td>
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<tr>
<td>Assignment-1</td>
<td>10</td>
</tr>
<tr>
<td>Assignment-2</td>
<td>10</td>
</tr>
<tr>
<td>Project (proposal+presentation+report + work)</td>
<td>60 (10+10+10+30)</td>
</tr>
<tr>
<td>Others (classactivity, surprisequiz, scribing, etc.)</td>
<td>10</td>
</tr>
</tbody>
</table>

**Project Evaluation:**

- Team of 3 members.
- 10 points: Proposal: 1 page + refs; Write about what you want to do, something achievable in 3 months.
- 10 points: Final report: 2 pages + analysis figures + proofs + refs; Describe the main contribution. Reference previous work for everything else.
- 10 points: Final presentation (5 slides) / video (4 minutes) / poster (1 A0 size)
- Core research work, up to 30 points obtainable. If you do more, this may offset scoring in other parts of the project evaluation.
  - (15 points max) Re-implementation of code + main experiment, or error creation of several experiments using existing code
  - (5 points max) Additional interesting ablations, experiments, analysis
  - (10 points max) New ideas that unfortunately did not work
  - (15 points max) New working idea, publishable in a conference like ICVGIP, required for highest grade.

**For Office Use Only (start on new page)**

**Mapping of Course Outcomes to Program Objectives:**

- 1—Lowest, 2—Medium, 3—Highest, or a ‘-’ dash mark if not at all relevant. Program outcomes are posted at

  https://iiitaphyd-my.sharepoint.com/:w/r/personal/dyacad_iiit_ac_in/Documents/NBA-2020-21/Course%20Content/IIIT-CSE-ECE.docx?d=w111f0effcaea41b3a4d1e8a3fbc6332d&csf=1&web=1&e=ztKhby
### Course Title
Topics in Signal Processing

### Course Code
EC5.401

### Faculty Name
Santosh Nannuru

### Credits
4

### L - T - P
3 – 1 – 0

### Semester, Year
Spring 2022

### Pre-Requisites
Signal Processing, Linear Algebra

### Course Outcomes

1. **Apply concepts from traditional signal processing for the study of graph signals and their processing**
2. **Apply Laplacian and Adjacency matrices from spectral graph theory to transform and interpret vertex-domain graph signals in frequency-domain**
3. **Analyze graph signals to perform the signal processing operations of filtering, denoising, sampling, and reconstruction**
4. **Analyze the connections between traditional signal processing and graph signal processing to develop abstract mathematical intuition for modeling and problem solving**
5. **Design and execute a project which applies graph signal processing to solve a problem using the tools learned in the course**

### Course Topics

This offering of Topics in Signal Processing will focus on Graph Signal Processing (GSP).
In contrast to traditional signals which defined over regular domains such

<table>
<thead>
<tr>
<th>CO1</th>
<th>CO2</th>
<th>CO3</th>
<th>CO4</th>
<th>CO5</th>
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</table>

#### Teaching-Learning Strategies in Brief (4-5 sentences):

The plan is to use the slides in general to explain the problem and methods. This would include the handwritten notes or using whiteboard whenever required to describe the topics mathematically. The outline has quite a few topics from research papers and would be presented like a paper in detail. Coding sessions (using graph data) would be conducted to make the topics/papers easier to understand.

Note: This course description format comes into effect from Spring 2022.
as time (e.g., speech), space (e.g., images) and space-time (e.g., video),
graph signals are signals defined over an irregular domain of graph. Relation between various components of traditional time and space
domain signals are captured by the temporal (past, present, future) and spatial (left, right, etc.) relations respectively. For graph signals, this
relation is specified by the accompanying graph i.e., the vertices (nodes)
and connections between the vertices (edges).

Review – brief review of relevant signal processing and linear algebra concepts
Graph and graph signals – definition and descriptors of a graph (Laplacian
and Adjacency matrices), spectral graph theory in brief, examples of
graphs, signals over the graph domain Signal processing over graphs–
shift operation, notion of frequency and smoothness, graph Fourier
transform (GFT), vertex-domain and frequency-domain representation of
graph signals, graph filters and convolution Signal processing over graphs –
band-limited graph signals, sampling and reconstruction of graph
signals, uncertainty principles, denoising, compression, learning graph
structure from signals, joint time-vertex signal processing Applications –
image processing, sensor networks, brain signals, etc.

