INTERNATIONAL INSTITUTE OF INFORMATION TECHNOLOGY
HYDERABAD

PG Core and Elective Courses Syllabus – spring 2022 semester

Note: Syllabus for the courses highlighted in the RED color will be updated soon.

S.I. No.	C. Code	C. Name	Faculty Name
1	CS1.406	Advanced Algorithms	SuryajithChillara
2	CE0.601	Advanced Mechanics of Materials and Design	Venkateswarlu Mandadi
3	CS1.501	Advanced Optimization: Theory and Applications	Pawan Kumar
4	CE1.603	Advanced Structural Analysis	P Pravin Kumar Venkat Rao
5	EC4.501	Advances in Robotics and Control	Spandan Roy
6	EC2.405	Applied Electromagnetics	Ramalinga Sharma Kalluri
7	CS9.422	Behavioral Research: Statistical Methods	Vinoo A R,Vishnu Sreekumar
8	CS9.430	Cognitive Neuroscience	Kavita Vemuri
9	CS9.432	Cognitive Science and AI	BapirajuSurampudi
10	CS1.403	Compilers	Vignesh Sivaraman
11	HS1.206	Comprehension of Indian Music	Saroja T K
12	CS9.435	Computational Social Science	Ponnurangam Kumaraguru
13	CS7.505	Computer Vision	Anoop Namboodiri
14	CS0.302	Computing Tools	Sudipta Banerjee,Avinash Sharma
15	CS4.409	Data Foundation Systems	Vikram Pudi
16	CS4.401	Data Systems	Krishna Reddy Polepalli
17	CE5.501	Design of Hydraulic Structures	Rehana Shaik
18	MA4.301	Differential Equations	Lakshmi Burra
19	EC2.408	Digital VLSI Design	Zia Abbas
20	CE8.401	Disaster Management	Sunitha Palissery
21	CS4.403	Distributed Data Systems	Kamalakar Karlapalem
22	CS3.401	Distributed Systems	Lini Teresa Thomas
23	CE1.601	Earthquake Engineering	Pradeep Kumar Ramancharla
24	EC2.502	Flexible Electronics	Aftab M. Hussain
25	CS9.437	Green Buildings	Vishal Garg
26	CS9.433	Hydro Informatics	Rehana Shaik
27	CS9.431	ICTs for Development	Nimmi Rangaswamy

28	CL5.404	Indian Grammatical Tradition	Dipti Mishra Sharma
29	CS8.402	Information Security Audit and Assurance	Shatrunjay Rawat
30	CS3.404	Internals of Application Servers	Ramesh Loganathan
31	CS1.408	Introduction to Game Theory	Sujit P Gujar
32	SC1.420	Introduction to Particle Physics	Subhadip Mitra
33	HS0.204	Introduction to Philosophy of Technology	Ashwin Jayanti
34	HS1.207	Introduction to Sanskrit	Peter M Scharf
35	EC4.402	Introduction to UAV Design	Harikumar K
36	MA4.303	Linear partial differential equations and variational calculus	Samyadeb Bhattacharya
37	HS1.203	Literature, History, and Belonging in Hyderabad	Nazia Akhtar
38	SC4.411	Machine Learning for Natural Sciences	Nita Parekh,GirishVarma,PrabhakarBhimalapuram
39	EC4.404	Mechatronics System Design	Nagamanikandan Govindan
40	HS0.205	Minds, Machines and Intelligence	Don Wallace Freeman Dcruz
41	SC2.316	Molecular Modeling and Simulations	Deva Priyakumar U
42	MA4.405	Multivariate Analysis	Venkateswarlu Mandadi
43	CS9.434	Music, Mind and Technology	Vinoo A R
44	SC3.410	NGS Data Analysis	Nita Parekh
45	SC1.315	Nonlinear Dynamics	Abhishek Deshpande
46	CS9.436	Optical Remote Sensing	Ramachandra Prasad Pillutla
47	CS1.404	Optimization Methods	Naresh Manwani
48	SC2.301	Physics of Soft Condensed Matter	Krishnan Marimuthu
49	SC1.415	Physics of the early Universe	Diganta Das
50	CS8.401	Principles of Information Security	Srinathan Kannan
51	EC2.409	Principles of Semiconductor Devices	Anshu Sarje
52	CS1.409	Quantum Algorithms	Shantanav Chakraborty
53	HS1.202	Readings in Indian Literatures	Sushmita Banerji
54	EC4.403	Robotics: Planning and Navigation	K Madhava Krishna
55	CS6.401	Software Engineering	Raghu Babu Reddy Y
56	CS4.410	Spatial Data Sciences	Rajan Krishnan Sundara
57	CE1.602	Stability of Structures	Sunitha Palissery
58	CS7.403	Statistical Methods in AI	Vineet Gandhi
59	CS8.403	System and Network Security	Ankit Gangwal
60	HS3.302	The State in Colonial India	Aniket Alam
61	EC5.402	Time Frequency Analysis	Jayanthi Sivaswamy,ChiranjeeviYarra

62	EC5.501	Topics in Coding Theory	Prasad Krishnan
63	CS7.602	Topics in Deep Learning	Charu Sharma,Makarand Tapaswi
64	EC5.401	Topics in Signal Processing	Santosh Nannuru
65	CS6.502	Topics in Software Foundations	Venkatesh Choppella

Note: Syllabus for the courses highlighted in the RED color will be updated soon.

Course Code: CS1.406

Title of the Course: **Advanced Algorithms**

Faculty Name: Suryajith Ch

L-T-P……3-1-0 **Credits**…4

Prerequisite Course / Knowledge:

Should have taken Introduction to Algorithms, and Formal Languages, orequivalent 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)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	2	2	2	1	1	1	2	1	1	1	2	3	1	1	3
CO2	2	3	2	2	1	1	1	2	2	2	1	3	3	1	1	3
CO3	2	2	2	2	1	1	1	2	1	1	1	2	3	1	1	3

CO4	1	3	2	2	1	1	1	2	2	2	1	3	3	1	1	3
CO5	2	2	2	2	1	1	1	2	2	2	1	3	3	1	1	3
CO6	2	2	2	2	1	2	1	2	1	1	1	2	3	1	1	3

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,andsymmetry breaking

Reference Books:

1. R. Motwani and P. Raghavan (1995), Randomized Algorithms, Cambridge University Press.USA.
2. J. JaJa (1992), Introduction to Parallel Algorithms, Addison-Wesley, USA.
3. G. Tel (2000).Distributed Algorithms,2nd Edition, Cambridge University Press. 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%
- Quiz1: 15%
- Quiz 2: 15%
- End Exam: 30%

Course

Code: **CS1.501**

Title of the Course: Advanced Optimization: Theory and Applications

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	1	1	1	-	-	2	2	1	3	3	3	1	3
CO2	3	3	3	3	3	1	-	-	2	2	1	3	3	3	2	3
CO3	1	3	1	3	1	-	-	-	2	2	1	3	3	3	2	3
CO4	1	2	3	2	3	-	-	-	2	2	3	3	3	3	2	3
CO	3	3	3	3	3	-	-	-	2	2	3	3	3	3	2	3

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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: 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 :

- Stephen Boyd and Lieven Vandenberghe, Convex Optimization, Cambridge University Press, 2004.
- Ian Goodfellow, Yoshua Bengio and Aaron Courville, Deep Learning, MIT Press, 2016.
- Prateek Jain and Purushottam Kar, Non-convex Optimization for Machine Learning, 2017, arXiv.
https://arxiv.org/pdf/1712.07897.pdf
- W. Hu, Nonlinear Optimization in Machine Learning,
https://web.mst.edu/~huwen/lectures_Nonlinear_Optimization_in_Machine_Learning.pdf

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 one mini-project.