Preferred Text Books:

Online resources and reference papers will be shared Reference Books : --

E-book Links : --

Grading Plan : 

(The table is only indicative)

<table>
<thead>
<tr>
<th>Type of Evaluation</th>
<th>Weightage (in %)</th>
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<tbody>
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<td>Assignments</td>
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<td>Project</td>
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<td>Term Paper</td>
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Mapping of Course Outcomes to Program Objectives: (1 – Lowest, 2—Medium, 3 –
Highest, or a ‘-’ dash mark if not at all relevant).

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<th>PO 1</th>
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<th>PO11</th>
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<th>PSO2</th>
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</table>
Teaching-Learning Strategies in brief (4-5 sentences):
Lectures are used to explain the core concepts in graph signal processing. Notes and slides will be shared along with online resources. Tutorials will be used for doubt clarifications and problem solving. Assignments are given to promote application of concepts to difficult problems. The course project exposes students to real-world applications and the role of graph signal processing.

Course Title: Topics in Software Foundations
Credits: 4 (Two 1.5-hour lectures per week)
Name of the Faculty: Venkatesh Chopella

Prerequisites
Corequisites
Distributed Systems

2 Objective

The objective of this course is to explore the modelling and design of advanced software systems from both a theoretical and practical perspective. The theory equips the student with a conceptual vocabulary for describing systems. The practical perspective provides an opportunity to look at how systems are designed in the real world and how these designs may be expressed and reasoned and implemented.

The course is in three parts. The first part (Unit 1) is an introduction to the notion of (interactive/reactive) transition systems, their behaviour and composition. The second part of the course (Units 2 and 3) is an introduction to the study of patterns of design of concurrent and distributed software systems using models of transition systems. The third part (Unit 4) is the analysis and modelling of real-world systems using the theoretical and design principles discussed in the previous two parts.

3 Course specific outcomes

After completing the course, the student should be able to accomplish the following:

1. CO1: Model simple to moderate interactive applications
Using the formalism of interactive system, model simple systems like an Automatic Teller...
Machine, Boom Barrier Controller, etc.

2. C02: Specify properties of systems. Formally state correctness conditions of sequential, concurrent and distributed systems.

3. C03: Express Patterns of design formally
Write down formal descriptions of some basic and advanced design patterns, like Observer, State and Model-View-Controller.

4. C04: Analyse the design of real-world systems
Take a real world system and identify its design in terms of patterns and express the patterns using a formal notation.

4 Detailed Syllabus

Unit 1: Principles

Unit 2: Patterns of Distributed Programming
Using Patterns to design distributed systems.
Crash Recovery, Replication and Consistency.
Putting it all together - Designing a distributed key value store using patterns.

Unit 3: Patterns of S/W Architecture and Design

Unit 4: Case studies
Analysis of real-world, large systems. Examples could include UPI, Aadhar, OpenCRM and other open-source systems.

5 References
There is no text book for the course. Material will be used from a variety of books, research papers and online websites. Some reference books and sites are listed below.

- Patterns of Distributed Systems. Unmesh Joshi.
  https://martinfowler.com/articles/patterns-of-distributed-
systems/

6 Teaching-Learning Strategies

The course will be lecture-driven. Students will need to complete assignments (including programming assignments) to demonstrate understanding of the material covered in class. In addition, there will be project presentations of case studies done by students. The project presentation will include a term paper and a talk.

7 Assessment Methods (Tentative)

<table>
<thead>
<tr>
<th>Assignments</th>
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<tbody>
<tr>
<td>Midsem</td>
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<tr>
<td>Project</td>
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</table>

8 Mapping of Course Outcomes to Programme and Programme Specific Outcomes

<table>
<thead>
<tr>
<th>Programme Outcome (PO/PSO)</th>
<th>CO1</th>
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<th>CO4</th>
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<td>PO2</td>
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<td>Problem Analysis</td>
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<td>PO3</td>
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<td>Design/Develop</td>
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<td>Complex Problems</td>
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<td>Modern tool usage</td>
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<td>Engr. &amp; Society</td>
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<td>Environment &amp; Sustainability</td>
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<td>Ethics</td>
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<td>Team work</td>
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<td>Communication</td>
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<td>Life learning</td>
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<td>Specialised knowledge</td>
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Programme Outcomes (POs)

PO1 :: Engineering knowledge
Use concepts from varied disciplines including Computer Science, Electronics, Mathematics, and the Sciences, to engineer and develop systems of varying scale.

PO2 Problem analysis
Identify, formulate and analyze complex engineering problems reaching substantial conclusions using first principles of Mathematics, Natural Sciences and Engineering Sciences.

PO3 Design/Development of solutions
Identify and bring to fore the necessary concepts from Computer Science and arrive at creative ways to solve problems that take into account the societal, cultural, and ethical considerations.

PO4 Conduct investigations of complex problems
Interpolate and extrapolate based on existing knowledge base and self-learning skills to investigate the dynamics of complex problems and find solutions.

PO5 Modern tool usage
Demonstrate requisite hands-on skills to work with a variety of software packages, libraries, programming languages, and software development environment tools useful in engineering large scale systems.

PO6 The engineer and society
Make judicious use of resources and understand the impact of technology across the societal, ethical, environmental, and economic aspects.

PO7 Environment and sustainability
Find technological solutions by considering the environmental impact for sustainable development.

PO8 Ethics
Practice principles of professional ethics and make informed decisions after a due impact analysis.

Appendix: Programme and Programme Specific Outcomes

<table>
<thead>
<tr>
<th>Roadmap for technologies</th>
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<tr>
<td>Potential for PG study</td>
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</table>
PO9 Individual and team work
Work efficiently in individual and team-oriented projects of varying size, cultural milieu, professional accomplishments, and technological backgrounds.

PO10 Communication
Effectively communicate and exchange ideas and solutions to any individual including peers, end-users, and other stakeholders.

PO11 Project management and Finance
Apply the principles of project management in general and software project management in particular with focus on issues such as the life cycle, scoping, costing, and development.

PO12 Life-long learning
Exhibit the aptitude for independent, continuous, and life-long learning required to meet their professional and career goals.

Programme Specific Outcomes (PSOs)

PSO1
Exhibit specialized knowledge in some sub-areas of Computer Science and Engineering such as Theoretical Computer Science, Computer Systems, Artificial Intelligence, Cyber-physical Systems, Cyber-security and use this specialized knowledge base to solve advanced problems

PSO2
Perform gap analysis in terms of systems and technologies and prepare roadmaps for incorporating state-of-the-art technology into system analysis, design, implementation, and performance.

PSO3
Demonstrate research and development skills needed to define, scope, develop, and market futuristic software systems and products.

PSO4
Demonstrate knowledge and skills at the required depth and breadth to excel in post-graduate and research programs.

Author: Venkatesh Choppella

Course Title : User Research Methods
Course Code : CS9.501
Faculty : Priyanka Srivastava
Program : M.Tech IYear ISemester- Product Design and Management*
L-T-P : 3-1-0
( L= Lecture hours, T= Tutorial hours, P=Practical hours) Credits: 2

1. Prerequisite Course/ Knowledge:
Noprerequisitesarerequired

Semester,Year : 1“Sem– Year1 (Spring,2022)

(Ex:Spring,2022)

2. Course Outcomes (COs) (5 to 8 for a 3 or 4 credit course):

_______________________________________________

_______________________________________________
After completion of this course successfully, the students will be able to...

**CO-1:** Will be able to use common experience research methods, like 3-dimensional framework using attitudinal and behavioural, qualitative and quantitative, and context of use; conduct field studies, stakeholder interviews, log analysis; affinity wallet etc.

**CO-2:** Learn to understand users’ need and pain points by creating user stories, empathy maps, personas, user journey maps.