6. Assessment methods and weightages in brief :

Assignments in theory: 15 marks, Mid Semester Examination: 25 marks , End Semester Examination: 30 marks, Assessment of four projects: 30 marks

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Course Code: EC4.501

Title of the Course: Advances in Robotics and Control

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: Designinversedynamicsbasedrobustcontrollertoaddressuncertaintyinrobot dynamics

CO-6: Designadaptive-robustcontrollerforroboticsystemstoaddressunmodelled dynamics

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

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3	PSO 4
CO1	2	3	2	2	1	1	1	2	1	1	1	3	1	1	1	3
CO 2	2	3	2	2	1	1	1	2	2	2	1	3	1	1	1	3
CO 3	2	3	2	3	1	1	1	2	1	1	1	3	1	1	1	3
CO 4	2	3	2	2	1	1	1	2	2	2	1	3	1	1	1	3
CO 5	3	3	1	3	1	1	1	2	2	2	1	3	1	1	1	3
CO 6	3	3	1	3	1	1	1	2	2	1	1	3	1	1	1	3

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

1) Mark W. Spong, Seth Hutchinson, and M. Vidyasagar, Robot Modeling and Control, John Wiley &Sons.

2) Nonlinear Systems by Hassan Khalil, PrenticeHall.

3) Applied Nonlinear Control by Slotine and Lee, PrenticeHall.

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

Thecourselectureswillincludeactivitiesthatpromotetheunderstandingofthe lecturecontentbyusingsmallexamplesthatstudentsworkoutduringtheclass 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 scientificpublications.

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

- Assignments:20%
- Project:20%
- Quiz1:15%
- Quiz 2:15%

– End Exam:30%

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Course Code: CS9.422

Title of the Course: Behavioral Research: Statistical Methods

Faculty Name: Vishnu Sreekumar + Vinoo Alluri

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: 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 ProgramSpecific Outcomes (PSOs) – Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	3	1	1	1	2	1	1	1	1	-	-	-	-	-	-
CO2	2	2	2	3	3	2	1	1	3	1	-	-	-	-	-	-
CO3	2	3	2	3	3	3	1	1	3	1	-	-	-	-	-	-
CO4	2	3	2	3	3	3	1	1	3	1	-	-	-	-	-	-
CO5	1	1	1	1	1	3	1	1	2	1	-	-	-	-	-	-

CO6	2	2	3	3	3	1	1	1	2	2	-	2	1	1	2	3

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 inbrief:

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%

Course Code:

CS9.430

Title of the Course: Cognitive Neuroscience

Faculty Instructor: Kavita Vemuri

L-T-P: 3-0 -1. Credits: 4

1. Prerequisite Course / Knowledge:

1. Intro to psychology
2. Cognitive Science

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

	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO11	PO1 2	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	3	0	2	0	0	0	3	0	0	0	3	0	0	0	4

CO 2	3	3	3	3	3	3	1	3	3	3	0	3	2	1	2	4
CO 3	3	3	2	4	2	1	2	1	0	1	1	3	3	3	1	4
CO 4	3	3	3	3	1	3	1	3	1	1	1	2	2	2	1	4
CO 5	3	3	3	3	3	1	1	1	3	2	3	3	2	2	2	4
CO 6	2	2	3	3	2	1	1	1	3	1	1	1	2	1	1	4
CO 7	1	1	1	1	2	1	4	4	2	1	1	1	2	1	1	4

4. 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. Decision making
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 reenforced. 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):

Type of Evaluation	Weightage (in %)
Mid Sem-1 Exam	**15**
Mid Sem-2 Exam	**15**
End Sem Exam	**20**
Quiz (2)/viva	**20**
Project/term paper	**30**
Other Evaluation _____	

Course Code:

CS9.432

Title of the Course: COGNITIVE SCIENCE AND AI

Faculty Name: . BAPI RAJU S.

L - T - P: 3-1-0 **Credits 4**

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

Semester, Year : Spring 2022

(Ex: 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)

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

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 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 RL-framework for understanding various aspects of skill acquisition such as compositionality, abstraction, curiosity, mental simulation, etc.

Module 5: Predictive (Bayesian) Brain. Predictive coding and the related ideas of Bayesian Brain and Free Energy Principle -- theoretical frameworks of brain function. Generate-compare-update process of a mental model of the environment. Debates about the Predictive Brain and Free Energy Principle.

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 project.

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)

Pearl, J. & Mackenzie, D. (2018). The Book of Why: The New Science of Cause and Effect. Basic Books. (General Reading)

V. Srinivasa Chakravarthy (2019). Demystifying the Brain: A Computational Approach (1st Edition), Springer, Singapore. (General Reading)

Shimon Edelman (2008). Computing the Mind: How the Mind Really Works. New York: Oxford University Press, 2008

Kenji Doya, Shin Ishii, Alexandre Pouget, Rajesh PN Rao (2007). Bayesian brain: Probabilistic approaches to neural coding. MIT press

Rumelhart, D.E., J.L. McClelland and the PDP Research Group (1986). Parallel Distributed Processing: Explorations in the Microstructure of Cognition. Volume 1: Foundations, & Volume 2: Psychological and Biological Models, Cambridge, Massachusetts: MIT Press (Still a classic, highlights various issues in Cognitive Science & Computational Models)

C. M. Bishop (2006). Pattern Recognition and Machine Learning. Springer.

I. Goodfellow, Y. Benjio, A. Courville (2016). Deep Learning. MIT Press

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 Intelligence. https://arxiv.org/abs/2002.06177.

Manfred Eppe, Christian Gumbsch, Matthias Kerzel, Phuong Nguyen, Martin V. Butz, and Stefan Wermter (2020). Hierarchical principles of embodied reinforcement learning: A review. arXiv:2012.10147v1

Matt Botvinick (Jul 3, 2020): Neuroscience, Psychology, and AI at DeepMind | Lex Fridman Podcast #106 https://www.youtube.com/watch?v=3t06ajvBtl0&ab_channel=LexFridman

Yoshua Bengio and Gary Marcus on the best way forward for AI (Moderated by Vincent Boucher, Dec 2019).
https://www.youtube.com/watch?v=EeqwFjqFvJA&ab_channel=Montreal.AI

Merel, J., Botvinick, M. & Wayne, G. Hierarchical motor control in mammals and machines. Nat Commun 10, 5489 (2019). https://doi.org/10.1038/s41467-019-13239-6

Blake A. Richards, Timothy P. Lillicrap, Philippe Beaudoin, Yoshua Bengio, et al. (2019). A deep learning framework for neuroscience. Nature Neuroscience, 22: 1761–1770. https://doi.org/10.1038/s41593-019-0520-2

Doya K, Taniguchi T (2019). Toward evolutionary and developmental intelligence. Current Opinion in Behavioral Sciences, 29, 91-96. http://doi.org/10.1016/j.cobeha.2019.04.006.

Schrimpf M, Kubilius J, Hong H, et al. (2018). Brain-Score: Which Artificial Neural 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 linguistic meaning from brain activation. Nat Commun 9, 963 (2018). https://doi.org/10.1038/s41467-018-03068-4

Pearl, J. (2018). Theoretical impediments to machine learning with seven sparks from the causal revolution. arXiv:1801.04016.

Lake, B., Ullman, T., Tenenbaum, J., & Gershman, S. (2017). Building machines that learn and think like people. Behavioral and Brain Sciences, 40, E253. doi:10.1017/S0140525X16001837

Kumaran, Dharshan, Demis Hassabis, and James L. McClelland (2016). "What learning systems do intelligent agents need? Complementary learning systems theory updated." Trends in cognitive sciences 20.7 (2016): 512-534.

Friston, K. J. The free-energy principle: a unified brain theory? Nature Neuroscience, 11:127– 138, 2010.

E-book Links :

Grading Plan :

(The table is only indicative)

Type of Evaluation	Weightage (in %)
Quiz-1	10%
Mid Sem Exam	15%
Quiz-2	10%
End Sem Exam	--
Assignments / Term Paper / In-class Presentation / Peer Review	25%
Project	40%
Term Paper	-- See Above --
Other Evaluation	

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 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	2	1	1	1	1	1	1	1	1	1	1	2	2	1	2	1
CO 2	3	3	1	2	1	1	1	1	1	1	1	2	2	2	3	2
CO 3	2	2	2	3	2	1	1	1	1	1	1	2	2	2	3	2
CO 4	2	3	2	3	3	1	1	1	3	3	1	2	3	2	2	3
CO 5	2	2	3	2	1	1	2	2	2	1	1	3	3	1	3	3

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

Lectures will initially introduce the motivations and concepts, illustrated with simpler 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 the students 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.

Course Code: **CS1.403**

Title of the Course: Compilers

Faculty Name: Vignesh Sivaraman

L-T-P: **3-1-0.** Credits: **4**

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

1. Prerequisite Course / Knowledge:

Computer Programming. Data structures and algorithms. Computer Systems Organization. Operating Systems. Automata Theory.

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 Leve: **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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	3	-	2	-	-	-	-	2	3	3	3	3
CO2	3	3	3	3	3	-	-	-	-	-	-	2	3	3	3	3
CO3	3	3	3	3	3	-	-	-	-	-	-	2	3	3	3	3
CO4	2	3	3	3	3	-	-	-	3	3	-	2	3	3	3	3
CO5	2	2	3	3	3	-	-	3	3	3	3	2	3	3	3	3

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:

1. Keith Cooper and Linda Torczon. 2011. Engineering a Compiler, Second Edition. Morgan Kaufmann Publishers Inc., San Francisco, CA, USA.

Alfred V. Aho, Monica S. Lam, Ravi Sethi, and Jeffrey D. Ullman. 2006. Compilers: Principles, Techniques, and Tools (2nd Edition). Pearson.

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 Code:
HS1.206

Course Title: Comprehension of Indian Music

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 varietycontributes 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, MythuswamyDixitar and SyamaSastry.
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 makesthe art an integral part of the society.
- Ability to recognize different musical forms with a systematic approach.
- Understandingthe 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 SangitaSastra* by A.S. PanchapakesaAyyar
5. *Appreciating Carnatic Music* by ChitraveenaN.Ravikiran
6. *Nuances of Hindustani Classical Music* by HemaHirlekar
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 SuvarnaNalapat
11. *SangithaRatnakara of Sarngadeva*byShringy RK and Premlata Sharma
12. *Matanga and his work Brhaddesi*-edited by PremLatasharma
13. Videos and audios of music which practically demonstrate all the concepts of the course.

Grading :

Quizzes – 20%

Assignments-30%

Individual Project and viva- 40%

Class participation -10%

Course Code: **CS4.401**

Title of the Course: **Data Systems**

Faculty Name: Krishna Reddy P

L-T-P: **3-1-1.** Credits: **4**

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

1.Prerequisite Course / Knowledge:

Basic principles of Operating systems, Structured Query Language, Relational Data Model, Data structures, Programming language, Algorithms,

2.Course Outcomes (COs)

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

CO-1. Develop the tree-based and hash-based indexing algorithms to improve efficiency of the retrieval

CO-2. Tune the optimizer moduleof DBMS to meet the performance demands of diverse 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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	3	-	1	-	3	1	3	2	3	3	2	3
CO2	3	3	3	1	3	-	1	-	2	2	2	3	3	2	1	1

CO 3	3	2	2	1	2	2	1	-	2	2	2	1	3	3	3	2
CO 4	3	2	2	1	2	2	1	-	2	2	2	1	3	3	3	2
CO 5	3	2	2	1	2	2	1	-	2	2	2	1	3	3	3	2
CO 6	3	3	3	3	2	2	1	-	2	2	3	2	3	3	3	3

'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 :

- Hector Garcia-Molina, Jeffrey D. Ullman and Jennifer Widom , Database System Implementation, Pearson Education, 2003
- Elmasri & Navathe, Fundamentals of Database Systems, 6th Edition, Pearson Education, 2013
- Raghu Ramakrishnan and Johannes Gehrke ,Database Management Systems, Third edition, Mc Graw Hill, 2017
- Abraham Silberschatz, Henry F.Korth, S.Sudarshan, Database system concepts, fifth edition, Mc Graw Hill, 2006
- Research papers

5.Teaching-Learning Strategies in brief:

Lectures by integrating ICT into classroom teaching, weekly tutorials involving problem solving and active learning by studentsand 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

Course Code: MA4.301

Title of the Course: Differential equations

Faculty Name: Lakshmi Burra

L-T-P: **3-1-0** Credits: **4**

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

1.Prerequisite Course / Knowledge:

Knowledge of Calculus

2.Course Outcomes (COs)

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

CO-1Competence 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-3Competence 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 Frobeniusmethod

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

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PS O1	PSO 2	PSO 3	PSO 4

CO 1	2	2	2	2	3	-	1	-	3	1	3	2	3	3	2	3
CO 2	2	2	2	1	3	-	1	-	2	2	2	3	3	2	1	1
CO 3	1	1	1	1	1	1	1	-	2	2	2	1	1	1	1	1
CO 4	3	2	2	1	2	2	1	-	2	2	2	1	3	3	3	2
CO 5	3	2	2	1	2	2	1	-	2	2	2	1	3	3	3	2
CO 6	1	1	1	1	1	2	1	-	1	1	1	1	1	1	1	1

'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 andPopulation Dynamics, Exact Differential Equations and IntegratingFactors,Numerical Approximations: Euler's Method (7.5 hours);

Unit 3: Homogeneous Differential Equations withConstant Coefficients Solutions of Linear Homogeneous Equations; theWronskian, 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 5Systems of Linear Algebraic Equations; LinearIndependence, Eigenvalues, Eigenvectors ,Basic Theory of Systems of First-Order LinearEquations,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
- Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley
- 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 :

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 project: 30 marks

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CourseCode:

EC2.408

Title of the Course: Digital VLSIDesign

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,stateoftheartdesignissuesindigitalcircuits,understandtheCMOSdigitalICdesign 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)

	PO1	PO2	PO3	PO 4	PO5	PO 6	PO7	PO 8	PO9	PO10	PO11	PO12	PSO1	PSO 2	PSO 3	PSO 4
CO1	3	2	1	1	1	1	2	2	2	1	1	2	3	2	2	2
CO2	3	3	2	2	2	1	1	2	1	1	1	1	3	1	1	1
CO3	3	3	2	2	2	1	1	2	2	2	1	2	3	1	1	1
CO4	3	2	3	3	3	1	1	2	2	2	1	3	3	1	1	1
CO5	2	3	3	3	3	1	1	2	3	3	3	3	3	1	2	1
CO6	2	3	3	3	3	1	1	2	3	3	3	3	3	2	1	1

Each Course Outcome (CO) may be mapped with one or more Program Outcomes (POs). Write'3'intheboxfor'High-level'mapping,2for'Medium-level'mapping,1for'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),BodyEffect,Channel-LengthModulation,MOSTransistorsasaSwitch, 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 DissipationduetoChargeSharing,Statici.e.LeakagePowerDissipation(leakagemechanism): p–n Junction Reverse-Biased Current, Band-to-Band Tunnelling Current, Tunnelling 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 voltageimpact.

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.

FinFETtechnologywillalsobediscussedinparallel.Suchdelay/leakageestimationtechniques will also be applied to FinFETcircuits.

Reference Books:

1. Jan M. Rabaey, A. Chandrakasan, B. Nikolic "Digital Integrated Circuits - A Design Perspective, PHI.
2. Douglas A. Pucknell, K. Eshraghian,"Basic VLSI Design", 3rd Edition, Prentice Hall of India.
3. Neil H. E. Weste, K. Eshraghian, "Principles of CMOS VLSI Design", ASystems Perspective, 2nd Edition, Pearson Education Pvt. Ltd.

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

Thecoursewillstartwiththebackgroundthatdriveustothedevelopmentofstate-of-the-art digitalVLSIdesigns,thenfundamentalandcoretopicsofthecoursewillbediscussedindetail broadlyatlogicandtransistorlevelwithhands-onwithrelatedCADtools.Circuitsimulations, layout,RTLcoding,synthesis,etc.willbehighlyencouragedthroughoutthecourse.Thebroad 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 inteams.

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%

Course Code:
CE8.401

Title of the Course: **Disaster Management**

Faculty Name: Sunitha Palissery

L-T-P: **3-1-1.** Credits: **4**

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

1. Prerequisite Course /Knowledge:

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

2. 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

CO-6. Reorganise inter-personal skills required to manage inter-disciplinary, inter-departmental collaborations in disaster management

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO 2	PSO 3	PSO 4
CO1	1	1	1	2	1	3	3	3	2	2	3	3	1	1	1	1
CO2	3	3	3	2	3	1	1	1	2	2	2	1	2	2	2	3
CO3	3	3	3	3	2	1	1	1	1	1	1	1	3	3	2	3
CO4	1	1	1	1	1	2	2	3	3	3	3	3	1	1	1	2
CO5	1	1	2	2	2	3	3	3	1	1	2	2	1	1	2	1
CO6	1	1	2	2	2	2	2	2	3	3	3	3	1	2	3	1

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

4. DetailedSyllabus:

Unit 1: Disaster Management Cycle- Mitigation, Preparedness, Response, Rehabilitation, Reconstruction, Recovery, Resilience, Capacity Building (9 hours);

nit 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 (7hours);

Unit 5: Disaster Risk Analysis-Mapping, Modelling, Risk Analysis, Introduction to Risk Modelling & Analysis using softwares, hands-on training (QGIS) (7 hours)

References :

1. Alexander, D., (1999), *Natural Disasters*, Kluwer Academic,London
2. Bhandani, R.K., *An Overview on Natural & Man-made Disasters and their Reduction*, CSIR, NewDelhi
3. Bryant,E., (1995), *Natural Hazards*, Cambridge University Press, NewYork
4. Coppola, D.P., (2007), I*ntroduction to International Disaster Management*, Elsevier Science (B/H),London
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 Publishers, Distributors, Jaipur,India
8. National Disaster Management Authority (NDMA), *Guidelines*, NDMA, India (https://ndma.gov.in/en/ndma-guidelines.html)
9. Robinson, A., (1996), *Earth Shock*: *Hurricanes, Volcanoes, Earthquakes, Tornadoes and other Forces of Nature*, Thames and Hudson, NewYork
10. Sinha, P.C., (2006), *Disaster Vulnerabilities and Risks: Trends, Concepts, Classification & Approaches*, SBS Publishers & Distributors, New Delhi,India

5. Teaching-Learning Strategies inbrief:

Lectures by integrating ICT into classroom teaching, tutorials involving simulation modelling, analysing GIS data for predicting disasters, critical and active learning, and project-based learningbydoingterm-projectswhichinvolveshands-onuseofcomputerprogrammingskills and software/hardware tools applications.

6. Assessment methods and weightages inbrief:

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

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Course Code: CS3.401

Title of the Course: Distributed Systems

Faculty Name: Lini Thomas

L-T-P 3-1-0 **Credits 4**

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

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

	PO 1		PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO 11	P O 12	PS O1	PS O2	PS O3	PS O4
CO 1	1		1	1	1	1	1	1	1	1	2	1	2	3	3	3	3
CO 2	1		2	2	2	3	2	1	1	2	1	2	2	3	3	3	3
CO 3	1		1	2	2	1	2	1	1	1	2	1	2	3	3	3	3
CO 4	1		2	2	2	1	2	1	1	2	2	1	2	3	3	3	3
CO 5	2		2	2	2	1	1	1	1	2	1	2	2	3	3	3	3
CO	2	2	2	2	2	1	2	1	1	2	2	2	2	3	3	3	3

6																	

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:

1. A.D. Kshemkalyani, M. Singhal, (2011) Distributed Computing: Principles, Algorithms, and Systems, ISBN: 9780521189842, paperback edition, Cambridge University Press, USA.

2. N. Lynch, 1996. Distributed Algorithms, Morgan Kauffman, USA, Chapter 5.

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%

Course Code: CE1.601

Title of the Course: Earthquake Engineering

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 forstructural 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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO	PSO	PSO	PSO
CO1	3	3	1	1	2	3	3	-	-	-	-	-	3	3	2	3
CO2	2	1	2	2	2	1	1	-	-	-	-	-	2	2	3	3
CO3	1	2	3	2	2	3	2	-	-	-	-	-	2	3	3	3

CO 4	3	3	2	3	3	3	2	-	-	-	-	-	3	2	2	3
CO 5	2	2	2	3	3	3	3	-	-	-	-	-	3	3	2	2
…..																
…..																

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:

1. Seismic Design of Reinforced Concrete and Masonry Buildings by T. Paulay and M.J.N. Priestley.
2. Earthquakes by Bruce A. Bolt.
3. Earthquake Engineering, Application to Design by Charles K. Erdey.
4. Earthquake Engineering: From Seismology to Performance Based Design by Yousef Bozorgnia and VitelmoBertero.

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.

Course Code:

EC2.502

Title of the Course: Flexible Electronics

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):

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

to.. 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 Progr:am Specific Outcomes (PSOs) – Course ArticulationMatrix

	PO 1	PO2	PO3	PO4	PO5	PO 6	PO7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO 2	PSO 3	PSO 4
CO 1	3	2	1	1	1	1	1	1	1	1	1	2	2	1	1	2
CO 2	3	2	1	1	1	1	1	1	1	1	1	2	3	1	1	1
CO 3	2	3	3	1	1	2	2	1	1	1	1	1	2	1	2	2
CO 4	1	3	3	2	1	1	1	1	1	2	1	1	2	1	2	1
CO 5	1	1	3	2	1	2	2	2	1	2	2	1	1	2	2	1
CO 6	1	3	1	3	2	1	2	2	3	3	2	2	1	1	1	1

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. DetailedSyllabus:

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:

1. Sami Franssila, *Introduction to Microfabrication*, Wiley VCH,2010
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 5sentences):

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 5sentences):

Continuous evaluations:
Assignments – 20%
MCQ Quizzes –20%

Comprehensive exams: End semester exam – 35% Term-paper report – 25

Course Code: CS9.431

Title of the Course - ICTs for Development

Faculty Name: Nimmi Rangaswamy

L-T-P: 4-0-0]. Credits: 4

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

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 dop 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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4

CO1	3	3	3										
CO2	3	3	3										
CO3	2	2	2							1	1		
CO4										2	2		
CO5										3	3		

'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 disuses 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:

1. J. Timmons Roberts and Amy Bellone Hite, Eds. The Globalization and Development Reader: Perspectives on Development and Global Change, Blackwell: London, 200

***REFERENCE BOOKS:**

1. Amartya Sen, Development as Freedom, Anchor Books: New York, 1999

2. C K Prahalad, The Fortune at the Bottom of the Pyramid: Eradicating Poverty Through Profits, Revised and Updated 5th Anniversary Edition, Prentice Hall, New Jersey

3. Jeffrey Sachs, The End of Poverty: Economic Possibilities for Our Time, Penguin Books: New York, 2006

4. Friedman, Thomas L. 2006. The World Is Flat: A Brief History of the Twenty-first Century, Farrar, Straus and Giroux

5. Easterly, W. 2002. "The Elusive Quest for Growth: Economists' Adventures and Misadventures in the Tropics. MIT Press

6. Turkle, S. (1984) The second self. New York: Simon & Schuster.

7. Mizuko Ito, Daisuke Okabe, and Misa Matsuda, eds., 2005, Personal, Portable, Pedestrian: Mobile Phones in Japanese Life(Cambridge, MA: MIT Pres

8. Turkle, S. (1995). Life on the screen: Identity in the age of the Internet. New York: Simon & Schuster.

9. Castells, Manuel (2001): Internet Galaxy. Oxford University Press

10. Lessig, Lawrence. 2009. "RE, Revived" i Remix: Making Art and Commerce Thrive in the Hybrid Economy. The Penguin Press, New York

11. Lister et. al. (2008): New Media A Critical Introduction. London and New York, Routledge.

GRADING PLAN:

Type of Evaluation Weightage (in %)

Mid Sem Quiz 10%

End Sem Quiz 10%

Project Oral Presentation 20%

Project Report 1 15%

Project Oral Presentation 20%

Project Report 2 15%

Class Participation & Attendance 10%

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 Code: CS3.404

Title of the Course : Internals of Application Servers

FACULTY NAME **:** Ramesh Loganathan

3-1-0-4

TYPE-WHEN : Spring 2022

PRE-REQUISITE: None

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 middlewares 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:

Course Code: CS1.408

Title of the Course: Introduction to Game Theory

Faculty Name: Sujit Gujar

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-1understand how to define a game and strategies in a game

CO-2demonstrate familiarity with different solution concepts in game theory
CO-3write algorithms to solve many game theoretic problems

CO-4understand the concept of mechanism design (incentive engineering)

CO-5 analyze given autonomous system for any strategic behavior of the agents

CO-6design mechanism for autonomous agent systems to make them game theoretically sound

CO-7 design agents to patriciate in auction-based competition

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

	PO 1		PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO 11	PO1 2	PS O1	PSO 2	PSO 3	PSO 4
CO 1	1		1	3	1	1	1	1	1	1	1	1	3	3	1	1	3
CO 2	1		1	3	1	1	1	1	1	1	1	1	3	3	1	1	3
CO 3	1		3	3	1	3	1	1	1	1	2	1	3	3	1	1	3
CO 4	1		2	3	1	2	2	1	1	1	1	1	3	3	1	1	3
CO	2		3	3	3	2	2	1	1	1	1	1	3	3	2	2	3

5																	
CO 6	3		3	3	2	2	2	1	1	1	1	1	3	3	3	2	3
CO 7	3		2	3	2	3	3	1	1	3	3	1	3	3	3	2	3

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:

(a) What is game? Extensive form games vs strategic form games, two player zero sum games, mini-max theorem, dominant strategy equilibrium, Nash equilibrium and its existence. Co-operative game theory, core, imputations, Shapley value, Nash bargaining solution.
(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 give 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 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):

Type of Evaluation	Weightage (in %)

Mid Sem Exam	-
End Sem Exam	25
Quizzes/Reading Assignment	15
Programming/Reading Assignments	15
Scribes	5
Course Participation	5
Project (Competition)	10

Course Code: SC1.42

Title of the Course: Introduction to Particle Physics

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.
CO-2 **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.
CO-3 **Discover** the representation of elementary processes with Feynman diagrams.
CO-4 **Recognize** the relativistic generalization of Quantum Mechanics through the Klein-Gordon and Dirac equations and **outline** the basic workings of Quantum Electrodynamics.
CO-5 **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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1											2		1		3
CO2	2	2										2		2		3
CO3	3	2										2		2		3
CO4	3	3	1											1	1	3

CO5	3	3	2										1	2	3

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:

1. D J Griffiths, Introduction to Elementary Particles, John Wiley & Sons.
2. F Halzen and A D Martin, Quarks and Leptons, John Wiley & Sons.
3. D H Perkins, Introduction to High Energy Physics, Cambridge U.
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%)

Course Code: EC4.402

Title of the Course: Introduction to UAV Design

Faculty Name: Harikumar K

L-T-P: 3-1-0 **Credits:** 4

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

1.Prerequisite Course /Knowledge:
BasicsofLinearAlgebra,LaplacetransformandVectorcalculus.

2.CourseOutcomes(COs)(5to8fora3or4creditcourse):

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

CO-1 Determinethedesignspecificationsoftheunmannedaerialvehicle(UAV)usedforaparticular 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.

CO-6 Performtheflightsimulationandflighttestingoftheprototypeuavandverifyitsstabilityand performancecharacteristics**.**

3.MappingofCourseOutcomes(COs)withProgramOutcomes(POs)andProgramSpecificOutcomes (PSOs) – Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	3
CO2	2	2	3	1	1	1	1	1	1	1	1	1	1	1	1	3
CO3	3	3	3	1	1	1	1	1	1	1	1	1	1	1	1	3
CO4	3	3	2	1	1	1	1	1	1	1	1	1	1	1	1	3
CO5	2	2	3	1	2	1	1	1	3	1	1	1	1	1	1	3
CO6	2	2	2	1	1	1	1	1	3	1	1	1	1	1	1	3

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.DetailedSyllabus:

Unit 1: Types of UAVs--- Multi-rotors, fixed wing (FWUAV), Hybrid VTOLs

Unit2: Multi-rotordesign---
Conceptofoperation(CONOPS),designspecifications,differentreferenceframes, axisconventions,forcesandmoments,sizingandassembly,sensorsandcontrol.

Unit3:FWUAVFlightmechanicsandcontrol---wing,fuselage,stabilizerandcontrolsurfaces,propulsion system,forces(lift,drag,thrust,sideforce),moments(roll,pitch,yaw),trimconditions,longitudinalstatic stability,lateralanddirectionalstability,PIDcontrolthroughsuccessiveloopclosure.

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.

Unit5: Differentconfigurations(tilt-rotor,tailsitter),transitiondynamics,designspecifications,sizing, stability andcontrol.

Reference Books:

1. DanielPRaymer,AircraftDesign:AConceptualApproach,secondedition,AIAAUSA,1992.
2. JohnD.Anderson,Introductiontoflight,thirdedition,McGraw HillUSA,1989.
3. R.W.BeardandT.M.McClain,SmallUnmannedAircraft:TheoryandPractice,firstedition,Princeton University Press USA,2012

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

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 performanceanalysis.Detailedstudentassignmentforpracticingthedifferentelementsofconceptualdes ign phase. Open book exam followed by detailed project submission including simulation studies, prototype development and flighttesting.

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

Type of Evaluation	Weightage (in %)
Quizzes	**10**
Assignments	**40**
Project	**50**

Course Code: HS1.203

Title of the Course: Literature, History, and Belonging in Hyderabad

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 andunderstand the role of literature in studying and knowing history;
2. explain the complexities of Hyderabad's history and society and larger questions of identityand belonging;
3. apply important techniquesof 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.

1. Translations by ShaguftaShaheen and Sajjad Shahid of poems by Dakhni poets. In Kousar J. Azam (Ed.), *Languages and literary cultures in Hyderabad* (2017)
2. Makhdoom Mohiuddin – *The Red Dawn* (1944; poems)
3. Ian Bedford – *The Last Candles of the Night* (2014; novel)
4. Letters by Sarojini Naidu. In Makarand Paranjape(Ed.), *Sarojini Naidu: Selected Letters, 1890s-1940s* (1996)
5. Huma R. Kidwai – *The HussainiAlam House* (2012; 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)
8. Sarojini Naidu – *The Bird of Time* (1912; poems); Hoshang Merchant, "Secunderabad Sans Light."
9. Jai Undurti and Harsho Mohan Chattoraj – *Hyderabad Graphic Novel* (2014; graphic novel)

Reference Books :

1. Benichou, Lucien. *From Autocracy to Integration: Political Developments in Hyderabad State (1938–1948).* Orient Longman, 2000.
2. Bhukya, Bhangya. *A History of Modern Telangana.* Orient Blackswan, 2017.

3. Datla, Kavita Saraswathi. *The Language of Secular Islam: Urdu Nationalism and Colonial India*. Orient Blackswan, 2013.
4. Eaton, Richard M. *India in the Persianate Age: 1000-1765*. Allen Lane, 2019.
5. Kugle, Scott. *When Sun Meets Moon: Gender, Eros, and Ecstasy in Urdu Poetry*. Orient Blackswan, 2016.
6. Leonard, Karen.*Locating Home: India's Hyderabadis Abroad*. Oxford University Press, 2007.
7. Leonard, Karen. *Hyderabad and Hyderabadis*. Manohar, 2014.
8. Pernau, Margrit. *The Passing of Patrimonialism: Politics and Political Culture in Hyderabad, 1911–1948*. Manohar, 2000.
9. Pillai, Manu C. *Rebel Sultans: The Deccan from Khilji to Shivaji*. Juggernaut, 2018.
10. Stree Shakti Sanghatana. *We Were Making History: Life Stories of Women in the Telangana People's Struggle*. Kali for Women, 1989.

E-book Links :

Grading Plan :

Type of Evaluation	Weightage (in %)
Short Assignments (500-600 words; 5 best out of 6 will count)	5 x 6% = 30%
Assignment (1000-1200 words)	20%
Participation	10%
Project	(50%)

Mapping of Course Outcomes to Program Objectives:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 12	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1						3		2									3
CO2						2				3							3
CO3						3		3		3							3

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.

Course Code: SC4.411

Title of the course: Machine Learning for Natural Sciences

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)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	3	1	3	1	1	1	1	2	2	1	3	1	1	1	2
CO2	1	2	2	2	1	1	1	1	2	2	1	1	3	1	1	2
CO3	2	3	1	3	1	1	1	1	2	2	1	3	2	1	1	2
CO4	1	3	2	2	1	1	1	1	2	2	1	1	3	1	2	2
CO5	1	3	2	3	1	1	1	1	2	2	1	1	3	1	1	3
CO6	1	2	1	2	2	1	1	1	2	2	1	2	3	2	2	2
CO7																

'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%

Course Code: HS0.205

TITLE OF THE COURSE : Minds, Machines, and Intelligence

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 intelligentsystems.

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.

Anderson, M. & Anderson, S. (eds). 2011. *Machine Ethics*. Cambridge University Press. Brockman, J. (ed). 2019. *Possible Minds: 25 Ways of Looking at AI.* Penguin Press.

Buckner, C. 2018. Empiricism without Magic: Transformational Abstraction in Deep Convolutional Neural Networks. *Synthese*, 195, 5339–5372.

Buckner, C. 2019. Deep Learning: A Philosophical Introduction. *Philosophy Compass*. e12625.

Cain, M. J. 2016. *The Philosophy of Cognitive Science*. Polity Press.

Curd, M. &Psillos, S. 2014. *The Routledge Companion to Philosophy of Science*, 2nd *Edition*. Routledge.

Henderson, D. and Horgan, T. 2011. *The Epistemological Spectrum: At the Interface of Cognitive Science and Conceptual Analysis.* Oxford University Press.

Hetherington, S. 2019. *What is Epistemology?* Polity Press.

Humphreys, P. 2021. Epistemic Opacity and Epistemic Inaccessibility. In Resch, M. et al (eds) *The Science and Art of Simulation II: Epistemic Opacity in Computer Simulation & Machine Learning*. Springer.

Marcus, G. (2020). The Next Decade in AI: Four Steps Towards Robust Artificial Intelligence. https://arxiv.org/abs/2002.06177.

Milkowski, M. 2013. *Explaining the Computational Mind*. MIT Press.

Pearl, J. & Mackenzie, D. 2018. *The Book of Why: The New Science of Cause and Effect*. Basic Books.

Perry, J., Bratman, M. & Fischer, J. (eds.) 2015. *Introduction to Philosophy: Classical and Contemporary Readings*, 7th Edition. Oxford University Press.

Piccinini, G. 2021. *Neurocognitive Mechanisms: Explaining Biological Cognition.*

Oxford University Press.

Powers, T. M. (ed). 2017. *Philosophy and Computing: Essays in Epistemology, Philosophy of Mind, Logic and Ethics*. Springer.

Rosen, G., Byrne, A., Cohen, J., Harman, E., and Shiffrin, S. 2018. *The Norton Introduction to Philosophy.* W.W. Norton and Co.

Stich, S. & Donaldson. T. 2019. *Philosophy: Asking Questions, Seeking Answers*. Oxford University Press.

Sullivan, E. 2021. Understanding from Machine Learning Models. British Journal for the Philosophy of Science, axz035.

Turri, J. 2014. *Epistemology: A Guide*. Wiley-Blackwell.

Zednik, C. 2019. Solving the Black Box Problem: A Normative Framework for Explainable Artificial Intelligence. *Philosophy and Technology*.

GRADING PLAN:

Type of Evaluation	Weightage (in %)

Participation	5%
Assignments (max 700 words each)	25%
Paper 1 (max 2000 words)	20%
Peer reviews of paper 1	10%
Paper 2 (max 3500 words)	30%
Peer reviews of paper 2	10%

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.

Course Code: MA4.405

Title Of the Course: Multivariate Analysis

Faculty Name: Venkateshwarlu M

L—T—F: 3-1-0; **credits**: 4

1. **Prerequisite**: Basic statistics, Matrix analysis, Calculus

2. Course Outcomes

CO 1	Understand the intricacies of simultaneous analysis of several variables
CO 2	Understand the theoretical foundation for multivariate analysis
CO 3	Cover several areas of applications
CO 4	Understand the statistical inference in the context of several variables
CO 5	Understand the multivariate extensions of standard univariate procedures
CO 6	Understand the additional multivariate techniques and apply them to solve problems

3. Course Articulation Matrix

Course	Program Outcomes	Program Specific Outcomes

outcomes	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
1	3	2	2	3	3	1			1	1		2				
2	3	3	1	1	3	1			1	1		2	2	1	3	2
2	3	2	2	1	2	1			1	1		2	3	1	2	3
4	3	3	2	2	3	1			1	1		2	3	1	2	2
5	2	3	2	2	3	1			1	1		2	3	2	2	2
6	3	2	1	1	2	1			1	1		2	2	2	3	3

4. Detailed Syllabus

Unit 1	Random variables, vectors, and matrices. Partitioning. Linear functions. Mahalanobis distance	3 hours
Unit 2	Multivariate Normal, properties, estimation of parameters, Maximum likelihood method, Wishart distribution	3 hours
Unit 3	Hotelling T-square tests, likelihood ratio test, Union-Intersection test, Confidence intervals and Tests, Tests on subvector	6 hours
Unit 4	Multivariate analysis of variance, one way classification, Two-way analysis, Tests on subvector	6 hours
Unit 5	Discrimination, Two groups, Several groups, Tests of hypotheses, Classification, Two groups, Several groups, Estimation of error rates	6 hours
Unit 6	Multiple regression, Multivariate regression, Fixed x's, Estimation, Hypothesis tests.	6 hours
Unit 7	Canonical Correlations and variates, Properties, Tests of significance, Interpretation of canonical variates	6 hours
Unit 8	Principal Components, Methods for discarding components, Interpretation, Relationship between Principal Components and Regression	3 hours
Unit 9	Basic factor model, estimation of loadings and commonalities, Determining the number of factors, Rotation of factor loadings	3 hours

References:

R.A. Johnson, Applied multivariate statistical analysis

T.W. Anderson, An introduction to multivariate analysis

K.V. Mardia, Multivariate analysis

5. Teaching-Learning Strategies

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

6. Assessment Methods and Weightage

Assignments 20, Quizzes 20, Mid Semester 20, End Semester 40 marks.

Course Code: CS9.434

Title of the Course: Music, Mind, and Technology

Faculty Name: Vinoo Alluri

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 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.

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	1	1	3	1	1	1	1	1	2	-	1	2	1	1	1
CO2	1	1	1	1	2	2	2	1	1	1	-	1	1	1	2	2
CO3	3	1	1	1	1	1	1	2	1	1	-	1	1	1	1	1
CO4	3	2	1	2	3	2	1	1	3	1	-	2	2	2	1	2
CO5	2	1	2	2	3	1	1	1	2	1	-	1	2	1	1	2
CO6	3	3	3	3	2	1	1	1	3	2	-	1	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. DetailedSyllabus:

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 inbrief:

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 inbrief:

Quiz 1 =10%

Quiz 2 =10%

Assignments = 30%
Final Project = 40%

Class participation = 10%

Title of the Course: Nonlinear dynamics

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1	3	3								1	3	3	3
CO2	3	3	1	1	3								1	3	1	3
CO3	3	3	1	3	3								1	3	3	3
CO4	3	3	1	3	3								1	3	3	3
CO5	3	3	1	3	3								1	3	3	3
CO6	3	3	1	3	3								1	3	3	3
CO7	3	3	3	3	3								1	3	3	3

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
3. Simulating, Analyzing and Animating Dynamical Systems: A Guide to XPPAUT for Researchers and Students by Bard Ermentrout

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%

Course Code: CS9.436

Title of the Course: **Optical Remote Sensing**

Faculty Name: Ramachandra Prasad P

L-T-P: **3-0-1**. Credits: **4**

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

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**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	1	1	2	1	2	1	1	1	1	1	1	1	2	2	2	2

CO 2	2	1	2	2	2	2	2	2	2	1	2	2	3	2	2	2
CO 3	2	2	2	2	3	2	1	1	1	1	2	2	2	2	2	2
CO 4	2	2	2	2	2	1	1	1	1	1	2	2	2	2	2	2
CO 5	2	2	2	2	3	2	2	2	2	1	2	3	3	2	2	2
CO 6	1	2	2	1	2	1	1	1	1	1	1	2	2	2	2	1

4. <u>Detailed Syllabus</u>:

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-pushbroom; Aerial photographs-satellite image; types of resolutions and their tradeoff

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, Density slicing

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, Ground truth, 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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Course Code: SC2.301

Title of the Course: Physics of Soft Condensed Matter

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4

CO1	3	2										1	1	1	2
CO2	3	3										2	2	2	2
CO3	3	2										1	1	1	2
CO4	3	2										1	1	2	2
CO5															
CO6															
CO7															

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 Code: SC1.415

Course Title: **Physics of Early Universe**

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1										2		3	1	2
CO2	2	1										2		3	1	2
CO3	1	1												2	3	1
CO4	2	2										1		2		3
CO5	3	1										2		3		3

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-2: Geometry and Dynamics: Universe in the eyes of Newton. Geometry. Mass and curvature. Freedman equations. Model universes: empty universe, matter or radiation dominated universe, multi-component universe

Unit-3: Black-body radiation and the early history: Observation of CMB. Recombination and decoupling. Last scattering. Temperature fluctuations
Unit-4: Very early history of the Universe: Thermal history. Nucleosynthesis. Cold dark matter
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%

Course Code: EC2.409

Title of the Course: Principles of Semiconductor Devices

Faculty Name: Anshu Sarje

L-T-P 3-1-0 Credits 3

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

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-1Describe 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-3Calculate 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

	PO1		PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3		1	1	1	1	1	1	1	1	1	1	3	2	2	1	3
CO2	3		3	1	1	1	1	1	1	1	3	1	3	2	3	3	3
CO3	2		2	3	2	1	1	1	1	1	1	1	3	2	2	3	3
CO4	2		1	2	3	3	1	2	1	1	1	1	3	2	3	1	3

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

Unit6: MOS & MOSFET

Unit7: 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 (1minute 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):

Type of Evaluation [3 credit- lecture]	Weightage (in %)
Mid Sem Exam 1	15*
Mid Sem Exam 2	15*
End Exam	25*
Assignments	15
Mini Project	25
1 minute paper (in class) [weekly prescheduled]	5

Course Code: HS1.202

Title of the Course: Readings in Indian Literatures

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: Studythe 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

	PO 1		PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
CO 1							2										
CO 2									2								
CO 3													1				
CO 4									1								
CO 5							1										
……																	
……																	

4.Detailed Syllabus:

Unit 1: Individual and Society

Unit 2: Histories in the making

Unit 3: Troubled corners of our making

Reference Books:

Ahmad, Aijaz. *In Theory: Classes, Nations, Literatures*. London: Verso, 1992.

Bennet, Tony and John Frow, eds. *The Sage Handbook of Cultural Analysis.* London: Sage Publications, 2008.

Grassman, Edith. Ed. *Why Translation Matters,* Orient Blackswan. New Delhi.2011

Nandy, Ashish. *The Intimate Enemy: Loss and Recovery of Self under Colonialism*. OUP, Delhi.1983

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)

Herbert (Nabarun Bhattacharya, Trans.2019)

Ghachar Ghochar (Vivek Shanbaugh)

A Country Without a Post Office (Agha Shahid Ali, 2013)

These Hills Called Home: Stories from a War Zone (Temsula Ao)

*The Black Hill***, (**Mamang Dai, 2014)

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:

Type of Evaluation	**Weightage (in %)**
In-class Quiz x 2	**10% x 2 = 20%**
Term Paper 1	

	20%
Term Paper 2	**20%**
Term Paper 3	**20%**
Term Paper 4	**20%**

Course Code: EC4.403

Title of the Course: Robotics: Planning and Navigation

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)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4

CO1	3	2	1	1	1	1	1	2	2	1	1	2	1	1	1	2
CO2	3	3	1	2	1	1	1	2	2	1	1	1	1	1	1	2
CO3	2	3	1	2	1	1	1	2	2	2	1	2	1	1	1	3
CO4	3	2	3	2	2	1	1	2	2	2	1	3	1	1	1	3
CO5	2	2	3	2	3	1	1	2	3	3	3	3	1	1	1	3

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%

CourseCode: CS6.401

Title of the Course: Software Engineering

Faculty Name: Raghu Reddy

L-T-P: 3-0-1 **Credits:** 4

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

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 a software design and use product quality metrics to assess the quality of delivered software

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

	PO1	PO2	PO3	PO 4	PO 5	PO6	PO7	PO 8	PO9	PO10	PO11	PO12	PSO1	PSO 2	PSO 3	PSO 4
CO1	1	2	1	1	1	1	1	1	2	2	1	1	1	1	1	1
CO2	1	2	2	2	2	2	2	1	3	3	2	2	1	1	2	1
CO3	2	1	2	3	3	1	1	1	2	2	2	2	2	2	1	2
CO 4	2	1	2	2	2	1	1	1	3	3	2	2	1	1	2	2
CO5	1	1	2	2	2	1	1	1	3	3	1	1	2	1	2	2
CO 6	1	2	3	3	3	1	1	2	3	3	1	2	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: Software Development Lifecyle 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, Factory Method

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:

1. Design Patterns: Elements of Reusable Object- Oriented Software. E. Gamma, R. Helm, R. Johnson, and J. Vlissides. Pearson, 2015, ISBN-13 : 978-9332555402
2. Refactoring: Improving the Design of Existing Code. Martin Fowler. Addison-Wesley, 2018. ISBN-13 : 978-0134757599
3. Software Architecture in Practice, 3rd edition by Len Bass, Paul Clements and Rick Kazman, Addison- Wesley, 2012. ISBN-13 : 978-9332502307

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 critique the designs.

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

Final Exam	22 %
Mid-term Quiz	12 %

Unit Questions	12 %
3 Unit Projects (2 * 17) + (1 * 10)	44 %
Other In-class Activities	10 %

Course Code: CS7.403

Title of the Course: Statistical Methods in Artificial Intelligence

Faculty Name: Vineet Gandhi

L-T-P: 3:1:0 Credits: 4

(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

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	3	2	2	1	3	2	2	3	2	2	2	2	2	2	1	2
CO 2	3	3	3	3	1	3	2	3	1	2	2	3	1	3	2	2
CO 3	1	2	2	2	2	1	2	1	1	1	2	3	3	2	2	3
CO 4	2	2	2	3	3	1	1	1	1	1	2	3	3	2	2	3
CO 5	3	1	1	2	3	3	3	2	3	2	2	2	2	3	3	3

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:

1. Richard O. Duda, Peter E. Hart, David G. Stork, *Pattern Classification*, 2nd Edition, John Wiley and Sons, October 2000

2. Christopher M. Bishop, *Pattern Recognition and Machine Learning*, 2nd Edition, Springer, 2011

3. Ian Goodfellow and Yoshua Bengio and Aaron Courville, *Deep Learning*, 1st Edition, MIT Press, 2016

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 Code : HS3.302
Course Title: The State in Colonial India

Faculty Name: Aniket Alam

Credits : 4 (four)

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

Semester, Year: Spring, 2022
(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 kingships 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*
3. Sumit Sarkar: *Modern Times: India 1880s to 1950s.*

Reference Books :

1. Sekhar Bandyopadhyay: *From Plassey to Partition*.
2. Romila Thapar: *From Lineage to State*.
3. Sabyasachi Bhattacharya: *The Colonial State: Theory and Practice*.
4. David Held: *Political Theory and the Modern State.*
5. Manu Goswami: *Producing India – From Colonial Economy to National Space*.

6. Ashin Das Gupta and M.N. Pearson: *India and the Indian Ocean, 1500-1800*.
7. Thomas Metcalf: *Ideologies of the Raj*.
8. Stewart Gordon: *Marathas, Marauders, and State Formation in 18th Century India*.
9. Amiya Kumar Bagchi: *The Political Economy of Underdevelopment.*
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*.
13. Eric Stokes: *The English Utilitarians and India*.
14. C A Bayly: *Empire and Information: Intelligence Gathering and Social Communication in India, 1780-1870*.
15. Mathew Edney: *Mapping an Empire: The Geographical Construction of British India, 1765-1843.*
16. Douglas M Peers and Nandini Gooptu: *India and the British Empire*.
17. Tirthankar Roy: *The Economic History of India – 1857-1947*.
18. Tirthankar Roy: *The East India Company: The Worlds Most Powerful Corporation*.
19. Krishna Kumar: *Politics of Education in Colonial India*.
20. Ian J. Kerr: *Engines of Change: The Railroads that Made India*.
21. Shriram Maheshwari: *The Census Administration under the Raj and After*.
22. Nicholas B Dirks: *Castes of Mind: Colonialism and the Making of Modern India*.
23. Madhav Gadgil, Ramachandra Guha: *This Fissured Land.*
24. Sharad Singh Negi: *Indian Forestry Through the Ages*.
25. Bankey Bihari Misra: *The Bureaucracy in India: An Historical Analysis of Development up to 1947*.
26. Stephen Cohen: *The Indian Army: Its Contribution to the Development of a Nation*.
27. A. S. Gupta: *The Police in British India, 1861 – 1947*.
28. Francis G. Hutchins: *The Illusion of Permanence – British Imperialism in India*.

Articles.

1. M. Athar Ali: "Political Structures of the Islamic Orient in the Sixteenth and Seventeenth Centuries" in Irfan Habib ed. *Medieval India 1 – Researches in the History of India, 1200-1750*.
2. Bipan Chandra: "Colonialism, Stages of Colonialism and the Colonial State" *Journal of Contemporary Asia*, Vol 10, No 3, 1980.
3. Sabyasachi Bhattacharya: "Colonial Power and Micro-Social Interactions: Nineteenth Century India", *EPW*, 1-8 June 1991.
4. Ramachandra Guha, "Forestry in British and post-British India, an Historical Analysis", *Economic and Political Weekly*, xvii, 1983, pp 1882-96

5. Mahesh Rangarajan, "Imperial Agendas and India's Forests : The Early History of Indian Forestry, 1800-1878", *Indian Economic and Social History Review*, 1994
6. Ramachandra Guha and Madhav Gadgil, "State Forestry and Social Conflict in British India", *Past and Present*,cxxiii, 1989, 99141-77.
7. Sudipta Kaviraj: "On the Construction of Colonial Power: Structure, Discourse, Hegemony", NMML Occasional Paper.
8. Sudipta Kaviraj: "On the Enchantment of the State: Indian Thought in the Role of the State in the Narrative of Modernity", in *Trajectories of the Indian State*.
9. Bernard Cohn: "The Census, Social Structure and Objectification in South Asia", in *An Anthropologist among the Historians and Other Essays*.
10. Bernard Cohn: "Representing Authority in Victorian India".
11. Padmanabh Samarendra: "Census in Colonial India and the Birth of Caste", *EPW*, 13 Aug, 2011.
12. K N Reddy: "India's Defence Expenditure, 1872-1967", *IESHR*, No 7, 1970.
13. Neeladri Bhattacharya: "Colonial State and Agrarian Society", in S. Bhattacharya and R Thapareds, *Situating Indian History*.
14. W. Murray Hogben: "An Imperial Dilemma – The Reluctant Indianisation of the Indian Political Service" *Modern Asian Studies*, Vol 15, No 4, (1981)

E-book Links :

Grading Plan :
(The table is only indicative)

Type of Evaluation	Weightage (in %)
Quiz-1	**0%**
Mid SemExam	**0%**
Quiz-2	**0%**
End Sem Exam	**30%**
Assignments	**15%x3 (45%)**
Project	**25%**
Term Paper	**0%**
Other Evaluation	**0%**

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	-	-	-	-	-	2	2	3	-	2	-	3	-	-	-	2
CO2	-	-	-	1	-	2	2	2	-	2	-	3	-	-	-	3
CO3	-	-	-	-	-	2	-	2	-	-	-	2	-	-	-	2
CO4	-	-	-	-	-	2	-	2	-	2	-	2	-	-	-	2
CO5	-	-	2	2	3	2	2	1	2	2	2	2	1	2	-	3
CO6.	-	-	2	-	2	3	-	3	2	2	-	2	1	2	-	3

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.

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

Course Code: EC5.401

Course Title: Topics in Signal Processing

Faculty Name: Santosh Nannuru **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 : Signal Processing,

LinearAlgebra CourseOutcomes :

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 infrequency-domain
3. Analyze graph signals to perform the signal processing operations of filtering, denoising, sampling, andreconstruction
4. Analyze the connections between traditional signal processing and graph signal processing to develop abstract mathematical intuition for modeling and problemsolving
5. Design and execute a project which applies graph signal processing to solve a problem using the tools learned in thecourse

CourseTopics :

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 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

Signalprocessingovergraphs– shiftoperation,notionoffrequencyandsmoothness,graphFourier transform (GFT), vertex-domain and frequency-domain representation of graph signals, graph filters andconvolution

Signal processing over graphs – band-limited graph signals, sampling and reconstruction ofgraph signals, uncertainty principles, denoising, compression, learning graph structure from signals,joint time-vertex signalprocessing

Applications – image processing, sensor networks, brain signals, etc.

Preferred Text Books : Online resources and reference papers

will be shared ReferenceBooks : --

E-bookLinks :--

GradingPlan :

(The table is only indicative)

Type of Evaluation	Weightage (in %)
Mid SemExam	**25**
Assignments	**20**
Project	**40**
Term Paper	**15**

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

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	3	1	1	1	1	1	1	2	-	3	2	2
CO 2	3	3	3	3	3	1	1	1	1	1	1	2	-	3	2	2
CO 3	3	3	3	3	3	1	1	1	1	1	1	2	-	3	2	2
CO 4	3	3	3	3	3	1	1	1	1	1	1	2	-	3	2	2
CO 5	3	3	3	3	3	3	1	1	2	3	2	2	-	3	2	2

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