**CO-3:** Identify and recognize the problem and gaps, generate possible solutions to user problems.

**CO-4:** Ethicsof conducting study and observations.

**CO-5:** User research data presentation and summary.

### 4. Detailed Syllabus

**Unit 1: Understanding User**

**Unit 2: Lab and Field, Quantitative and Qualitative methods Unit**

**Unit 3: Ethics in User Research**

**Unit 4: Statistics – How to present User Research Results**

<table>
<thead>
<tr>
<th>Unit 1</th>
<th>Unit 2</th>
<th>Unit 3</th>
<th>Unit 4</th>
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</thead>
<tbody>
<tr>
<td><strong>Understanding User</strong></td>
<td><strong>Observation Techniques</strong></td>
<td><strong>Ethics</strong></td>
<td><strong>Data Visualization and Presentation</strong></td>
</tr>
<tr>
<td>Introduction and Qualitative Research Overview – foundation of user experience, key terms, highlight the hall of shame, why user-centric design and control is important; attitudinal and behavioural dimension</td>
<td>Conducting studies in usability lab, Lab studies – eye-tracking, behavioural observations, control design observations</td>
<td>Code of conduct; Participants Rights, Privacy – data safety, Respect – individual rights, time and effort, Sensitive and Empathetic; Risk analysis; Informed Consent</td>
<td>Qualitative Analysis – Thematic, values, product quality etc. organize and summarisedata</td>
</tr>
<tr>
<td>User need assessments, Qualitative research method, Interview protocols followed with activities. Know your user – age, gender, cognitive/psychological perspectives, people with disability or accessibility, role of person in understanding user, empathy and journey map</td>
<td>Field study, site visits, naturalistic observations, controlled field</td>
<td></td>
<td>Quantitative Analysis – count, accuracy, response time</td>
</tr>
<tr>
<td>How to conduct interview, make observations, and extract data from interview, ethics and card</td>
<td>Industry practice – A/B and Multivariate testing</td>
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</tbody>
</table>
Reference Books:

5. Teaching-Learning Strategies in Brief (4 to 5 sentences):
- The course will offer primarily lecture and activity-based learning course.
- Students will be required to participate in activities and discuss the observations with their peers individually and will be asked to present their observations.
- Students will be encouraged to take assignments inspired from their everyday experiences and will be asked to evaluate the event/phenomenon/ process critically and scientifically using user research methods.
- These activities will be performed either as individual or as a team, where they will be asked to demonstrate the individual contribution to the team activities.

6. Assessment Methods and Weightages in Brief (4 to 5 sentences):

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<tr>
<th></th>
<th>Class/Home Activities</th>
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<td>3.</td>
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<td>4.</td>
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<td>5.</td>
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**TITLE**: Values, Ethics and AI  
**CREDITS**: 3-0-0-2 (half course)  
**TYPE-WHEN**: Spring (H2)  
**FACULTY NAME**: Rajeev Sangal and Shatrunjay Rawat  
**PRE-REQUISITE**: Basic understanding of Ethics  
**OBJECTIVE**: To understand the connection between human values and ethics, and explore their relevance and applications on IT Systems in general and AI in particular.  
**COURSE TOPICS**: 
1) Universal Values (based on Co-Existential Philosophy)
   a) Values in individual
   b) Values in relationship
   c) Values in society
2) Relating Values with ethics
   a) Relationship between values and ethics
   b) Trusteeship principle
3) Ethics of technology – Dimensions
   a) Development and empowerment of
      i) User
      ii) Family
      iii) Society
   b) Sustainability with nature
4) AI and big data
   a) Issues
   b) Privacy of Individuals
   c) Ownership of my personal data: Who? Exploitation
   d) Explainability
   e) Empowerment

The course will be primarily driven by class room discussions and assignments.

PREFERRED TEXT BOOKS: No single text book. Required study material will be shared/identified as course progresses.

REFERENCE BOOKS: Will be identified as course progresses

PROJECT: TBD

GRADING: Based on class participation, assignments, quiz/end semester evaluation, etc.

1) Class Participation: 20%
2) Assignments: 20%
3) Quiz: 25%
4) End semester evaluation: 35%

OUTCOME: Understanding of basic human values, its connect with ethics, and their application in the domain of IT Systems, AI, Big Data. Student will develop the basic ability to identify whether an IT System is aligned to basic human values and adhere to ethical norms.

REMARKS: