INTERNATIONAL INSTITUTE OF INFORMATION TECHNOLOGY
HYDERABAD

PG Core and Elective Courses Syllabus – Spring 2022

Ver3. 22-12-2021

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

S.I. No.	C. Code	Course Name	Credits	Faculty Name
1	CS1.406	Advanced Algorithms	3-1-0-4	Suryajith Ch
2	CE0.601	Advanced Mechanics of Materials and Design	3-1-0-4	Venkateshwarlu M
3	CS1.501	Advanced Optimization: Theory and Applications	3-1-0-4	Pawan Kumar
4	CE1.603	Advanced Structural Analysis	3-1-0-4	Pravin Kumar Venkat Rao
5	EC4.501	Advances in Robotics & Control	3-1-0-4	Spandan Roy
6	EC2.405	Applied Electromagnetics	3-1-0-4	K R Sarma
7	CS9.422	Behavioral Research: Statistical Methods	3-0-1-4	Vishnu Sreekumar + Vinoo Alluri
8	PD2.321	Business Fundamentals-1	3-1-0-2	Priyatej K
9	PD2.421	Business Fundamentals-2	3-1-0-2	Priyatej K
10	CS9.430	Cognitive Neuroscience	3-1-0-4	Kavita Vemuri
11	CS9.432	Cognitive Science and AI	3-1-0-4	Bapi Raju S
12	CS1.403	Compilers	3-1-0-4	Vignesh Sivaraman
13	HS1.206	Comprehension of Indian Music	3-1-0-4	TK Saroja
14	CS9.435	Computational Social Science	3-1-0-4	Ponnurangam K
15	CS7.302	Computer Graphics (H1)	3-1-0-2	Avinash Sharma
16	CS7.505	Computer Vision	3-1-0-4	Anoop Namboodiri
17	CS0.302	Computing Tools	3-1-3-4	Sudipta Banerjee + Avinash Sharma
18	CS4.409	Data Foundation Systems	3-1-0-4	Vikram Pudi
19	CS4.401	Data Systems	3-1-0-4	Krishna Reddy
20	CE5.501	Design of Hydraulic Structures	3-1-0-4	Shaik Rehana
21	PD1.401	Design Thinking - Idea to Evaluate	3-1-0-2	Raman Saxena
22	PD1.301	Design Thinking - Research to Define	3-1-0-2	Raman Saxena
23	MA4.301	Differential Equations	3-1-0-4	Lakshmi Burra
24	CS7.303	Digital Signal Analysis (H1)	3-1-0-2	Anil Kumar V
25	EC2.408	Digital VLSI Design	3-1-0-4	Zia Abbas
26	CE8.401	Disaster Management	3-1-0-4	Sunitha P
27	CS4.403	Distributed Data Systems	3-1-1-4	Kamal Karlapalem
28	CS3.401	Distributed Systems	3-1-0-4	Lini Thomas
29	CE1.601	Earthquake Engineering	3-1-0-4	Pradeep Kumar R
30	HS0.209	Exploring Masculinities	3-0-0-2	Vindhya Undurti, TISS, Hyd
31	EC2.502	Flexible Electronics	3-1-0-4	Aftab Hussain
32	CS9.437	Green Buildings	3-1-0-4	Vishal Garg

33	CS9.433	Hydro Informatics	3-1-0-4	Shaik Rehana
34	CS9.431	ICTs for Development	3-1-0-4	Nimmi Rangaswamy
35	CL5.404	Indian Grammatical Tradition **(H2)**	3-0-0-2	Dipti Misra Sharma
36	CS8.402	Information Security Audit and Assurance	3-1-0-4	Shatrunjay Rawat
37	CS3.404	Internals of Application Servers	3-1-0-4	Ramesh Loganathan
38	EC4.402	Intro to UAV Design	3-1-0-4	Harikumar Kandath
39	CS1.305	Introduction to Algorithms Engineering (H2)	3-1-0-2	Kishore Kothapalli
40	CS9.311	Introduction to Brain and Cognition (H2)	3-1-0-2	Kavita V + Vishnu Sreekumar
41	CS1.408	Introduction to Game Theory	3-1-0-4	Sujit Gujar
42	CS8.301	Introduction to Information Security (H2)	3-1-0-2	Ashok Kumar Das
43	CS7.401	Introduction to NLP	3-1-0-4	Manish Shrivastava
44	SC1.420	Introduction to Particle Physics	3-1-0-4	Subhadip Mitra
45	HS0.204	Introduction to Philosophy of Technology	3-1-0-4	Ashwin Jayanthi
46	CS9.312	Introduction to Quantum Information and Computation (H1)	3-1-0-2	Indranil Chakrabarty
47	HS1.207	Introduction to Sanskrit	3-1-0-4	Peter Scharf
48	MA4.303	Linear Partial Differential Equations and Variational Calculus	3-1-0-4	Samyadeb Bhattacharya
49	HS0.210	Literature and the Ethics of telling a Story	3-0-0-2	Sushmita Banerjee
50	HS1.203	Literature, History, and Belonging in Hyderabad	3-1-0-4	Nazia Akhtar
51	SC4.411	Machine Learning for Natural Sciences	3-1-0-4	Nita Parekh + Prabhakar B
52	EC4.404	Mechatronics System Design	3-1-0-4	Nagamanikandan + Harikumar K
53	HS0.205	Minds, Machines and Intelligence	3-1-0-4	Don Decruz
54	SC2.316	Molecular Modeling and Simulations	3-1-0-4	Deva Priyakumar
55	MA4.405	Multivariate Analysis	3-1-0-4	Venkateshwarlu M
56	CS9.434	Music, Mind, and Technology	3-1-0-4	Vinoo Alluri
57	SC3.410	NGS Data Analysis	3-1-0-4	Nita Parekh
58	SC1.315	Nonlinear Dynamics	3-1-0-4	Abhishek Deshpande
59	CS9.436	Optical Remote Sensing	3-1-0-4	RC Prasad
60	CS1.404	Optimization Methods	3-1-0-4	Naresh Manwani
61	CS3.307	Performance modeling of computer systems(H2)	3-1-0-2	Tejas Bodas
62	SC2.301	Physics of Soft Condensed Matter	3-1-0-4	Marimuthu Krishnan
63	SC1.415	Physics of The Early Universe **(40)**	3-1-0-4	Diganta Das
64	CS8.401	Principles of Information Security	3-1-0-4	Srinathan K
65	EC2.409	Principles of Semiconductor Devices	3-1-0-4	Anshu Sarje
66	PD2.401	Product Management 101	3-1-0-2	Ramesh Loganathan
67	CS1.303	Program Verification (H1)	3-1-0-2	Venkatesh Choppella
68	CS1.409	Quantum Algorithms	3-1-0-4	Shantnav Chakravarthy
69	HS0.208	Questions of Crime and Punishment in Literature	3-0-0-2	Nazia Akhtar

70	HS1.202	Readings in Indian Literatures	3-1-0-4	Sushmita Banerjee
71	EC4.403	Robotics: Planning and Navigation	3-1-0-4	Madhava Krishna K
72	HS0.207	Science & Technology Critical Perspectives	3-0-0-2	Harjinder Singh
73	HS7.301	Science, Technology and Society	3-1-0-4	Radhika Krishnan
74	CS6.401	Software Engineering	3-1-0-4	Raghu Reddy
75	CS3.302	Software Programming for Performance (H2)	3-1-0-2	Suresh Purini
76	CS6.302	Software Systems Development	3-1-0-4	Raghu Reddy
77	CS4.410	Spatial Data Sciences	3-1-0-4	KS Rajan
78	CE1.602	Stability of Structures	3-1-0-4	Sunitha P
79	CS7.403	Statistical Methods in AI	3-1-0-4	Vineet Gandhi
80	CS8.403	System and Network Security	3-1-0-4	Ankit Gangwal
81	HS3.302	The State in Colonial India	3-1-0-4	Aniket Alam
82	HS0.206	Thinking through moral problems	3-0-0-2	Ashwin Jayanti
83	EC5.402	Time Frequency Analysis	3-1-0-4	Jayanthi Sivaswamy + Chiranjeevi Yerra
84	EC5.501	Topics in Coding Theory	3-1-0-4	Prasad Krishnan
85	CS7.602	Topics in Deep Learning	3-1-0-4	Charu Sharma + Makarand Tapaswi
86	EC5.401	Topics in Signal Processing	3-1-0-4	Santosh Nannuru
87	CS6.502	Topics in Software Foundations	3-1-0-4	Venkatesh Choppella
88	CS9.501	User Research Methods	3-1-0-2	Priyanka Srivastava
89	HS0.211	ValuesEthics and AI	3-0-0-2	Rajeev Sangal + Shatrunjay Rawat

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Title of the Course : Advanced Algorithms
Course Code : CS1.406
Faculty Name : Suryajith Ch
L-T-P :3-1-0
Credits :4
Prerequisite Course / Knowledge:

Should have taken Introduction to Algorithms, and Formal Languages, or equivalent courses
Course Outcomes (COs):
After completion of this course successfully, the students will be able to.

CO-1: Demonstrate familiarity with using randomness in computing

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

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

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

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

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

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

	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	1	2	2	2	1	1	1	2	1	1	1	2	3	1	1	3
CO 2	2	3	2	2	1	1	1	2	2	2	1	3	3	1	1	3
CO 3	2	2	2	2	1	1	1	2	1	1	1	2	3	1	1	3
CO 4	1	3	2	2	1	1	1	2	2	2	1	3	3	1	1	3
CO 5	2	2	2	2	1	1	1	2	2	2	1	3	3	1	1	3
CO 6	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, and symmetry 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%

Title of the Course **:** Advanced Mechanics of Materials and Design
Faculty Name : Venkateswarlu Mandadi

Name of the Program: Electives for PG CASE Students

Course Code **:** CE0.601

Credits : 4

L—T—P **:** 3-1-0;

Semester, Year : Spring, 2022

1. Prerequisite: Mechanics of Materials
2. Course Outcomes

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

3. Course Topics

Flexure	von Mises yield criterion, Elastic section modulus, Plastic section modulus, Moment curvature relation, Unsymmetrical bending, Shear strength, Bending strength, Bending moment capacity in the presence of shear forces	6 hours
Torsion	Saint-Venant torsion theory, Prandtl stress function, Membrane analogy, Lateral torsional buckling, Elastic critical buckling moment	6 hours
Columns and Trusses	Basic strut buckling, Elastic critical buckling force, Inelastic buckling, Residual stresses, Beam Columns, amplification factors, Beam-column design equation, Beam column with lateral torsional buckling, Web buckling, Simple Trusses, Buckling of compression members, Slender trusses, Slender trusses subjected to compression and bending	6 hours

Arches	Buckling of arches, In-plane buckling, Out-of-plane buckling, Parabolic arch, Elastic critical buckling load, Equivalent strut method, Elastic critical buckling load by Timoshenko method	6 hours
Thin-Walled Structures	Unstiffened plates in compression, Shear buckling of unstiffened plates, Unstiffened plates in compression and shear, Stiffened plates in compression, Stiffened plates in shear, Stiffened panels subjected to shear and compression, Stiffened plates with lateral loads, Stiffened panels in shear, compression, and bending	6 hours
Composite Structures	Shear studs, Effective width, Serviceability limit state design, ULS bending strength, Elastic design of shear studs, Plastic design of shear studs	6 hours

4. Preferred Text Books: Cook, R, D.,, Advanced Mechanics of Materials

   Spiegel, P. E., Applied Structural Steel Design

5. Reference Books:

   Boresi, A. P., Advanced Mechanics of Materials

   McCormac, J. C., Structural Steel Design

6. Grading Plan

Type of Evaluation	**Weightage (%)**
Quiz 1	15
Mid Sem Exam	20
Quiz 2	15
End Sem Exam	20
Assignments	30

7. Mapping of Course Outcomes to Program Objectives

Course outcomes	Program Outcomes												Program Specific 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

8. Teaching-Learning Strategies

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

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

1. Prerequisite Course / Knowledge:

Linear Algebra, Calculus

2. Course Outcomes (COs)

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

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

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

	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
CO5	3	3	3	3	3	-	-	-	2	2	3	3	3	3	2	3

'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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Title of the Course : Advanced Structural Analysis
NAME of Faculty : Dr. P. Pravin Kumar Venkat Rao
Name of the Academic Program: M.Tech in CASE
Course Code : CE1.603
L-T-P : 3-1-0
Credits : 4

1. Prerequisite Course / Knowledge: Basic Structural Analysis

2.Course Outcomes (COs):

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

CO 1: Develop the stiffness matrix for prismatic members and have a sound knowledge ofmatrix computations.

CO 2: Analyze determinate and indeterminate plane and space truss/frame system.CO 3: Derive the collapse load factors for a given structure

CO 4: Understand how standard software packages (routinely used for frame analysis in designoffices) operate.

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

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

4.Detailed Syllabus:

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

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

Unit 3: Analysis of spring and bar assembly, Analysis of plane truss, space truss, plane frame, plane grid and space frames subjected to joint loads, Analysis of structures for axial load, Frames with inclined members, Analysis for member loading (Self, Temperature & Imposed), Inclined supports, Lack of fit,Initial joint displacements, Effect of shear deformation, Inclined roller supports.

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

Reference Books:

1. Cheng, F.Y. "Matrix Analysis of Structural Dynamics", M. Dekke, NY, 2000.
2. Menon, D. "Structural Analysis", Narosa Publishing House, 2008.
3. Kanchi, M.B. "Matrix Analysis of Structural Analysis", John Willey & Sons, 2nd Edition 1999.
4. Kasmali A. "Matrix Analysis of Structures", Brooks/Cole Publishing Co., 1999.
5. Gere, W. and Weaver, J.M. "Matrix Analysis of Structural Analysis", 3rd Edition, Van Nostrand Reinhold, NY, 1990.
6. Martin, H.C. "Introduction to Matrix Method of Structural Analysis", McGraw Hill Book Co.,1996.
7. Menon, D. "Advanced Structural Analysis", Narosa Publishing House, 2009.
8. Ghali, A., Neville, A.M. and Brown, T.G. "Structural Analysis: A Unified Classical and Matrix Approach" 6th Edition, Chapman & Hall, 2007.
9. Mcguire, W, Gallagher R.H., Ziemian, R.D. "Matrix Structural Analysis", 2nd Edition, John Wiley& Sons, Inc., 2000.
10. Wong, M.B. "Plastic Analysis and Design of Steel Structures", Elsevier Publications, 2009.

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

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

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

Assignments and Quizzes - 40%Mid

Semester Exam - 25%

End Semester Exam - 35%

Title of the Course : Advances in Robotics and Control
Course Code : EC4.501
Faculty Name : Spandan Roy
L-T-P :3-1-0
Credits : 4
Prerequisite Course / Knowledge:

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

Course Outcomes (COs):

After completion of this course successfully, the students will be able to..
CO-1: Demonstrate familiarity with Euler-Lagrange dynamics
CO-2: Apply principles of computed torque method for controller development of a robotic system
CO-3: Understanding the concepts of Lyapunov theory for stability analysis
CO-4: Apply principles of Lyapunov theory for controller design
CO-5: Design inverse dynamics based robust controller to address uncertainty in robot dynamics
CO-6: Design adaptive-robust controller for robotic systems to address un modelled dynamics

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	2	2	1	1	1	2	1	1	1	3	1	1	1	3
CO2	2	3	2	2	1	1	1	2	2	2	1	3	1	1	1	3
CO3	2	3	2	3	1	1	1	2	1	1	1	3	1	1	1	3
CO4	2	3	2	2	1	1	1	2	2	2	1	3	1	1	1	3
CO5	3	3	1	3	1	1	1	2	2	2	1	3	1	1	1	3
CO6	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):

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

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

- Assignments: 20%
- Project: 20%
- Quiz1: 15%
- Quiz 2: 15%
- End Exam: 30%

Title of the Course : Behavioral Research: Statistical Methods
Course Code : CS9.422
Faculty Name : Vishnu Sreekumar + Vinoo Alluri
L-T-P : 3-1-0
Credits : 4

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

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%

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

1.Prerequisite Course /Knowledge:

No prerequisites are required

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

OBJECTIVE OF THE COURSE

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

DETAILS OF THE COURSE SYLLABUS

- Introduction to principles of Management and entrepreneurship

- Basics of business model development and business planning

- Legal aspects of new venture creation and IPR

- Entrepreneurial Marketing

- Human resource management

- Introduction to entrepreneurial finance and Accounting

- Supervisory Skills for Business Leadership
- Negotiation and Conflict Resolution

- Business Ethics

Title of the Course : Business Fundamentals # 2
Fundamentals of Management for Entrepreneurship
Faculty Name **:** Priyatej K
Course Code : PD2.421
Program : M.Tech I Year I Semester – Product Design and Management*
L-T-P : 3-1-0
(L= Lecture hours, T=Tutorial hours, P=Practical hours)
Credits : 2

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

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

DETAILS OF THE COURSE SYLLABUS

- Strategic Management for New Business

- Introduction to entrepreneurial finance and Accounting

- Supervisory Skills for Business Leadership

- Negotiation and Conflict Resolution

- Business Ethics

Title of the Course : Cognitive Neuroscience
Course Code : CS9.430
Faculty Instructor : Kavita Vemuri
L-T-P : 3-0 -1
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

.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

3.Detailed Syllabus:

OBJECTIVE : Understand the mechanisms of t h e 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 _____	

Title of the Course : COGNITIVE SCIENCE AND AI
Course Code : CS9.432
Faculty Name : BAPI RAJU S.
L - T – P : 3-1-0
Credits :4
(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	PO1 0	PO1 1	PO1 2	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 projectare 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.

Title of the Course : Compilers
Course Code : CS1. 403
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 Title **:** Comprehension of Indian Music

Course Code : HS1.206
Faculty Name : TK Saroja
Credit : 3-0-0-4

Course Description:

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

Objectives:

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

Course outcomes:

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

Reference Materials:

1. *South Indian Music* – Volumes 1 to 6 by Professor P.Sambamurthy
2. *The quest for Music Divine* by Suresh Chandra Dey
3. *The Spiritual Heritage of Tyagaraja* by C.Ramanujacharya and Prof V. Raghavan
4. *Karnataka 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 Title : Computational Social Science
Faculty Name : Ponnurangam Kumaraguru
Name of the Program : Applicable to all Programs on campus including, CSE, CLD, CHD, CND, both at UG & Masters level.
Course Code : CS9.435
Credits :4
L - T – P :3-0-1
(L - Lecture hours, T-Tutorial hours, P - Practical hours)
Semester, Year **:Spring, 2022**

(Ex: Spring, 2022)

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

Course Outcomes :

- CO-1: Students will describe the opportunities and challenges that the digital age creates for social sciences research.
- CO-2: Students will evaluate modern social research from the perspectives of both social science and data science.
- CO-3: Students will create research proposals that blend ideas from social science and data science.
- CO-4:Students will be able to summarize and critique research papers in Computational Social Science
- CO-5: Students will conduct, develop, and practice the techniques needed to conduct their proposed research, through course project.

Course Topics :

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

Module 1: Social Research

- **Computational Social Science 101**
  - What is Computational Social Science?
  - Is Computational Social Science = or Computer Science + Social Science?
  - Why study Computational Social Science?
  - Challenges with only Computer Science or Social Science
  - Does Social Media data == Computational Social Science? Class debate.
- Social Science vs. Data Science
- Prediction vs. Causality

Read / Listen / Watch:

- Hanna Wallach. 2018. Computational social science ≠ computer science + social data. Commun. ACM 61, 3 (March 2018), 42–44. DOI:https://doi.org/10.1145/3132698
  https://cacm.acm.org/magazines/2018/3/225484-computational-social-science-computer-science-social-data/fulltext

- Lazer D, Pentland A, Adamic L, Aral S, Barabasi AL, Brewer D, Christakis N, Contractor N, Fowler J, Gutmann M, Jebara T, King G, Macy M, Roy D, Van Alstyne M. Social science. Computational social science. Science. 2009 Feb 6;323(5915):721-3. doi: 10.1126/science.1167742. PMID: 19197046; PMCID: PMC2745217. https://pubmed.ncbi.nlm.nih.gov/19197046/
- Coded Bias
  - Trailer https://youtu.be/jZl55PsfZJQ
  - Full documentary https://www.netflix.com/title/81328723

Module 2: Modeling & Causal Inference

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

- **Read / Listen / Watch:**
  - Blumenstock et al. 2015. Predicting Poverty and Wealth from Mobile Phone Metadata. Science. https://www.unhcr.org/innovation/wp-content/uploads/2016/11/blumenstock-science-2015.pdf
  - Lazer, David and Kennedy, Ryan and King, Gary and Vespignani, Alessandro, Google Flu Trends Still Appears Sick: An Evaluation of the 2013-2014 Flu Season (March 13, 2014). Available at SSRN: https://ssrn.com/abstract=2408560 or http://dx.doi.org/10.2139/ssrn.2408560
  - M. R. Khan, J. Manoj, A. Singh and J. Blumenstock, "Behavioral Modeling for Churn Prediction: Early Indicators and Accurate Predictors of Custom Defection and Loyalty," 2015 IEEE International Congress on Big Data, 2015, pp. 677-680, doi: 10.1109/BigDataCongress.2015.107.
  - Chapter 3 of Mostly Harmless Econometrics: An Empiricist Companion

Module 3: Mass Collaborations

- Human Computation
  - Galaxy Zoo
    - Lintott, Chris J, Kevin Schawinski, Anže Slosar, Kate Land, Steven Bamford, Daniel Thomas, M. Jordan Raddick, et al. 2008. "Galaxy Zoo: Morphologies Derived from Visual Inspection of Galaxies from the Sloan Digital Sky Survey." *Monthly Notices of the Royal Astronomical Society* 389 (3):1179–89. https://doi.org/10.1111/j.1365-2966.2008.13689.x
      https://watermark.silverchair.com/mnras0389-1179.pdf
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  - Crowd-coding of political manifestos
    - Benoit, Kenneth, Drew Conway, Benjamin E. Lauderdale, Michael Laver, and Slava Mikhaylov. 2016. "Crowd-Sourced Text Analysis: Reproducible and Agile Production of Political Data." *American Political Science*

Review 110 (2):278–95. https://doi.org/10.1017/S0003055416000058 https://kenbenoit.net/pdfs/Crowd_sourced_data_coding_APSR.pdf

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    - Hand, Eric. 2010. "Citizen Science: People Power." *Nature News* 466 (7307):685–87. https://doi.org/10.1038/466685a.
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  - eBird: Bird data from birders
    - Kelling, Steve, Daniel Fink, Frank A. La Sorte, Alison Johnston, Nicholas E. Bruns, and Wesley M. Hochachka. 2015. "Taking a Big Data Approach to Data Quality in a Citizen Science Project." *Ambio* 44 (Suppl 4):601– 11. https://doi.org/10.1007/s13280-015-0710-4.
  - Photocity
    - Tuite, Kathleen, Noah Snavely, Dun-yu Hsiao, Nadine Tabing, and Zoran Popovic. 2011. "PhotoCity: Training Experts at Large-Scale Image AcquisitionThroughaCompetitiveGame."In*Proceedingsofthe2011 Annual Conference on Human Factors in Computing Systems*,1383–92. CHI '11. New York: ACM. https://doi.org/10.1145/1978942.1979146 https://dl.acm.org/doi/pdf/10.1145/1978942.1979146
    - Agarwal, Sameer, Yasutaka Furukawa, Noah Snavely, Ian Simon, Brian Curless, Steven M. Seitz, and Richard Szeliski. 2011. "Building Rome in a Day." *Communication of the ACM* 54 (10):105–12. https://doi.org/10.1145/2001269.2001293.
- How to develop our own (including around course project) Mass Collaborations?
  - Opportunities
  - Methods
  - Challenges

Module 4: Ethics

- Studies of concern
  - Experiment on 700,000 Facebookusers
    - Kramer, Adam D. I., Jamie E. Guillory, and Jeffrey T. Hancock. 2014. "Experimental Evidence of Massive-Scale Emotional Contagion Through Social Networks." *Proceedings of the National Academy of Sciences of the USA* 111 (24):8788–90. https://doi.org/10.1073/pnas.1320040111
  - Tastes, Ties, and Time study on Facebook users
    - Wimmer, Andreas, and Kevin Lewis. 2010. "Beyond and Below Racial Homophily: ERG Models of a Friendship Network Documented on Facebook." *American Journal of Sociology* 116 (2):583–642. http://www.jstor.org/stable/10.1086/653658.
    - Lewis, Kevin, Marco Gonzalez, and Jason Kaufman. 2012. "Social

Selection and Peer Influence in an Online Social Network." *Proceedings of the National Academy of Sciences of the USA* 109 (1):68–

72. https://doi.org/10.1073/pnas.1109739109.

- Web Censorship
  - Burnett, Sam, and Nick Feamster. 2015. "Encore: Lightweight Measurement of Web Censorship with Cross-Origin Requests."

    In *Proceedings of the 2015 ACM Conference on Special Interest Group on Data Communication*, 653–67. SIGCOMM '15. London:

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  - Narayanan, Arvind, and Bendert Zevenbergen. 2015. "No Encore for Encore? Ethical Questions for Web-Based Censorship

    Measurement." *Technology Science*,

    December. http://techscience.org/a/2015121501/.

  - Jones, Ben, and Nick Feamster. 2015. "Can Censorship Measurements Be Safe(R)?" In *Proceedings of the 14th ACM Workshop on Hot Topics in Networks*, 1:1–1:7. HotNets-XIV. New York: ACM. https://doi.org/10.1145/2834050.2834066.

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

Module 5: Biases in CSS Research

- Biases & inaccuracies at the source of the data
- Biases & inaccuracies during processing
- Biases in social data
- Inferences from biased data

- **Read / Listen / Watch:**
  - danah boyd & Kate Crawford (2012) CRITICAL QUESTIONS FOR BIG DATA, Information, Communication & Society, 15:5, 662-679, DOI: 10.1080/1369118X.2012.678878
  - Daniel Gayo-Avello. 2011. Don't turn social media into another 'Literary Digest' poll. Commun. ACM 54, 10 (October 2011), 121–128. DOI:https://doi.org/10.1145/2001269.2001297
  - McFarland DA, McFarland HR. Big Data and the danger of being precisely inaccurate. Big Data & Society. December 2015. doi:10.1177/2053951715602495
  - https://en.wikipedia.org/wiki/Weapons_of_Math_Destruction
  - Ricardo Baeza-Yates. 2018. Bias on the web. Commun. ACM 61, 6 (June 2018), 54–61. DOI:https://doi.org/10.1145/3209581
  - Hargittai E. Potential Biases in Big Data: Omitted Voices on Social Media. Social Science Computer Review. 2020;38(1):10-24. doi:10.1177/0894439318788322
  - Olteanu Alexandra, Castillo Carlos, Diaz Fernando, Kıcıman Emre. Social Data: Biases, Methodological Pitfalls, and Ethical Boundaries. Frontiers in

Big Data. VOLUME 2, 2019 DOI=10.3389/fdata.2019.00013
https://www.frontiersin.org/article/10.3389/fdata.2019.00013

Preferred Text Books :

1. Salganik, Matthew J., Bit by Bit: Social Research in the Digital Age, Princeton University Press, 2018. Free Online Version: https://www.bitbybitbook.com/en/1st-ed/preface/

Reference Books :

E-book Links :

https://www.bitbybitbook.com/en/1st-ed/preface/

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

https://www.researchgate.net/profile/Joshua-Angrist/publication/51992844_Mostly_Harmless_Econometrics_An_Empiricist%27s_Companion/links/00b4953344a9a0cb13000000/Mostly-Harmless-Econometrics-An-Empiricists-Companion.pdf

Grading Plan :

(The table is only indicative)

Type of Evaluation	Weightage (in %)
Quizzes	20.0
Assignments + Activities	30.0
Project report + Blog + Video	20.0 [15 + 2.5 + 2.5]
Project	30.0
Other Evaluation _____	

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	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	3	1	-	-	-	3	-	-	-	3	-	1	3	-	-	3
CO 2	3	1	-	-	3	3	-	-	3	3	-	1	3	-	-	3
CO 3	3	3	-	-	-	3	1	3	3	3	-	1	3	3	-	3
CO 4	3	1	-	-	-	-	-	-	3	3	-	1	3	1	-	3
CO 5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

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

Learning

- Lectures
- Reading research papers
- Class participation: questions, discussions
- Online discussion: Teams

Learning by doing

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

POTENTIAL GUEST LECTURES:

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

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

Title of the Course	: Computing Tools
Name of the Faculty	: Sudipta Banerjee + Avinash Sharma
Name of the Academic Program	: M.Tech. in CASE, Bioinformatics (1st year, 2nd semester)
Course Code	: CS0.302
L-T-P	:3-1-3
Credits	:4

Prerequisite Course / Knowledge:

1. First course on programming and problem-solving

2. Basics of Python language, to be able to use relevant libraries and toolkits

Course Outcomes (COs):

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

CO-1. Model and create datasets.

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

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

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

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

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

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

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

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

Detailed Syllabus:

Unit 1: Databases (Design, SQL)

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

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

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

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

Reference Books:

1. Official documentation and online tutorials on Python, VTk, etc.
2. Python – https://docs.python.org/3/tutorial/

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

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

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

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

Title of the Course : Data Foundation Systems – A Project-Based Elective Course
Course Code : CS4.409
Faculty Name : Vikram Pudi
Credits :1-1-3-4

Name of the Program : Elective for B.Tech/M.Tech/MS/PhD students in

L - T – P :

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

Semester, Year : Spring, 2022

(Ex: Spring, 2022)

Pre-Requisites : SSAD, SSDD, or background knowledge/experience in python web programming

Course Outcomes :

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

1. Participate in building large, deployable software systems
2. Automate data ingestion
3. Fluently use Javascript, NodeJS and related frameworks to build interactive web-components
4. Fluently use one or more modern Python backend web frameworks
5. Rapidly build responsive websites with complex layouts

Course Topics :

1. Code and design review of large software systems
2. NodeJS
3. Asynchronous Javascript web components
4. One or more modern python web framework (e.g. django, py4web, etc.)
5. Responsive webpages and complex layouts
6. Data scraping and ingestion

Preferred Text Books:

Online material:

1. Python documentation
2. NodeJS documentation
3. HTML5/CSS and bootstrap (or similar) layouts tutorial
4. Django/py4web documentation

Reference Books :

E-book Links :

Grading Plan :

(The table is only indicative)

Type of Evaluation	Weightage (in %)
Quiz-1	**15%**
Mid SemExam	
Quiz-2	**15%**
End Sem Exam	
Assignments	**10%**

Project	**60%**
Term Paper	
Other Evaluation	Project evaluation will be based on deliverables at intermediate deadlines, including for requirements, screenshots, database design, prototype building, etc. A: If deliverable is deployable, well-designed and efficient A-: If deliverable is deployable B: If deliverable is deployable with some more effort B- to C-: If deliverable is deployable with considerably more effort. F: If deliverable is not deployable.

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	PO1 2	PSO 1	PSO 2	PSO 3	PSO 4
CO 1	3	3	3	3	3	1	1	1	3	2	2	3	2	1	2	1
CO 2	3	3	3	2	3	1	1	1	3	2	2	3	2	1	2	1
CO 3	3	3	3	2	3	1	1	1	3	2	2	3	2	1	2	1
CO 4	3	3	3	2	3	1	1	1	3	2	2	3	2	1	2	1
CO 5	3	3	3	3	3	1	1	1	3	2	2	3	2	1	2	1

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

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

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

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

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

Sample projects to choose from:

1. Dataset library

2. Data ingestion from various sources
3. Data annotation plugins
4. Dataset approval workflow
5. Javascript components to handle medical images (CT/MRI/X-Ray)

Title of the Course : Data Systems
Course Code : CS4.401
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 module of 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

	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	2	2	2	2	3	-	1	-	3	1	3	2	3	3	2	3
CO 2	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 students and Project-based Learning by doing 5 mini-projects in laboratory by the students

6.Assessment methods and weightages in brief:

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

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

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

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

(March-April)

1. Objective

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

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

1. Detailed Syllabus:

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

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

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

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

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

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

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

Reference Books:

1. Case: Design Thinking and Innovation at Apple, Stefan T. & Barbara F. (HBS 9-609-066)
2. Case: Embrace- A Baby Warmer, Project by Stanford University.
3. Case: Mainframe design for new Generation
4. Book: HBR's 10 Must Reads on Design Thinking, by Harvard Business Review
5. Book: Change by Design by Tim Brown
6. Book: Design Thinking for Creativity and Business Innovation Series by Idris Mootee
7. Book: Design Thinking: A Culture of Innovation by Sean Koh
8. Book: Design Thinking, by Nigel Cross
9. Book: The Design of Everyday Things by Donald A. Norman

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

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

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

1.	Class/Home activities	N= 6	18%
2.	Project in Group – with 2-3 students	N=1	40%
3.	Assignment	N=1	14%
4.	Final Exam	N=1	20%
5.	Experiment participation-based credit and Peer review	N=2	8%
		TOTAL	**100%**

Course Title : Design Thinking – Ideate to Evaluate
Course Code : PD1.401
Program : M.Tech I Year I Semester – Product Design and Management*
L-T-P : 3-1-0
(L= Lecture hours, T=Tutorial hours, P=Practical hours) Credits: 2

2. Prerequisite Course / Knowledge:

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

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

(March-April)

3. Objective

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

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

4. Detailed Syllabus:

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   - Revisit and deliberate on the actionable brief and tweaking the same if needed.
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   - Process and techniques of Ideation to generate many ideas.
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   - Types of Prototypes – Low fidelity & high fidelity
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   - Types of user testing and evaluation.
   - Process of user testing/validation using prototypes.

- Use case of user testing/validation (TBD)

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- Final presentation of the work.

Reference Books:

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11. Case: Embrace- A Baby Warmer, Project by Stanford University.
12. Case: Mainframe design for new Generation
13. Book: HBR's 10 Must Reads on Design Thinking, by Harvard Business Review
14. Book: Change by Design by Tim Brown
15. Book: Design Thinking for Creativity and Business Innovation Series by Idris Mootee
16. Book: Design Thinking: A Culture of Innovation by Sean Koh
17. Book: Design Thinking, by Nigel Cross
18. Book: The Design of Everyday Things by Donald A. Norman

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

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

students need to spend 4 hours per week on home/field assignments.

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

1.	Class/Home activities	N= 6	18%
2.	Project in Group – with 2-3 students	N=1	40%
3.	Assignment	N=1	14%
4.	Final Exam	N=1	20%
5.	Experiment participation-based credit and Peer review	N=2	8%
TOTAL			**100%**

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

1. Prerequisite Course / Knowledge:
No prerequisites are required

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

(Jan – Feb)

2. Objective

The overall goal of this design thinking course is to help you design better solutions, products, services, systems, processes, strategies, and experiences.

This course is aimed at guiding you through the Design Thinking Process and will help you developing a solid understanding of the overall process, phases and methods in design thinking. Introduce the concept of Human-centred approach, empathy, collaboration, co-creation and product-user & product-market fit. It will provide the theory and operational skills to follow Human (User)-Centred approach and how to implement this knowledge in your professional work life.

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

3. Detailed Syllabus:

1. **UNLEARNING** *(Week 1 - Lecture 1 & 2)*

Initial part of the course will emphasize on unlearning and to cultivate a knack for design thinking, and creative problem solving among the students that will work as a good foundation before introducing them to detailed process, methods and tools of DESIGN THINKING.

2. **UNDERSTANDING DESIGN AND DESIGN DOMAIN** *(Week 2 - Lecture 3 & 4)*

- Understanding Design
- Role & Functions of design and designers.
- Design Elements – (Function, Ergonomics & Aesthetics) + Desirability, Feasibility & Viability)
- Understanding Design Domains and perspectives – Product Design, HCI, Visual Communication, Service Design and User Experience

3. **INTRODUCTION TO DESIGN THINKING** *(Week 3 - Lecture 5 & 6)*

- What is Design Thinking?
- Why Design Thinking?

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

5. **DESIGN THINKING PROCESS** *(Week 4 - Lecture 7 & 8)*

- Design Thinking Process – human-focused, empathy, research, ideation and prototype- driven, innovative design approach.
- User-Centred Design / Double Diamond Process explaining stage of Discovery, Define, Design, Prototype & Test and Implement.
- Introduce/Initiate Design Thinking Pilot Project which is built into course structure and will run parallel to the course content in the DT-Part1 and will conclude in DT-Part 2.

6. **DISCOVERY PHASE (***Week 5 - Lecture 9 & 10)*

- What is Discovery and Validation phase and why?
- Understanding User Context? – Why & How to Empathies?
- Understanding the User Needs and Goals through empathy by observing their behaviour and drawing conclusions based on qualitative information
- Understanding the Business Goals
- Tools and Methods and Deliverables

7. **DEFINE PHASE** *(Week 6 - Lecture 11 & 12)*

- Analysis and Synthesis of Data and Information.
- Driving Insights (both user and business) and solution directions
- Tools and Deliverables of the Define phase

8. **DRIVING ACTIONABLE BRIEF** *(Week 7 - Lecture 13 & 14)*

- Through the process of analysis and synthesis, identifying user-business insights, arriving at an actional brief in form of HMW statement.
- Debriefing and briefing on upcoming course "Design Thinking 101 – Research to Define"

Reference Books:

1. Case: Design Thinking and Innovation at Apple, Stefan T. & Barbara F. (HBS 9-609-066)

2. Case: Defining Innovative Mobile Strategies: How Design Thinking Offers an Effective Way to Address the "Wicked Problem" of Enterprise Mobility by SAP
3. Book: HBR's 10 Must Reads on Design Thinking, by Harvard Business Review
4. Book: Design Thinking by Tim Brown (HBR – R0806E)
5. Book: Innovation Through Design by Bill Moggridge
6. Book: Design Thinking and Social Innovation by Tim Brown and Jocelyn Wyatt in Stanford Social Innovation review

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

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

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

1.	Class/Home activities	N= 6	18%
2.	Project in Group – with 2-3 students	N=1	40%
3.	Assignment	N=1	14%
4.	Final Exam	N=1	20%
5.	Experiment participation-based credit and Peer review	N=2	8%
		TOTAL	**100%**

Title of the Course : Differential equations
Course Code : MA4.301
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 to develop

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 Frobenius method

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

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

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO 11	PO12	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 and Population Dynamics, Exact Differential Equations and Integrating Factors, Numerical Approximations: Euler's Method (7.5 hours);

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

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

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

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

References:

- Boyce di-Prima, Elementary Differential Equations and Boundary Value Problems (John Wiley and sons
- 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

Title of the Course : Digital Signal Analysis
Faculty Name : Anil Kumar V
Course Code : CS7.303
L-T-P :2-1-0
Credits :2
Typical Course Design Name of the Academic Program B. Tech. in CSE

Prerequisite Course / Knowledge:

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

Course Outcomes (COs):

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

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

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

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

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	1	1	1	1	1	2	1	1	2	-	3	-	-
CO2	3	2	1	1	1	1	1	1	2	1	1	2	-	3	-	-
CO3	3	2	2	1	1	1	1	1	2	1	1	2	-	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: Basics of Fourier series and transform, sampling and quantisation, different types of signals and systems.

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

Unit 3: Application of concepts using speech signals.

Reference Books:

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

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

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

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

Assignments -- 20%
Quiz-- 30%
End exam -- 50%

Title of the Course	: Digital VLSI Design
Course Code	**:** EC2.408
Faculty Name	**:** Zia Abbas
L-T-P	**:**3-1-0
Credits	:4

Prerequisite Course / Knowledge:

Basic knowledge of digital design.

Course Outcomes (COs):

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

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

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

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

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

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

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

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

	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(gm), Body Effect, Channel-Length Modulation, MOS Transistorises Switch, MOS Inverter, Switching Characteristics, Driving Large Capacitive Loads, CMOS Realization, Switching Characteristics, CMOS NAND, NOR and other basic combinational/sequential circuits, CMOS Complex circuits, CMOS technology scaling, CMOS Gate sizing-logical effort, Complementary CMOS, Pass transistor logic, Dynamic CMOS design, Transmission gate, Layout basics, Floor Planning, Introduction to FinFET technology.

Unit 3: Digital Design - From Power perspective: Introduction, Dynamic power dissipation (Short-Circuit and Switching), Dynamic Power in the Complex Gate, Switching Activity, Switching Activity of Static CMOS Gates, Transition Probability in Dynamic Gates, Power 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 voltage impact.

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

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

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

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

Title of the Course : Disaster Management
Course Code : CE8.401

Faculty Name : Sunitha Palissery
L-T-P : 3-1-1
Credits : 4
(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. Detailed Syllabus:

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, New Delhi
3. Bryant,E., (1995), *Natural Hazards*, Cambridge University Press, New York
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, New York
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 learning by doing term-projects which involves hands-on use of computer programming skills 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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Title of the Course : Distributed Data Systems

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

Course Code : CS4.403
L-T-P : 3-1-1
Credits : 4
(L= Lecture hours, T=Tutorial hours, P=Practical hours)

1. Prerequisite Course / Knowledge:
Data Systems

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

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

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

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

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

4. Detailed Syllabus:
Unit 1: Distributed database, Distributed database architecture (3 hours)
Unit 2: Distributed database design – fragmentation and allocation (6 hours)
Unit 3: Distributed query processing, optimization and execution (8 hours)
Unit 4: Distributed transaction management, concurrency control, recovery, commit protocols (5 hours)

Unit 5: columnar stores and cloud data systems (2 hours)

- Four projects related to the above syllabus will be done by students. Implementation heavy about 3,000 lines of code project.

References:

- Ozsu and Valduriez, Principles of Distributed Database Systems, 4th Edition, Pearson Education, 2020

5.Teaching-Learning Strategies in brief:

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

6. Assessment methods and weightages in brief :

Assignments in theory: 10 marks, Mid Semester Examination in theory: 15 marks , End Semester Examination in Theory: 30 marks, Assessment of four projects: 45 marks

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Title of the Course : Distributed Systems
Course Code : CS3.401
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

	PO1		PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1		1	1	1	1	1	1	1	1	2	1	2	3	3	3	3
CO2	1		2	2	2	3	2	1	1	2	1	2	2	3	3	3	3
CO3	1		1	2	2	1	2	1	1	1	2	1	2	3	3	3	3
CO4	1		2	2	2	1	2	1	1	2	2	1	2	3	3	3	3
CO5	2		2	2	2	1	1	1	1	2	1	2	2	3	3	3	3
CO 6	2	2	2	2	2	1	2	1	1	2	2	2	2	3	3	3	3

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%

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

1.Prerequisite Course / Knowledge:

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

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

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

CO-1 Use the understanding of the earthquake engineering 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	PSO1	PSO2	PSO3	PSO4
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
CO4	3	3	2	3	3	3	2	-	-	-	-	-	3	2	2	3
CO5	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 Vitelmo Bertero.

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.

Title of the Course	: Exploring Masculinities
Faculty Name	: Vindhya Undurti
Name of the Program	: Humanities Elective
Course Code	: HS0.209
Credits	: 2 credits
L - T - P	: 18 Lecture hours (12 classes)
Semester, Year	: Spring 2022

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

Course Description :

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

Course Outcomes :

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

1. Explain how masculinities are socially constructed
2. Understand the connections between harmful masculinities and perpetration of violence
3. Critically reflect on their own individual behavior, socialization patterns and identity development in order to contextualize the understanding of masculinities in the 'personal'.

Course Topics :

Module I:

- Introduction: Origins of scholarly interest and research in masculinities
- How are power, violence and the social construction of masculinities connected?

Module II:

- Gender stereotypes, construction of male identity: An intersectional approach
- Social psychology of sexism: hostile and benevolent sexism and links with violence perpetration

Module III:

- Ethical masculinities

Readings:

Bowker, L. (1998/2013). *Masculinities and violence.* Newbury Park, CA: Sage

https://sk.sagepub.com/books/masculinities-and-violence/n11.xml

Connell, R.W. (2005). *Masculinities*. University of California Press.

Sharma, A., & Das, A. (2016). Men, Masculinities and Violence. *Graduate Journal of Social Science.*

Grading Plan :

Type of Evaluation	Weightage (in %)
Quiz-1 (3-5 questions; answers of 200-300 words)	**20%**
Assignment 1/Reflective piece (1000-word essay)	**30%**
Quiz-2 (3-5 questions; answers of 200-300 words)	**20%**
Assignment 2 (1000-word essay)	**30%**

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 (4-5 sentences) :

The teaching-learning strategy will consist of a combination of powerpoint-based lectures, and discussions on the selected readings. In addition, there will be classroom activities designed to encourage students to take an experiential stance and critically reflect on their own socialization patterns and construction of identities for a critical appraisal of the concepts learnt in class. The participatory methodology of pedagogy will be supplemented with assessments aimed to test comprehension of students' knowledge, as well as their abilities of critical reflection, interpretative reading and structured writing.

Title of the Course : Flexible Electronics
Course Code : EC2.502
Faculty Name : Aftab Hussain
L-T-P :3-1-0
Credits :4
(L= Lecture hours, T=Tutorial hours, P=Practical hours)

1.Prerequisite Course / Knowledge:

Understanding of basic concepts of Physics and Chemistry taught up to the

10+2 level 2. Course Outcomes (COs) (5 to 8 for a 3 or 4 credit course):

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 Articulation Matrix

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

Unit 1: Physics of silicon electronics, silicon band structure, flexible materials Unit 2: VLSI fabrication: silicon wafer, deposition, lithography, etching

Unit 3: Flexible electronic systems, flexible PCBs, interconnects, flexible silicon processes

Unit 4: Flexible displays, flexible TFTs, OLEDs, flexible memory

Unit 5: Flexible energy harvesters, photovoltaics, flexible interconnects

Reference Books:

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 valuations:

Assignments – 20% MCQ

Quizzes –20%

Comprehensive exams:

End semester exam –35%

Term-paper report – 25

Title of the Course : ICTs for Development
Faculty Name : Nimmi Rangaswamy
Course Code : CS9.431
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 Title : Indian Grammatical Tradition
Course Code : CL5.404
Note: Please use course code for previously existing course
CREDITS :2
TYPE-WHEN : Spring 2021
FACULTY NAME : Dipti Misra Sharma
PRE-REQUISITE : None
OBJECTIVE **:** To explore the application of Indian grammatical traditions to modern languages. A major goal of the course would be to study how language conveys meaning.

COURSE TOPICS:

a) Pāṇini's grammar – Basic properties, organization – components and levels
b) Basic concepts
i) Morphology – prakriti and pratyaya vibhag (subanta and tinganta),
ii) Syntax and semantics – vibhakti and karaka, samas, saamarthya
iii) Relation between phrase structure grammar and dependency grammar
iii) Tatparya and Vivaksha
iv) sphota, pravitti nimitta

v) aakaaMkshaa, yogyataa, sannidhi
c) Modelling a computational grammar based on Panini's grammar
d) Mapping Computational Paninian Grammatical framework to Universal Dependency framework.

PREFERRED TEXT BOOKS:

Paul Kiparsky (2002) - On the Architecture of Pāṇini's Grammar∗ George

Cardona (1997) - Pāṇini: A Survey of Research (pg 210 – 225)

***REFERENCE BOOKS:**

Akshar Bharati et al – NLP, A Paninian Perspective

PROJECT:

GRADING PLAN:

Type of Evaluation	Weightage (in %)
Quiz 1	**10**
Quiz 2	**10**
End Sem Eval	**30**
Assignments	**15**
Project	**20**
Seminar	**15**

OUTCOME: An understanding of the Paninian grammatical framework and modelling language in it.

Title of the Course : Internals of Application Servers
Course Code : CS3.404
FACULTY NAME : Ramesh Loganathan
Credits :3-1-0-4
TYPE-WHEN : Spring 2022
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 middle wares and distributed object technology.
Typical distributed platforms' server Technology and Architecture
App Server architecture.
Lifecycle of an application- development, packaging, and deployment thru monitoring in production.
Clustering and High Availability
Distributed app platform Communication models
Contemporary application platforms.
Project problems Discussions
Project architecture & design reviews
Guest lectures from Industry
(Projects built in previous years- JMS Server. Distributed web services platform (SOA). MiroServices Platforms. Ai on the Edge. Fog computing (IOT) platform)

PREFERRED TEXTBOOKS:
***REFERENCE BOOKS:**

GRADING: Class quiz, Labs, and course project

OUTCOME: A systems level understanding of distributed application platforms through building a contemporary platform.

REMARKS:

Title of the Course	**:** Introduction to UAV Design
Faculty Name	**:** Harikumar Kandath
Course Code	**:** EC4.402
Name of the Academic Program	**:** B.Tech in Electronics and Communication Engineering
L-T-P	**:** 3-1-0
Credits	**:** 4

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

1. Prerequisite Course / Knowledge:
Basics of Linear Algebra**,** Laplace transform and Vector calculus**.**

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

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

CO-1 Determine the design specifications of the Unmanned Aerial Vehicle (UAV) used for a particular application.

CO-2 Explain the various design phases involved in the UAV design.

CO-3 Perform the conceptual design and preliminary design for multi-rotor, fixed-wing and hybrid UAVs.

CO-4 Perform the stability and flight performance analysis for the designed UAV.

CO-5 Able to manufacture a prototype UAV.

CO-6 Perform the flight simulation and flight testing of the prototype UAV and verify its stability and performance characteristics**.**

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

	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. Detailed Syllabus:

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

Unit 2: Multi-rotor design--- Concept of operation (CONOPS), design specifications, different reference frames, axis conventions, forces and moments, sizing and assembly, sensors and control.

Unit 3: FWUAV Flight mechanics and control--- wing, fuselage, stabilizer and control surfaces, propulsion system, forces (lift, drag, thrust, side force), moments (roll, pitch, yaw), trim conditions, longitudinal static stability, lateral and directional stability, PID control through successive loop closure.

Unit 4: FWUAV design--- Concept of operation (CONOPS), design specifications, preliminary sizing, airfoil selection, wing planform selection, control surface sizing, stabilizer sizing, selection of propulsion system (battery, motor/engine, propeller), stability and performance analysis, design trade-offs.

Unit 5: Different configurations (tilt-rotor, tail sitter), transition dynamics, design specifications, sizing, stability and control.

Reference Books:

1. Daniel P Raymer, Aircraft Design: A Conceptual Approach, second edition, AIAA USA, 1992.
2. John D. Anderson, Introduction to flight, third edition, McGraw Hill USA, 1989.
3. R. W. Beard and T. M. McClain, Small Unmanned Aircraft: Theory and Practice, first edition, Princeton University Press USA, 2012

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

Weekly lectures based on the course syllabus and based on the latest design technologies available in the literature and other industrial resources. Tutorials covering the use of software for UAV design and performance analysis. Detailed student assignment for practicing the different elements of conceptual design phase. Open book exam followed by detailed project submission including simulation studies, prototype development and flight testing.

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

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

Title of the Course : Introduction to Algorithm Engineering
Faculty Name : Kishore Kothapalli
Course Code : CS1.305
Credits :2
L - T - P :
(L - Lecture hours, T-Tutorial hours, P - Practical hours)

Semester, Year : Spring 2022
(Ex: Spring, 2022)

Pre-Requisites : first course on algorithms, programming, computer architecture/ organization

Course Outcomes:

(list about 5 to 6 outcomes for a full 4 credit course)

The action verbs to be used for writing the course outcomes can be found on slide 22 in the following presentation. You may remove this line and the following link after the course outcomes are formulated.

https://iiitaphyd-my.sharepoint.com/:b:/r/personal/dyacad_iiit_ac_in/Documents/NBA-2020-21/Reference%20Documents/Curriculum%20Design%20in%20NBA%20Framework%20and%20Course%20design%20for%20all%20faculty%20IIIT%20Hyderabad%207th%20july%202021.pdf?csf=1&web=1&e=387W1k

At the end of the course, a student will be able to:

CO – 1: Demonstrate familiarity and scope of algorithm engineering

CO – 2: Explain the significance of algorithm engineering and analyze the practical performance of algorithms in connection to the nature of input

CO – 3: Apply algorithm engineering principles to implement a variety of graph and semi-numerical algorithms

Course Topics :

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

1. Introduction to algorithm engineering, its scope, and its importance – 1
2. Cache-Aware Design: Algorithms and Techniques – 1
3. Cache-Oblivious Design: Algorithms and Techniques -1
4. A Primer on Parallel Algorithms – 3
5. Graph connectivity – 2
6. Eccentricity and Diameter – 2
7. Centrality Measures on Graphs – 2

Preferred Text Books:

Reference Books : Reference papers that are used for some of the course topics will be posted as they are discussed in class.

E-book Links : Book being developed by the instructor available at http://cstar.iiit.ac.in/~kkishore/pgae.pdf

Grading Plan : Since the course is a half-course, we will have one quiz evaluation and one final evaluation.

Type of Evaluation	Weightage (in %)
Quiz-1	**20%**
Mid Sem Exam	

Quiz-2	
End Sem Exam	**30%**
Assignments	**25%**
Project	**25%**
Term Paper	
Other Evaluation	

For Office Use Only (starts on a new page)

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

https://iiitaphyd-my.sharepoint.com/:w:/r/personal/dyacad_iiit_ac_in/Documents/NBA-2020-21/Course%20Content/IIIT-CSE-ECE.docx?d=w111f0effcaea41b3a4d1e8a3fbc6332d&csf=1&web=1&e=z1Khby

	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	1	2	2	2	1	1	1	1	1	2	1	1	2	1	1	2
CO 2	1	2	2	2	1	1	1	1	2	2	1	1	2	1	1	2
CO 3	1	2	3	3	1	1	1	1	2	2	1	1	2	1	1	2

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

The course will have hands-on exercises that help students understand the mechanisms available for algorithm engineering. The course project also equips them to explore an existing algorithm and a problem in depth and gain useful practical knowledge. The material used in the course is not part of standard textbook as yet, so lecture slides and reference papers will be made available for reading.

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

Course Title : INTRODUCTION TO BRAIN AND COGNITION
Faculty Name : KAVITA VEMURI and Vishnu Sreekumar
Name of the Program : BTech CSE
Course Code : CS9.301
Credits : 2
L - T - P : 2-0-0
(L - Lecture hours, T-Tutorial hours, P - Practical hours)

Semester, Year : Spring 2021 (H2)
(Ex: Spring, 2022)

Pre-Requisites : NONE

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: develop understanding and familiarity with seminal research findings in brain and cognition.
CO-2: read, interpret, critique, and evaluate research explaining brain/mind/behavior.
CO-3: critically think about the relationship between diverse fields such neuroscience, cognitive psychology, and cognitive science
CO-4: critical understanding and evaluation of the experiments, methods and practices for empirical and computational investigation of cognition utilizing various instruments by different teams in Cognitive Science Lab in order to make informed decision about the Lab to work for further research in the Dual Degree Program

Course Topics :
(please list the order in which they will be covered, and preferably arrange these as five to six modules.)
Module 1: Introduction
Brain Anatomy basics; Spatial and temporal aspects of the Brain and Cognition; Methods of Investigation of the Brain and Cognition
Module 2: Vision
Visual Perception; Recognizing Objects; Attention
Module 3: Memory
Acquisition; Relation between Acquisition and Retrieval; Memory of Complex Events
Module 4: Knowledge
Concepts; Language
Module 5: Thinking
Problem Solving and Intelligence; Conscious and Unconscious Thought

Preferred Text Books :
- Daniel Reisberg (2019). Cognition: exploring the science of the mind. 7th Edition. W. W. Norton & Company, NY, USA
- V. Srinivasa Chakravarthy (2019). Demystifying the Brain: A Computational Approach. Springer, Singapore (1st Edition).

Reference Books :

- Eric Kandel, James H. Schwartz, and Thomas Jessell (2012). Principles of Neural Science. McGraw Hill Education (5th Edition).
- John R. Anderson (2009). Cognitive Psychology and its Implications. Worth Publishers (7th Edition).

E-book Links :

Grading Plan :
(The table is only indicative)

Type of Evaluation	Weightage (in %)
Quizzes (3 out of 4: each 20%)	**60%**
End Sem Exam	**30%**
Term Paper	**10%**

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	1	1	2	1	1	2	1	1	1	1	1	2	1	1	1	1
CO 2	3	1	2	3	1	3	3	1	1	1	1	2	2	2	3	2
CO 3	2	1	2	2	1	3	2	2	1	1	1	2	1	2	3	1
CO 4	1	1	1	1	1	1	1	1	2	3	1	2	1	1	1	1

Teaching-Learning Strategies in brief (4-5 sentences) :
The IBC course is primarily lecture and discussion-based learning course. Students will be introduced to undergraduate-level introductory topics and issues in brain and cognition. Reading material will be assigned. Students will be required to engage in discussions, and to write a term paper on related topics. Students will be encouraged to relate the theory topics to everyday experiences and will be asked to evaluate the event/phenomenon/ processes critically and scientifically. They will be encouraged to interact with various research teams in Cognitive Science Lab to familiarize themselves with the research projects so that they can start thinking about a future lab to conduct their research work.

Title of the Course : Introduction to Game Theory
Course Code : CS1.408
Faculty Name : Sujit 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

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

CO6	3		3	3	2	2	2	1	1	1	1	1	3	3	3	2	3
CO7	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

Title of the Course : Introduction to Particle Physics
Course Code : SC1.42
Faculty Name : Subhadip Mitra
L-T-P : 3-1-0.
Credits : 4
(L= Lecture hours, T=Tutorial hours, P=Practical hours)

1.Prerequisite Course / Knowledge:
Some exposure to Quantum Mechanics & basic Mathematics (i.e., some linear algebra & complex analysis, basic group theory etc.) and most importantly, interest about the subject.

2.Course Outcomes (COs):

After completing this course successfully, the students will be able to
CO-1 **Describe** the particle content of the Standard Model.
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%)

Title of the Course : Introduction to Philosophy of Technology
Faculty Name : Ashwin Jayanti
Course Code : HSS318
Name of the Academic Programs :B.Tech. in CSE, B.Tech in ECE
L-T-P :3-0-0
CREDITS :4
(L = Lecture hours, T = Tutorial hours, P = Practical hours)

1. Prerequisite Course /Knowledge:
None

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

CO-1: Identify and recognize various conceptions of technology implicit in arguments for/against technology

CO-2: Classify and describe various theories and interpretations of technological change through history

CO-3: Compare analytical and continental approaches to technology and its relation to science and examine the limitations and advantages of both approach

CO-4: Evaluate and assess the moral significance of technical artefacts within particular social contexts

CO-5: Develop and synthesize philosophical frameworks with which to understand and assess the impact of contemporary technologies to society at large

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

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

4. Detailed Syllabus:

Unit I –Introduction: What is Philosophy of Technology? Engineering and Humanities Philosophies of Technology; Classical and Contemporary Philosophy of Technology

Unit II: Encountering Technological Artefacts –Conceptual history of 'technology'; What is 'technology'? Continental and Analytic Perspectives

Unit III: Epistemological Aspects to Technologies –Science, Technology, and Engineering; Philosophy of science and philosophy of technology; Knowing-how and knowing-that

Unit IV: Moral Status of Technologies –Norms, Values, and Technologies; Debates Concerning Moral Significance of Artefacts; Role of Design in Moral Status

Unit V: Philosophical Debates in Artificial Intelligence –Philosophical background to Artificial Intelligence; Philosophical and ethical issues within Artificial Intelligence

REFERENCE BOOKS:

- Hans Achterhuis (ed.), *American Philosophy of Technology: The Empirical Turn*, translated by Robert Crease, Indiana University Press:2001.
- Carl Mitcham, *Thinking Through Technology: The Path Between Engineering and Philosophy*, The University of Chicago Press:1994

- Robert C. Scharff and Val Dusek (eds.), *The Technological Condition: An Anthology (Second Edition)*, John Wiley & Sons:2014
- Peter-Paul Verbeek, *What Things Do: Philosophical Reflections on Technology, Agency, and Design*, translated by Robert Crease, The Pennsylvania State University Press, 2005
- Peter Kroes and Peter-Paul Verbeek (eds.), *The Moral Status of Technical Artefacts*, Dordrecht: Springer,2014.
- Stuart J. Russell and Peter Norvig, *Artificial Intelligence: A Modern Approach* (Second Edition), Pearson, 2003
- John Searle, *Mind: A Brief Introduction*, Oxford University Press:2004

5. Teaching-Learning Strategies inBrief

This course aims at reading, critically evaluating, and thinking through contemporary debates in philosophy of technology. For this purposes, the main strategy is to share the readings and resource material beforehand for the students to acquaint themselves with the topics and use the class time to discuss and evaluate the implications of the various positions respective to each topic. Continuous assessment methods will be employed to make sure the students have acquired the requisite conceptual understanding to explicate and argue for their position with greater nuance and logical rigor.

6. Assessment Methods and Weightages inBrief

Continuous assessment in the form of written assignments will carry the major weightage of the evaluation, with the rest of the weightage assigned to class participation in the ensuing discussions. The assigned weightage is as follows: Assignments: 60 marks, class participation: 10 marks, Mid semester exam: 10 marks, End semester exam: 20 marks.

Title of the Course	**:** Introduction to Quantum Information and Computation
Name of the Academic Program	**:** B.Tech. in Computer Science and Engineering
Course Code	**:** CS4.401
LTP	: 2-1-0.
Credits	: 2

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

Prerequisite Course / Knowledge:

Knowledge of Advanced Linear Algebra, Quantum Mechanics, Classical information Theory

Course Outcomes (COs):

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

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

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

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

CO-4. Design Quantum Circuits with Universal Gates,

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

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

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

Detailed Syllabus:

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

Unit 2. Foundations of Quantum Theory I: States, Ensembles, Qubits, Pure and Mixed states, Multi-qubit states, Tensor Products, Unitary transformations, Spectral Decomposition theorem, Singular value Decomposition, Generalized Measurement, Projective Measurement, POVM (4L)

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

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

Unit 5 Quantum Computation : Introduction to quantum computing, Pauli Gates, Hadamard

Gates, Universal Gates, Quantum algorithms . (2L)

Reference Books:

Preferred Text Books: 1. Quantum Computation and Quantum Information –M. A. Nielsen, I. L. Chuang. Cambridge University Press.

Other Books: 1. Quantum Computer Science: An Introduction --- N. D. Mermin, Cambridge University Press. 2. Quantum Computing: From Linear Algebra to Physical Realizations---M. Nakahara, T. Ohmi, Taylor and Franchis Group. 3. Lectures on Quantum Information (Physics Textbook)---D. Brub, G. Leuchs, WILEYVCH.

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

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

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

Mid	- 20%
End Sem	- 30%
Assignment	- 15%
Quizz	- 15%
Project	-20%

Course Title : A linguistic introduction to Sanskrit
Faculty Name : Peter M. Scharf
Name of the Program : HSS Course
Code : HS1.207
Credits :4
L - T – P **:** L2, P1

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

Semester, Year **:** Spring, 2022

(Ex: Spring, 2022)

Pre-Requisites: None

Course Outcomes:

Read simple Sanskrit containing the common grammatical forms covered, with the help of a dictionary.

Understand the difference between script and phonetics.
Understand sound change laws.

Understand morphological analysis and synthesis.
Understand syntactic structures.

https://iiitaphyd-my.sharepoint.com/:b:/r/personal/dyacad_iiit_ac_in/Documents/NBA-2020-21/Reference%20Documents/Curriculum%20Design%20in%20NBA%20Framework%20and%20Course%20design%20for%20all%20faculty%20IIIT%20Hyderabad%207th%20july%202021.pdf?csf=1&web=1&e=387W1k

Course Topics :

The course surveys basic Sanskrit grammar in a linguistically explicit manner accompanied by traditional oral practice and exercises consisting of readings adapted from ancient Indian narratives.

Week	Topic
Week 1	Ch. 1, Introduction to Sanskrit language and literature; Ch. 2, The Sounds of Sanskrit, and Ch. 3, Devanagari script
Week 2	Ch. 4, Sandhi
Week 3	Ch. 5, Verbs: present and past indicative active and middle of verbs of classes 1, 4, 6, and 10
Week 4	Ch. 6, Nouns: masculine and neuter a-stem
Week 5	Ch. 7, Nouns: feminine long a-stem; a-stem adjectives
Week 6	Ch. 8, Imperative and optative moods a-stem verbs
Week 7	Ch. 9, Mono and polysyllabic fem. long i/u-stem nominals
Week 8	Ch. 10, Present stem of verbs of classes 5, 8, and 9
Week 9	Ch. 11, i/u-stem nominals
Week 10	Ch. 12, Vocalic-r-stem nominals
Week 11	Ch. 12, Present stem of verbs of classes 2, 3, and 7
Week 12	Ch. 12, continued
Week 13	Ch. 13, Consonant stem nominals

Preferred Text Books : शब्दब्रह्मन् Sabdabrahman: a linguistic introduction to Sanskrit

Reference Books :

None E-book Links :

None

Grading Plan :

Type of Evaluation	Weightage (in %)
Weekly homework	**75%**
Quizes	**25%**
End Sem Exam	**0%**

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

https://iiitaphyd-my.sharepoint.com/:w:/r/personal/dyacad_iiit_ac_in/Documents/NBA-2020-21/Course%20Content/IIIT-CSE-ECE.docx?d=w111f0effcaea41b3a4d1e8a3fbc6332d&csf=1&web=1&e=z1Khby

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

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

Lectures introduce new material for intellectual understanding. Memorization internalizes basic information so that it is easily available for application. Exercises apply intellectual understanding and basic information and solidify understanding.

I will introduce new concepts and material once a week and engage students in oral/aural practice in a second meeting. Each meeting will include time to answer questions. Students will regularly do homework using an on-line interactive intelligent exercise platform that provides immediate feedback and supplies links to information to assist students in learning.

Because learning a language involves the cumulative acquisition of knowledge and skills, regular attendance and keeping up with assignments will be essential.

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

Course Title
Faculty Name

Name of the Program : Linear partial differential equations and variational calculus
Faculty Name : **Samyadeb Bhattacharya**
Course Code : **MA4.303**
Credits : **4**
L - T - P :
(L - Lecture hours, T-Tutorial hours, P - Practical hours)

Semester, Year : **Spring**
(Ex: Spring, 2022)

Pre-Requisites : Basic knowledge of ordinary differential equations

Course Outcomes :
a) Getting students equipped with skills to solve practical physical problems.
b) Basic ideas on partial differentiation, state functions, path functions etc.
c) Introductory ideas on thermodynamics, wave propagation and heat conduction in connection to partial differential equations.
d) Solid idea on the basics of partial differential equations and their uses.
e) Basic idea about constructing boundary value problems.

Course Topics :

1. Basic concepts and definitions.
2. Mathematical problems.
3. Linear operators.
4. Superposition principle.
5. First order quasi-linear equations and method of charecteristics.
6. Mathematical models: a) Vibrating strings and membranes, b) Heat conduction, c) Schroedinger equation
7. Classification of second order linear equations.
8. Method of separation of variables.
9. Introduction to eigenvalue problems.
10. Introduction to boundary value problems.

11. Variational calculus. a. Application: Least action principle, brachistochrone and related problems. b. Application:Euler-Lagrange's equation and related problems. c. Hamilton's principle and related problems.

Preferred Text Books : K.T. Tang, Mathematical methods Engineers and scientists 3.

Reference Books : Tyn Myint-U and Lokenath Debnath, Linear partial differential equations for scientists and engineers. (other references will be given during the course)

E-book Links : **Will be shared during the course**

Grading Plan :
(The table is only indicative)

Type of Evaluation	Weightage (in %)
Quiz-1	**10%**
Mid SemExam	**10%**
Quiz-2	**10%**
End Sem Exam	**20%**
Assignments	**25%**
Project	**25%**
Term Paper	
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

https://iiitaphyd-my.sharepoint.com/:w:/r/personal/dyacad_iiit_ac_in/Documents/NBA-2020-21/Course%20Content/IIIT-CSE-ECE.docx?d=w111f0effcaea41b3a4d1e8a3fbc6332d&csf=1&web=1&e=z1Khby

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

CO3																
CO4																
CO5																
…..																
…..																

Teaching-Learning Strategies in brief (4-5 sentences) :
In this course, the main objective is to help the student understand the fundamental aspects of partial differential equations and their usage in practical problems. The course is of two aspects. First is the technical and mathematical aspect, which will be taught meticulously. Second is that of physical and practical, where student will be taught to construct a physical problem.

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

Course Title : Literature and the Ethics of telling a Story
Faculty Name : Sushmita Banerji
Name of the Program : Humanities Elective
Course Code : HS0.210
Credits : 2 credits
L - T – P :
Semester, Year : Spring 2022
Pre-Requisites: Introduction to Human Sciences, Ethics 2 (Basics)

Course Description:

Theodore Adorno famously said, "to write poetry after Auschwitz is barbaric." He was clearly not talking about the act of writing poetry but rather the tension between ethics and aesthetics inherent in an act of artistic production that reproduces the cultural values of the society that generated the mass murder of Jews during WWII. How then does a writer presume to represent/re-present collective acts of extreme brutality while also not validating the culture that produces these violences?
This course shall look at key pieces of literature emerging from periods of extreme violence and orchestrated genocide in the 20th and 21st century to examine and interrogate models of remembering, testimony and representation. Readings shall include writings on the Holocaust, the Partition of India and Pakistan, and regional Indian Literatures.

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

1. Examine key ethical concepts and explain how they work or fail in the historical of war and genocide.

2. Examine prominent writers have dealt with fundamental ethical questions, moral dilemmas and personal failures and successes in key pieces of writing.
3. Synthesize their knowledge of theories and concepts in ethics to critically examine the world they live in and the cultural production they encounter and produce.

Course Topics:

Unit I: Introduction
Ethics in the World
Literature and its dimensions, What is the value of representation?
Unit II:
Ethical Questions and World War II Literature
Ethics of Suffering
Unit III:
Indian Literatures of Strife

Preferred Text Books:

Adorno, Theodor W., 1997. *Can One Live After Auschwitz?: A Philosophical Reader*, ed. by Rolf Tiedemann, trans. by Rodney Livingstone et al, *Cultural Memory in the Present*. Stanford: Stanford University Press (2003)

Ali, Agha Shahid. *A Country Without a Post Office*. Delhi: Penguin, 2013.

Ao, Temsula, *These Hills Called Home: Stories from a War Zone.* Zubaan/Penguin, 2005.

Bhalla, Alok. ed. *Stories About the Partition of India. Vol.1,2,3.* New Delhi: Indus, 1994.

Levi, Primo, *The Truce*, 1963 trans. by Stuart Woolf. London: Abacus Books (1987).

Reference Books:

Caruth, Cathy. *Unclaimed Experience: Trauma and the Possibility of History.* Baltimore: Johns Hopkins University Press, 1996.

Das, Veena, "Language and Body: Transactions and the Construction of Pain." *Life and Words: Violence and the Descent into the Ordinary.* Berkeley: University of California Press, 2007.

Derrida, Jacques, *Demeure: Fiction and Testimony*, with Maurice Blanchot, *The Instant of My Death*, translated by Elizabeth Rottenberg. Stanford: Stanford University Press, 2000.

Lang, Berel, *Holocaust Representation: Art within the Limits of History and Ethics.* Baltimore: The Johns Hopkins University Press, 2000.

Talbot, Ian. "Literature and the Human Drama of the 1947 Partition." *Partition and Post-Colonial South Asia: A Reader, Vol. II. Eds. Tai Young Tan and Gyanesh Kudaisya*. London: Routledge, 2008.

Assessments:

Quiz 1	**10%**
Quiz 2	10%
Quiz 3	10%
Final Quiz 4	20%
Term Paper 1	20%
Term Paper 2	20%

Teaching-Learning Strategies:

Students are expected to read prescribed texts in the course of the semester, watch any video lectures made available, and view films when required. This class is based on close reading of the texts prescribed and relies heavily on student participation and discussion.

This class shall deal with material students might disagree with. All informed disagreements, opinions, and discussions are encouraged. It shall however be the instructor's right to shut down any disrespectful behaviour.

Mapping of Course Outcomes to Program Objectives:

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

Title of the Course : Literature, History, and Belonging in Hyderabad
Course Code : HS1.203
Faculty Name : Nazia Akhtar
Name of the Program : Humanities Elective
Credits : 4

L - T - P : 36 hours (24 classes)
Semester, Year : Spring 2022
Pre-Requisites : Introduction to Human Sciences

Course Outcomes :

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

1. discuss Hyderabad's literary history and understand the role of literature in studying and knowing history;
2. explain the complexities of Hyderabad's history and society and larger questions of identity and belonging;
3. apply important techniques of textual analysis and their experience in writing an argumentative essay in other academic and professional contexts; and
4. devise a thoughtful and informed critical voice that will enable them to meaningfully situate culture and cultural productions in the world around them.

Course Topics :

1. (i) Introduction: Historical and Socio-Political Context
   (ii) The People's Poetry: Dakhni poetry and culture
2. Ghazal Poetry at the Asaf Jahi Court
3. Progressive Writing: Poetry and Novels
4. Women's Writing: Prose and Poetry
5. Writing from the Margins: Contemporary Contexts
6. "Every City is a Story": New Narratives of Globalization

Preferred Text Books : Chapters and excerpts from the following books will form the textbook for this course.

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 Hussaini Alam 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	PO12	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.

Title of the course : Machine Learning for Natural Sciences
Course Code : SC4.411

Faculty Name : Nita Parekh + Prabhakar B + Girish Varma
L-T-P : 4-0-0
Credits : 4
(L= Lecture hours, T=Tutorial hours, P=Practical hours)

Prerequisite Course / Knowledge:

Probability & Statistics, Linear Algebra, Statistical Models in AI

Course Outcomes (COs):

After completion of this course successfully, the students will be able to...
CO-1: Learn and demonstrate understanding the basic concepts in machine learning
CO-2: Demonstrate use of machine learning algorithms on simple problems
CO-3: For a selected problem, apply the understanding of the principles, to formulate a problem statement
CO-4: Build Models based on requirements of the problem statement
CO-5: Analyze the constructed models for their usefulness, find deficiencies and identify possible improvements.

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

	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%

Title of the Course : Mechatronics System Design
Faculty Name : Nagamanikandan + Harikumar K
L-T-P : 3-1-0
Credits : 4
(L= Lecture hours, T=Tutorial hours, P=Practical hours)

1. Prerequisite Course / Knowledge:

Basic programming (Python, C++), Linear Algebra, Numerical methods, Basic microcontroller knowledge.

2. Course Outcomes (COs):

After completion of this course successfully, the students will be able to CO-1 Describe important elements of mechatronics system

CO-2 Apply the previous knowledge of microcontroller programming for controlling multidisciplinary mechatronic systems.

CO-3 Describe and design basic mechanical elements and their feedback control. CO-4 Synthesize and analyze a range of mechanisms.

CO-5 Design and execute a multidisciplinary project based on the given specifications as part of a team.

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

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

CO3	3	2	2	1	2	1	1	1	1	2	1	2	1	1	1	3
CO4	3	3	3	1	2	1	1	1	1	2	1	3	1	1	1	3
CO5	3	3	3	2	3	2	2	1	3	3	2	3	1	2	3	3

4. Detailed Syllabus:

Unit 1: Sensors and Actuators:

Sensors for robotics application - position, speed, acceleration, orientation, range. Actuators - general characteristics, motors, control valves.

Unit 2: Computer based feedback control:

Sampled data control, sampling and hold, PID control implementation, stability, bilinear transformation.

Unit 3: Introduction to mechanical elements and transformations, basic concepts of kinematics and dynamics.

Unit 4: Design and analysis of mechanisms.

Unit 5: Programming and hardware experiments.

Reference Books:

1. Bentley, John P. "Principles of measurement systems," Pearson education, 2005.
2. D.R. Coughanowr, "Process system analysis and control," McGraw Hill, 1991
3. G.F. Franklin, J.D. Powell and M.L. Workman, "Digital control of dynamic systems", Addison Wesley, 3rd edition, 1998.
4. Hartenberg, R., & Danavit, J, "Kinematic synthesis of linkages," McGraw Hill, 1964.
5. http://wiki.ros.org/
6. User manual of microcontroller and data sheets of sensors and actuators

5. Teaching-Learning Strategies in brief:

This course aims to teach the students about designing and developing a mechatronics system by providing them with essential hardware and software. Part of the class is devoted to a learn-by-doing lesson where the students will learn theory and get hands-on experience with various aspects of the mechatronics system.

The goal for the students is to design, build, and debug the electromechanical system for a given task as a part of the course project.

6. Assessment methods and weightages in brief:

Mid semester exam 20%

Assignments 40%

The class work assignments will be based on the application of a step-by-step engineering design process to a problem assigned in the course.

Project 40%

Proposal (5%)

Project demonstration (25%)

Final report (10%)

TITLE OF THE COURSE : Minds, Machines, and Intelligence
Course Code : HS0.205
Faculty Name : Don Dcruz
CREDITS :4
PRE-REQUISITE : None

OBJECTIVE: Recent advances both in the fields of AI and cognitive science have initiated vigorous debates about data intensive machine learning models invading crucial aspects of society and how developments in unraveling the workings of the human brain puts technology on a path to realize robust artificial general intelligence. The course will critically explore our conceptual grasp of notions like thinking, rationality, and intelligence from a philosophical standpoint. The aim is to locate the known shortcomings of current AI with respect to what we understand about human cognition within debates in epistemology, philosophy of science and ethics. To achieve this, the course journeys through some fundamental philosophical questions like 'Can machines really think in the way humans do, and can they have conscious experiences like thoughts, desires and emotions?', 'Is machine intelligence and human intelligence comparable or are they fundamentally different?', and 'Can machines be held morally responsible for their decisions and can it learn what is right and wrong?'. The goal is to equip students with some intellectual tools to successfully navigate the coming age of intelligent systems.

COURSE TOPICS:

Module I: Philosophical preliminaries

Topic 1: Techniques and devices: argument analysis, logical tools, inference to the best explanation, conceptual distinctions, thought experiment, belief, knowledge, evidence, justification, confirmation, explanation, theory, model.

Module II: Metaphysics

Topic 2: The nature of cognition: Turing, Searle, qualia and consciousness. Topic 3: Computation and the philosophy of cognitive science

Module III: Epistemology

Topic 4: Nature of deep learning's success and standard criticisms, contemporary version of the rationalist vs empiricist debate, relevant history of philosophy (Locke, Berkeley, Hume and Kant).

Topic 5: Epistemological issues in AI: adversarial examples and knowledge, epistemic opacity of deep learning models and interpretability, explanation vs prediction in philosophy of science, use of deep learning models in science.

Module IV: Ethics

Topic 6: The problem of encoding normative principles, virtuous machines, artificial moral agents, conditions for responsibility, conceiving singularity and its risks.

READINGS: The complete set of topic-wise readings, including all reference books and papers, will be made available once the course begins. Given below are the books and articles, selections from which form which form the core readings for the lectures.

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.

Title Of the Course : Multivariate Analysis

Course Code : MA4.405

Faculty Name : Venkateshwarlu M

L—T—F : 3-1-0

Credits : 4

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

2. **Course Outcomes**

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 outcomes	Program Outcomes												Program Specific 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.

Title of the Course : Music, Mind, and Technology
Course Code : CS9.434
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 **:** Next Generation Sequence Data Analysis
NAME OF FACULTY **:** Nita Parekh
Course Code **:** SCI653
L-T-P **:** 3-1-0
(L= Lecture hours, T=Tutorial hours, P=Practical hours)
Credits **:** 4
Name of the Academic Program: CND

1. Prerequisite Course / Knowledge: Bioinformatics Course

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

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

CO-1: Handle confidently different types of next generation sequencing data.

CO-2: Appreciate mathematical and algorithmic concepts for whole genome and exome assembly, both reference-based and de novo and learn to carry out the analysis on real data.

CO-3: Identify different types of variations in NGS data, viz., small sequence variations, copy number variations, insertions and deletions, inversions and translocations, and annotate the variants.

CO-4: Perform differential gene expression analysis using NGS data

CO-5: Use judiciously different tools and databases for end-to-end analysis of NGS data.

The course provides in-depth hands-on analysis of NGS data using various publicly available resources and prepares the student for his research.

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

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

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: Workflow of NGS data analysis, Types of reads - single-end, paired-end, mate-pairs Sequencing technologies – Illumina, SOLiD, 454 - read lengths, accuracy, biases introduced, etc. Applications of NGS sequencing - RNA-Seq, De novo sequencing, non-coding RNA sequencing, bisulphite sequencing, metagenomics by NGS, etc.

Unit 2: Introduction to some basic Unix/Linux/R commands, NGS Data Formats - FASTA, FASTQ, SFF, VCF, SAM/BAM, etc., Parsing NGS Files (Accessing, Querying, Comparing, etc.)

Unit 3: Algorithms in Short Read Alignments. Alignment based assembly – Bowtie, BWA, De novo assembly – de Brujin graph. Tools for alignment-based assembly - Bowtie (genome), BWA (genome), HISSAT (transcriptome)

Unit 4: Downstream analysis of alignment-based assembly. Methods for identification of variants (genome-level), Data-preprocessing, Data pretreatment, Data analysis for Single nucleotide variations (SNVs), Structural variations (SVs) - CNVs, indels, inversions and translocations, Visualization and Annotation of variants, Differential gene expression analysis (CuffDiff) – (transcriptome-level)

Unit 5: Tools for de novo assembly - Velvet (genome), Soapdenovo (genome), Cufflinks (transcriptome). Downstream analysis of de novo assembly - Genome annotation, Enrichment analysis

Unit 6: Small RNA analysis

Reference Books:

1. Research Papers (to be uploaded on course website)
2. Algorithms for Next Generation Sequencing, Wing-Kin Sun
3. https://en.wikibooks.org/wiki/Next_Generation_Sequencing_(NGS)

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

The course will provide the skills to perform comprehensive genome analysis using next generation sequencing data, both at the whole-genome level (WGS) and transcriptome-level (RNAseq). A major component of the course is hands-on-sessions, wherein various publicly available resources will be used to carry out the analysis on real genome/transcriptome data to address biological problems. The course structure will be one theory lecture followed by one lab session. The course also has a project component wherein the students will carry an end-to-end
genome analysis using NGS data for a biological problem and submit a term paper on some recent application of NGS data analysis.

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

Assignment - 15%
Term paper + Project - 15%,
Mid semester exams - 20%
End semester exam - 50%

Title of the Course : Nonlinear dynamics
Course Code : SC1.315
Faculty Name : Abhishek Deshpande
L-T-P :3-1-0
Credits :4
(L= Lecture hours, T=Tutorial hours, P=Practical hours)

1.Prerequisite Course / Knowledge:

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

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

CO-1: Apply geometrical, analytical, and numerical methods for analyzing non-linear dynamics
CO-2: Calculate fixed points and determine their stability
CO-3: Analyze various types of bifurcations in one and two dimensions
CO-4: Analyze limit cycles and their stability
CO-5: Analyze chaotic dynamics
CO-6: Analyze discrete maps and period doubling
CO-7: Apply theoretical methods for analyzing nonlinear dynamics to problems in sciences and engineering.

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

	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%

Title of the Course : Optical Remote Sensing
Course Code : CS9.436
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**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	1	2	1	2	1	1	1	1	1	1	1	2	2	2	2
CO2	2	1	2	2	2	2	2	2	2	1	2	2	3	2	2	2
CO3	2	2	2	2	3	2	1	1	1	1	2	2	2	2	2	2
CO4	2	2	2	2	2	1	1	1	1	1	2	2	2	2	2	2
CO5	2	2	2	2	3	2	2	2	2	1	2	3	3	2	2	2
CO6	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-push broom; Aerial photographs-satellite image; types of resolutions and their trade off

Unit-3: Physics of Electro Magnetic Radiation (EMR) EMR properties/characteristics-wave model-particle model; Radiation laws applicable to remote sensing: EMR interaction with Atmosphere and Earth materials: EMR interactions with atmosphere, atmosphere structure,

Atmosphere blinds – windows; Absorption-scattering mechanism- types; EMR interactions with earth surface material-Specular - Diffuse; Albedo.

Unit-4: Data acquisition and image characteristics: Data creation at sensor level – telemetry-ground station acquisition: Old data formats (BIL, BIP, BSQ) and current; Data products: Special Products –Processing software, Image characteristics, and FCC creation-types. Additional ways of Acquiring data in Non-optical or near Optical Image processing

Unit-5: Image pre-processing: Image restoration- Atmosphere errors, correction-methods; Correcting geometric distortions – Types of errors, Spatial and pixel interpolation (types), map

projections and types: Image Enhancement - Contrast and Spatial enhancement, Hue, Intensity, and Saturation transformations, 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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TITLE **:** Optimization Methods
Course Code **:** CS1.404
CREDITS **:** 4 Credits
L-T-P **:** 3-1-0
TYPE-WHEN **:** Spring 2022
FACULTY NAME **:** Dr. Naresh Manwani
PRE-REQUISITE **:** Strict Prerequisites: NIL

EXPECTED BACKGROUND:

To follow this course, some level of familiarity with linear algebra (specially, vectors and matrices) is expected. In addition, student is expected to know the fundamentals of algorithms and some of the popular problems (eg. shortest path.)

OBJECTIVE:

1. To enable students to formulate and solve problems in an optimization framework.

2. To expose a set of powerful tools and techniques to the students. To demonstrate how these tools (i.e. optimization methods) can be used in practice.

3. To visualize the optimization algorithms and know the numerical and practical issues in their implementation.

4. To relate the optimization methods to applications in diverse areas.

COURSE TOPICS:

1. CO-1: Linear Programming, Geometric Interpretation, Simplex Method, Duality, primal dual method, Interior point methods, Ellipsoidal methods, Computational Issues.

2. CO-2: Integer programming, LP relaxation, Examples from combinatorial optimization. Shortest paths, network flows and matchings.

3. CO-3: Convex sets and functions. Need for constrained methods in solving constrained problems.

4. CO-4: Unconstrained optimization, Optimality conditions, Gradient Descent, Newton Method, Quasi- Newton Methods, Trust Region Methods. Conjugate Gradient Methods. Least Squares Problems.

5. CO-5: Constrained Optimization, Optimality Conditions and Duality. Convex Programming Problem. Quadratic Programming. Dual Methods, Penalty and Barrier Methods, Interior Point Methods.

6. CO-6: Linear Equations, Solutions based Matrix Factorization, Singular Value Decomposition,

7. CO-7: **Additional topics** (if time permits) related to

    1. Specific Algorithms (eg. Cutting plane algorithms, Stochastic gradients)

    2. Applications in Approximate Algorithms

    3. Computational issues in large scale optimization

    4. Heuristic methods for optimization

PREFERRED TEXT BOOKS:

1. S. Boyd and L Vandenberghe, ``Convex Optimization'', Cambridge University Press (Online Copy available at: http://www.stanford.edu/~boyd/cvxbook/).

2. L Vandenberghe, Lecture Notes for Applied Numerical Computing, (Online available at: http://www.ee.ucla.edu/~vandenbe/103/reader.pdf).

3. Edwin K. P. Chong, Stanislaw H. Żak, Introduction to Optimization, Fourth Edition, Wiley-Inter science Series in Discrete Mathematics and Optimization, John Wiley & Sons.

REFERENCE BOOKS:

1. M T Heath, ``Scientific Computing'', TMH (Most of First six chapters)
2. C H Papadimitriou and K Steiglitz, Combinatorial Optimization: Algorithms and Complexity'' (Most of First seven chapters), Dover.
3. D Bertisimas and J N Tsitsiklis, ``Introduction to Linear Optimization'', Athena Scientific.
4. J Matousek and B. Gartner, ``Understanding and Using Linear Programming'', Springer, 2007.

OUTCOME:

This course will help in sharpen the problem-solving skills of students. Students will have experience informally stating problems with the associated constraints, and solving them with computer friendly algorithms.

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

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

CO 7	3	3	3	3	3	-	-	-	2	2	2	2	3	3	3	3

GRADING PLAN:

Type of Evaluation	Weightage (in %)
Small Quizzes (10 quizzes)	10%
Mid-Sem Exams (2)	30%
End Sem Exam	20%
Assignments	25%
Term Paper/Project	10%
Scribe	5%

Course Title : Performance modeling of computer systems
Faculty Name : Tejas Bodas
Name of the Program : CSE and ECE
Course Code : CS3.307
Credits : 2
L - T – P :

(L - Lecture hours, T-Tutorial hours, P - Practical hours) 2-0-0

Semester, Year **: Spring 2022**

(Ex: Spring, 2022)

Pre-Requisites **: MA6.101 Probability and Statistics**

Course Outcomes **:**

Course outcomes (CO's): After completion of the course, the students will able to

1. Explain and identify the role of performance modeling in different computer systems such as data networks, server farms and cloud computing platforms.

2. Apply Markov chains to model and a variety of computer systems and analyze their performance metrics like response time, waiting time or job loss probability.
3. Derive expressions for the average delay or average number of jobs waiting for service in a variety of queueing systems.
4. Design and analyze the performance of multi-server queueing systems that have applications to cloud computing
5. Analyze and understand the impact of scheduling policies like FIFO, LIFO, processor sharing and random routing on the performance of queues.
6. Identify causes for performance degradation (large latency problem) in queueing systems and offer easy scalable solutions

Course Topics : Following is the tentative list of topics to be covered in this course in about 12 lectures. (Each lecture is of 90 mins.)

Module 1: (2 lectures)

- Motivation to Performance modeling (Modeling = Design + analysis)
- Probability refresher
- Basics of Stochastic processes

Module 2: (2 lectures)

- Discrete time Markov chains
- Continuous time Markov chains

Module 3: Elementary Queues (2 lectures)

- M/M/1 queue
- Loss queues
- Little's law and PASTA property

Module 4; Server-farms and networks (3 lectures)

- Multi-server queues
- Network of queues
- load balancing systems
- Applications to data centers, cloud computing and distributed systems

Module 5: Scheduling and resource allocation in computer systems (3 lectures)

- M/G/1 queues
- Performance analysis of FIFO, round-robin, processor sharing, LCFS
- SMART scheduling policies

Preferred Text Books: Performance modeling and design of computer systems (Cambridge press) by Mor Harchol-Balter (Professor, CMU)

Reference Books : 1) Probabilistic modeling by Isi Mitrani

2) Queueing Systems (vol 1 and 2) by Klienrock

E-book Links : NA

Grading Plan :

(The table is only indicative)

Type of Evaluation	Weightage (in %)
Quiz-1	15
Mid SemExam	30
Quiz-2	15
End Sem Exam	40
Assignments	0 0
Project	0
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). Program outcomes are posted at

https://iiitaphyd-my.sharepoint.com/:w:/r/personal/dyacad_iiit_ac_in/Documents/NBA-2020-21/Course%20Content/IIIT-CSE-ECE.docx?d=w111f0effcaea41b3a4d1e8a3fbc6332d&csf=1&web=1&e=z1Khby

	P O1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12	PS O1	PS O2	PS O3	PS O4
C O1	3	3	3	2	1	1	2	1	1	1	1	2	3	2	3	3
CO2	3	3	3	2	2	1	2	1	1	1	1	2	3	2	3	3
CO3	3	3	3	2	2	1	2	1	1	1	1	2	3	2	3	3
CO4	3	3	3	2	1	1	2	1	1	1	1	2	3	2	3	3
CO5	3	3	3	2	1	1	2	1	1	1	1	2	3	2	3	3
Co6	3	3	3	2	2	1	2	1	1	1	1	2	3	2	3	3
…..																

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

- The course is planned to be a fine balance between theory and practice.

- Traditionally, this course has been a theory intensive course with little emphasis on practical applications. We will however flip this around.
- We will introduce theoretical mathematical concepts on a need to know basis or as and when required.
- The emphasis will be to look at plenty of practical examples of queueing systems that we encounter not just in our daily lives but also see in advanced computing systems.
- The goal is not only to design queueing systems that offer better performance guarantees but also to be able to analyze such systems so as to fine tune or control them.
- The 12 lectures are meant to be very interactive, there would be lot of discussion and exchange of ideas on the design aspect of queueing systems.
- As for the analysis, ample practice problems and practice assignments would be provided to gain analytical expertise.

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

Title of the Course : Physics of Soft Condensed Matter
Course Code : SC2.301
Faculty Name : Marimuthu Krishnan
L-T-P : 3-1-0
Credits : 4

1.Prerequisite Course / Knowledge:
Science-I and Science-II (for non-CND students); thermodynamics and basic statistical mechanics (for CND students)

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

After completion of this course successfully, the students will be able to
CO-1 Apply theoretical and numerical methods to analyze the structure and dynamics of soft condensed matter
CO-2 Analyze the time evolution of phase space probability density functions for many-body systems
CO-3 Calculate radial distribution functions and structure factors for condensed systems
CO-4 Explain density fluctuations and fluctuation dissipation theorem
CO-5 Calculate radial distribution functions and structure factors for condensed systems
CO-6 Explain fluctuation theorems for non-equilibrium systems

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

	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 Title : Physics of Early Universe

Course Code : SC1.415

Name of the Faculty : Diganta Das
L-T-P : 3-1-0
Credits : 4
(L= Lecture hours, T=Tutorial hours, P=Practical hours)

1.Prerequisite Course / Knowledge:
Differentiation and integration, classical mechanics, electricity and magnetism

2.Course Outcomes (COs) (5 to 8 for a 3 or 4 credit course):
After completing this course successfully, the students will be able to
CO-1 **Explain** the large-scale structure of the universe and its observational components
CO-2 **Demonstrate** understanding of how mass, radiation distribution shapes the dynamics of the universe
CO-3 **Apply** their knowledge and **calculate** dynamical properties of few model universe
CO-4 **Discover** the thermal history of the early universe
CO-5 **Familiarize** themselves with several unsolved problems in the research of cosmology

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

	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. Cosmicmicrowave 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%

Title of the Course : Principles of Information Security
Name of the Academic Program : B.Tech. in Computer Science and Engineering
Course Code : CSE418
Credits: 4
L-T-P: 3-1-0
(L= Lecture hours, T=Tutorial hours, P=Practical hours)

1. Prerequisite Course / Knowledge:

Basic principles of algorithms.

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

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

CO-1 Discuss mathematic concepts of cryptographic primitives

CO-2 Describe fundamental concepts and algorithms of cryptography, including encryption/ decryption and hash functions

CO-3 Summarize different authentication techniques and describe programs like PGP & S/MIME

CO-4 Discuss network security principles, applications, and practices

CO-5 Analyse protocols for various system security objectives using cryptographic tools

CO-6 Evaluate the role of different security mechanisms like passwords, access control mechanisms, firewalls, etc.

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

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO 11	PO12	PS O1	PSO 2	PSO 3	PSO 4
CO 1	3	2	1	1									2	1		2
CO 2	3	2	2	2									3	2	2	3
CO 3	1	1	2	1									2	1	1	2
CO 4	2	2	2	2									2	1	2	2
CO 5	2	3	2	3									3	2	2	2
CO 6	1	1	2	1									1	1	2	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. Detailed Syllabus:

Unit 1: **Introduction:** Security Trends, Security attacks, Security services, Security Mechanisms, A Model for Network Security Model, Classical Encryption Techniques, Symmetric Cipher Model, Substitution Techniques, Transposition Techniques, Rotor Machines, Steganography.

Unit 2: **Block Ciphers and Data Encryption Standard:** Block Cipher Principles, Data Encryption Standard, Strength of DES, Differential and Linear Cryptanalysis, Block Cipher Design Principles, Advanced Encryption Standard, Evaluation Criteria of AES,AES Cipher, Multiple encryption and Triple DES, Block Cipher Modes of Operation, RC4.

Unit 3: **Public-key Encryption and Hash Functions:** Principles of Public Key Cryptosystems, RSA Algorithm, Key Management, Message Authentication and Hash Functions, Authentication

Requirements, Authentication Functions, Message Authentication, Hash Functions, Security of Hash Functions and MACs, Digital Signatures, Authentication Protocols, Digital Signature Standard.

Unit 4: **Network Security Applications:** Kerberos, X.509Authentication Service, Public Key Infrastructure, Pretty Good Privacy, S/MIME , IP Security Overview, IP Security architecture, Authentication Header, Encapsulating Security Payload, Combining Security associations, Key Management.

Unit 5: **System Security:** Secure Socket Layer and Transport Layer Security, Secure Electronic Transaction, Intruders, Intrusion Detection, Password Management, Malicious Software, Firewalls, Trusted Systems

Reference Books:

1. W. Stallings, Cryptography and Network Security Principles & Practices, 4th edition, Prentice Hall, 2005
2. J. Katz and Y. Lindell, Introduction to Modern Cryptography, CRC Press, 2007
3. B. Schneier, Applied Cryptography, 2nd edition, John Wiley & Sons, Inc, 2001
4. Research papers

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

Lectures by integrating ICT into classroom teaching; tutorials involving problem solving; being a fundamental course, it requires critical thinking and active learning by the students to solve problems.

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

Assignments	30 marks
Mid Semester Examination	30 marks
End Semester Examination	40 marks

Title of the Course : Principles of Semiconductor Devices
Course Code : EC2.409
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

Title of the Course : Product Management 101
Faculty Name : Ramesh lognathan
Course Code : PD2.401
Program : M.Tech I Year I Semester – Product Design and Management*
L-T-P : 3-1-0
(L= Lecture hours, T=Tutorial hours, P=Practical hours)
Credits : 2

1.Prerequisite Course / Knowledge:

No prerequisites are required

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

Course Outcomes :

Introduction to Product Management. Product management is an organizational function that guides every step of a product's lifecycle — from development to positioning and pricing — by focusing on the product and its customers first and foremost. To build the best possible

product, product managers advocate for customers within the organization and make sure the voice of the market is heard and heeded.

Course Topics :

Product Management Strategies (Product-Market strategies)Defining and Building products for

success in the markets.

Evaluating product-market fit

Develop a product mindset needed to bring viable products (or services) to market

Define the problem a product will solve while mapping the customer's journey and articulate user personas

Product roadmaps, prototyping decisions and product management techniques and

practicesAgile methods of software development and the Product Management process.

Preferred Text Books : None

Reference Books :

E-book Links :

Grading Plan : Class quizzes, Lab assignments, Mini project

(The table is only indicative)

Type of Evaluation	Weightage (in %)
Class Quizes	**10**
Qui z 1 (no Quiz 2)	**10**
Assignments	**30**
Project	**20**
End Sem Exam/ Term paper	**30**
Other Evaluation	

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

Course : Program Verification

Faculty Name : Venkatesh Chopella

Course Code : CS1.303

Credits **: 3-1-0-2**

1 Course structure

Name Program Verification

Credits 2, Lectures-Tutorials-Practicals=3-1-0 (hours/week)

Instructor Venkatesh Choppella

2 Prerequisite courses

1. Computer Programming
2. Discrete Mathematics

3 Course outcomes

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

1. **CO1: Specify simple computational problems** Use logic and func- tional notation to precisely specify a problem in terms of an input- output relation. This includes problems related to elementary data structures and sequential algorithms.
2. **CO2: Model sequential algorithms as iterative systems** Model se- quential algorithms for searching and sorting and basic graph algo- rithms as simple iterative systems.
3. **CO3 Prove sequential algorithms correct** Write down a complete proof of total correctness of sequential algorithms for searching and sorting.
4. **CO4: Use verification tools** Develop facility to use software tools (Dafny, or Z3 etc.) for expressing and verifying correctness of algorithms

4 Mapping of Course Outcomes to Programme and Programme Specific Outcomes

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

Programme Outcome (PO/PSO)	CO1	C02	C03	C04
PO1 Engg. Knowledge	3	3	3	3

P02 Problem Analysis	3	3	1	1
PO3 Design/Develop	3	3	3	3
PO4 Complex Problems	2	2	2	2
PO5 Modern tool usage	1	1	1	3
PO6 Engr. & Society	1	2	3	2
PO7 Environment & Sustainability	1	1	1	1
PO8 Ethics	1	2	2	1
PO9 Team work	1	1	1	2
P10 Communication	3	3	3	3
P11 Project Mgmt & Finance	1	1	1	1
P12 Life learning	3	2	2	2
PS01 Specialised knowledge	3	3	3	3
PS02 Roadmap for technologies	3	3	3	3
PS03 Research &	3	3	3	3
Programme Outcome (PO/PSO)	CO1	C02	C03	C04
~~Development Skills~~				
PS04 Potential for PG study	3	3	3	3

5 Syllabus

Propositional Logic: Syntax of propositional logic. Evaluation of propo- sitional logic formulas. Analytical tableaux. Deduction Systems.

First Order Logic: Quantifiers, syntax of first order logic. Evaluation. Deduction Systems. Applications to program specification. Writing proofs.

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

Hoare Logic Programs as predicate transformers. Hoare rules for assign- ment, sequential composition, conditional composition and iteration. Proofs in Hoare Logic.

6 Texts and References

6.1 Textbooks

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

MICS *A Mathematical Introduction to Computer Science*. Kasturi Viswanath.

Universities Press, 2008. This is the main text for the second half of the course. Reserve copies in the library.

6.2 Other References

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

7 Teaching and Learning strategies

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

8 Assessment (Tentative)

Item	Weight (%)
Homeworks	35
Quiz	15
Mid-semester exam	20
Final exam	30

Appendix: Programme and Programme Specific Out- comes

Programme Outcomes (POs)

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

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

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

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

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

PO6 The engineer and society Make judicious use of resources and un- derstand the impact of technology across the societal, ethical, environ- mental, and economic aspects.

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

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

PO9 Individual and team work Work efficiently in individual and team- oriented projects of varying size, cultural milieu, professional accom- plishments, and technological backgrounds.

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

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

PO12 Life-long learning Exhibit the aptitude for independent, continu- ous, and life-long learning required to meet their professional and career goals.

Programme Specific Outcomes (PSOs)

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

PSO2 Perform gap analysis in terms of systems and technologies and pre- pare roadmaps for incorporating state-of-the-art technology into sys- tem analysis, design, implementation, and performance.

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

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

Course Title : Quantum Algorithms
Faculty Name : Shantanav Chakraborty
Name of the Program : Computer Science Elective (UG3, UG4, Dual degree)
Course Code : New course
Credits :4
L - T - P: 3-1-0 (L - Lecture hours, T-Tutorial hours, P - Practical hours)

Semester, Year: Spring 2022

Pre-Requisites: Familiarity with basic Linear Algebra, probability theory, discrete math, algorithms

Desirable: Knowledge of elementary quantum mechanics.

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

CO.1 (Understand level) – Demonstrate familiarity with the basic postulates of quantum mechanics, quantum circuits, quantum algorithmic primitives, various basic and advanced quantum algorithms and their running times, different quantum computational models

CO.2 (Analyze level) – Analyze the behavior of basic and advanced quantum algorithms

CO.3 (Evaluate level) – Review literature on the state-of-the-art quantum algorithms

CO.4 (Evaluate level) – Evaluate the complexity of quantum algorithms in various computational models

Course Topics :

Unit 1: Introduction to quantum mechanics, qubits, quantum circuits, Deutsch Deutsch-Jozsa algorithm

Unit 2: Quantum Fourier Transform, Simon's algorithm, Quantum phase estimation, Shor's Factoring Algorithm.

Unit 3: Grover's search algorithm, Quantum amplitude amplification, Analog quantum search

Unit 4: Quantum walks, Quantum walk search, Element distinctness problem, Glued trees algorithm, Adiabatic quantum computing

Unit 5: Hamiltonian simulation, Linear combination of unitaries, The block-encoding framework

Unit 6: Quantum algorithms for solving linear systems and least squares, Quantum machine learning: reading the fine print

Preferred Text Books:

There is no required text book for this course. Good introductory material:

- MA Nielsen and IL Chuang, Introduction to Quantum Information and Computation,Cambridge University Press (2010)
- P. Kaye, R. Laflamme and M. Mosca, An Introduction to Quantum Computing, OxfordUniversity Press (2007)

These two books contain almost all the topics to be covered in Unit 1, Unit 2 and Unit 3.

Reference Books:

The following lecture notes are also recommended reading material:

- Lecture notes on Quantum Computation by John Preskill (Caltech)
- Lecture notes on Quantum Algorithms by Andrew Childs (U. Maryland)
- Lectures notes on Quantum Computation by Ronald de Wolf (CWI)

These lecture notes are updated periodically and covers some of the more recent topics on thesubject (Unit 4, Unit 5, Unit 6).

A great self-learning material for beginners is "Why now is the right time to study quantumcomputing", by Aram Harrow.

Additionally, we will be using various research articles throughout the course.

Grading Plan:

Type of Evaluation	Weightage (in %)
Assignments	20
Quiz	15
Course project	35
Final Exam	30

Course project details:

Students have to submit a course project where they have to work on a topic related to quantum algorithms. While a list of suggested topics will be made available, students are free to choose theirown topic. Along with surveying prior art, the students are strongly encouraged to identify or propose new research directions in that area.

The students can work on their own or form small groups of 2-3 students. The course project evaluation will have the following components:

- Project proposal (*5% of project grade*) – to be submitted by the end of Lecture 12
- Project presentation (*40% of project grade*) – to be made to the class (mandatory 10 minsallocated for questions)
- Paper (*55% of project grade*) – to be submitted by the end of the course

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

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

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

The lectures will facilitate inter-student and faculty-student discussions by incorporating small in-class exercises. There will be homework assignments that would help the student to re-engage with the essential components of the lecture and will test the student's ability to apply key concepts learnt, and also inform the faculty of the progress being made by the students in acquiring them. Given the advanced nature of the course, there will be a significant exploratory component: students will have to submit a course project on a topic related to quantum algorithms, wherein the students will be encouraged to not only review existing literature on the topic but also explore the possibility of identifying new possible research directions. Project presentations will facilitate inter-student discussions and exchange of new ideas.

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

Course Title : Questions of Crime and Punishment in Literature
Faculty Name : Nazia Akhtar
Name of the Program : Ethics 2 Sub-Elective
Course Code : HS0.208
Credits : 2 credits
L - T - P : 18 Lecture hours (12 classes)
Semester, Year : Spring 2022
Pre-Requisites : Introduction to Human Sciences, Ethics 1 (Basics)

Course Description :

What are the ethical questions that human beings struggle with? How do we make ethical choices? For that matter, how do ethical choices present themselves to us in the first place? How do we define a moral life as individuals? The study of ethics offers ways to approach ethical questions and lets us deliberate and think about them. Ethics have also always been an important concern of literature. Literature places human beings in a specific context and gives us a glimpse into their lives, choices, and actions, allowing us to see how these play out and what are the motivations, implications, and consequences involved. The impact and influence of creative writers, such as Fyodor Dostoevsky and Leo Tolstoy, on discussions of the big questions with which humanity grapples far exceed their specific context and milieu and remain relevant in today's world. This course will provide students the opportunity to examine, analyse, and discuss age-old ethical and moral dilemmas through their writings.

Course Outcomes :

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

4. examine key ethical concepts and explain how they work in a given context. These skills are portable and will stand students in good stead in the study and application of ethics in broader contexts.
5. assess how one of the most prominent creative writers and thinkers in history approached fundamental ethical questions, and analyse the development of ethics in his work.
6. synthesize their knowledge of theories and concepts in ethics with the ability to think and communicate carefully about ethical questions beyond casual statements or impressions, strengthening fundamental skills in critical thinking.

Course Topics :

Module I:

- Introduction: Ethics in the World
- Historical and Socio-Cultural Context

Module II:

- Ethical Questions in *Crime and Punishment*: ethical relativism, egoism, consequentialism, deontology, virtue ethics, feminist ethics

Module III:

- Ethics in Dialogue and Debate: "The Grand Inquisitor," Dostoevsky vs. Tolstoy

Preferred Text Books :

- Dostoevsky, F.M. *Crime and Punishment.* Translated by Richard Pevear and Larissa Volokhonsky. Vintage, 1993.
- Shafer-Landau, R. 2019. *Living Ethics: An Introduction with Readings*. Oxford University Press.

Reference Books :

- Cahn, S. M. ed. *Exploring Ethics: An Introductory Anthology* 5th Edition. Oxford University Press, 2020.
- Leatherbarrow, W.J, ed. *The Cambridge Companion to Dostoevskii.* Cambridge University Press, 2002 (Reprint 2004).
- Shafer-Landau, R. *Ethical Theory: An Anthology* 2nd Edition. Wiley-Blackwell, 2013.
- Stich, S. and Donaldson, T. *Philosophy: Asking Questions, Seeking Answers*. Oxford University Press. 2019.
- Vaughn, L. *Doing Ethics: Moral Reasoning, Theory and Contemporary Issues* 5th Edition. W. W. Norton and Co, 2019.

E-book Links : –

Grading Plan :

Type of Evaluation	Weightage (in %)
Quiz-1 (3-5 questions; answers of 200-300 words)	**20%**
Assignment 1 (1000-word essay)	**30%**
Quiz-2 (3-5 questions; answers of 200-300 words)	**20%**
Assignment 2 (1000-word essay)	**30%**

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 (4-5 sentences) :

The teaching-learning strategy in this course will consist of lectures based on set readings, which students are expected to complete in advance of the class. These lectures will incorporate prompts for classroom discussion and activities based on the readings to enable active learning and critical thinking. This learning will be further consolidated through assessments that will be designed to test and develop the student's knowledge and skills, especially interpretative reading and writing.

Title of the Course : Readings in Indian Literatures
Course Code : HS1.202
Faculty Name : Sushmita Banerji
L-T-P : 3-0-0
Credits : 4

1.Prerequisite Course / Knowledge:

None

2.Course Outcomes (COs):

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

CO-1: Engage in the pleasure and challenge of the close reading of literary texts

CO-2: Look at modern Indian literatures in translation to see how individuals imagine their own, particular lives and create a sense of a shared past and a shared culture

CO-3: Explore, among other issues, how the self is constructed through reading and writing, the relationship between memory and identity,

CO-4: Interrogate claims of authenticity or truth

CO-5: 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

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

CO3													1				
CO4									1								
CO5							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%**

Title of the Course : Robotics: Planning and Navigation
Course Code : EC4.403
Faculty Name : Madhava Krishna K
L-T-P :3-1-0
Credits : 4

Prerequisite Course / Knowledge:

Computer Programming, Data Structures and Algorithms. Knowledge of Functional Optimization is a plus.

Course Outcomes (COs):

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

CO-1 :Demonstrate familiarity with different paradigms in robotic motion planning

CO-2: Analyze robotic planning algorithms in the context of navigating in an environment to accomplish a goal

CO-3: Explain the significance of mathematical frameworks of functional optimization as well as robot kinematics in robotic planning and navigation tasks.

CO-4: Apply principles of functional optimization and robot kinematics to propose analytical frameworks, algorithms for solving real world problems in robotic motion planning, navigation.

CO-5: Create and Simulate the algorithms using state of the art software and libraries and evaluate its performance on specified tasks

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

	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%

Course Title : Science & Technology: Critical perspectives

Name of the Faculty : Harjinder Singh

Name of the Academic Program : CHD

Course Code : TBD

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

Credits : 2

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

1.Prerequisite Course / Knowledge: None

2.Course Outcomes (COs) :

After completing this course successfully, the students will be able to

CO-1 **Explain** diverse perspectives on **Science & Technology with an ethical scrutiny.**

CO-2 **Demonstrate** understanding of how science and technology have differential effects on different sections of society.

CO-3 **Apply** their knowledge to critically and ethically evaluate applications of science and technology to social problems.

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

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

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

4.Detailed Syllabus:

Unit-1: The problem of knowledge and science as an episteme; the nature of technology
Unit-2: Deterministic nature versus social construction of science and technology; differential effects on different sections of society

Unit-3: General critique of science - feminist critique, post-modern critique, etc.

Unit-4: Specific instances of ethical violations - abuse of science and technology, illustrations from biotechnology, technology of war, etc.

Reference Books:

1. **Maurizio Iaccarino, Science and ethics, EMBO Rep. 2001 Sep 15; 2(9): 747–750 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1084045/ (and references therein)**
2. **R. Volti, Society and Technological Change, Worth Publishers, NY, USA, 2009**

5.Teaching-Learning Strategies in brief :

Interactive class room teaching, multiple quizzes; enciuragement for brief student presentations.

6.Assessment methods and weightages in brief :

Assignments: 30%,

Class Quizzes : 20%,

End Semester: 40%

Term Paper : 10%

A jump in grade will be awarded for an exceptional term paper. Plagiarism of any degree will invite a 'F' grade with no discussion.

Title of the Course : Software Engineering
CourseCode : CS6.401
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 Title : Software Programming for Performance
Faculty Name : Suresh Purini
Course Code : CS3.302
L-T-P : 3-1-0
Credits : 2
Name of the Academic Program: B-Tech in Computer Science and Engineering
(L=Lecture hours, T=Tutorial hours, P=Practical hours)

1. Prerequisite Course/Knowledge

Basics of Algorithm Analysis, Computer Architecture

2. Course Outcomes (COs)

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

CO-1. Explain the algorithmic optimizations necessary to improve the performance of a software on a uniprocessor.
CO-2. Analyze cache dependent performance of algorithms

CO-3. Employ cache-aware (such as tiling)/cache oblivious (such as recursive multiplication) optimizations to improve program performance

CO-4. Analyze the software performance improvement using SIMD Array Processing and Vector Processing Architectures

CO-5. Explain different concurrency platforms such as Pthreads, Threading Building Blocks.

CO-6. Develop multicore programs using OpenMP pragmas

CO-7. Explain the basics of GPU architecture

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

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

CO7	1	1	-	1	-	-	-	-	-	2	-	3	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. Detailed Syllabus

Unit 1: Algorithmic optimizations – Introduction to optimization of matrix multiplication: Language dependent performance, Loop ordering, compiler optimization, loop parallelization, tiling, vectorization

Unit 2: Memory Hierarchy aware Optimizations – Review on Caches, Conflict misses, Ideal Cache Model and cache misses, Cache analysis of matrix multiplication, Tiling, Recursive Matrix Multiplication

Unit 3: Using SIMD units – Flynn's Taxonomy, Data Parallelism, SIMD Array Processing, Vector Processing – Vector Registers, Vector Functional Units, Memory Banking, Basic Vector Code Performance, Vector Chaining, Multiple Memory Ports, Masked Vector Instructions

Unit 4: Programming Multi-cores – Shared Memory Hardware, Concurrency Platforms – Pthreads, Threading Building Blocks, OpenMP – Creating Threads, Synchronization: critical, barrier, Parallel loops, Data Sharing, Memory model

Unit 5: Acceleration using Hardware Accelerators (GPU)

Reference Books:
No specific text book, but the material would be taken from different books such as:

1) Cormen, Thomas H., et al. *Introduction to algorithms*.
2) Hennessy, John L., and David A. Patterson. *Computer architecture: a quantitative approach*.

5. Teaching-Learning Strategies in brief

Weekly lectures cover the topics in the syllabus. Tutorials cover how to use some tools for measuring performance of software implementations. There are couple of assignments that will provide the students experience in programming some functions and improve the performance employing the techniques learned in theory. Firstly they would learn how to improve cache performance and then exploit parallelism in code by employing multicore programming using OpenMP.

6. Assessment methods and weightages in brief

Type of Evaluation	Weightage (in %)

Quizzes	**40**
Assignments	**60**

Course Title : Spatial Data Science
Faculty Name : K S Rajan
Name of the Program: Open to All Programs on Campus at UG, PG/PhD Level
Course Code :(PG-2 level course)
Credits : 4
L - T – P : 3-1-0
(L - Lecture hours, T-Tutorial hours, P - Practical hours)

Semester, Year **: Spring 2022**

(Ex: Spring, 2022)

Pre-Requisites **:** Basic understanding of Locational Data and Computing – Any UG3,UG4, M.Tech., MS, and Ph.D. student should be able to take it.

Prior course work in Spatial Informatics may help.

Course Outcomes **:**

CO-1: Describe how Spatial Data Science helps uncover patterns CO-2: Apply Geospatial techniques to Prepare the data for analysis

CO-3: Analyze the spatial and temporal data and interpret its outcomes

CO-4: Assessment of application of Spatial data science in key domain areas

CO-5: Design research projects that helps synthesize the learning into an application

Course Topics **:**

Module 1: Introduction to Spatial Data Science

- What is special about Spatial Data and Geo-AI?
- How Spatial and Spatio-temporal Big Data helps uncover patterns?
- Spatial Data Handling including spatial data models, data formats
- Challenges to computing approaches when applied to Spatial Data – Effectsof Topology

Module 2: Geospatial Data Analysis and Modelling

- Vector Data Spatial Analysis
- Raster Data Spatial Analysis
- How to use temporal data in conjunction with Spatial data
- GeoSpatial Data

ModellingModule 3: Spatial Sciences

- Spatial Statistics including Spatial auto-correlation, Spatial tessellation

- Data Mining applications on Spatial data including Spatio-temporalData Mining
- Network Analysis and Graph theory
- Few relevant topics from Computational Geometry
- Geovisualization – Maps to WebGISModule 4: Spatial Classification and Prediction
- Spatial decision trees
- Machine learning as applied to Spatial Data including Spatial-aware NeuralNetworks
- Hotspot Analysis
- Spatial Outliers detection

Module 5: Applications of Spatial Data Science

- Public Health – monitoring and mapping diseases, risk analysis and diseasespread modelling
- Agriculture – crop growth monitoring, crop yield patterns and resourceconstraints
- Location based services – routing applications, ride-sharing algorithms,optimal location

Preferred Text Books :

1. Spatial Computing, By Shashi Shekar and Pamela Vold. The MIT Press. 2020
2. GIS – A computing perspective. By Micheal Worboys and Matt Duckham. CRC Press;2nd edition 2004
3. Spatial Databases: A Tour. By S. Shekhar and S. Chawla, Prentice Hall, 2003, ISBN013-017480-7 .
4. Selected Research Papers and Articles (will be shared with the topics taught on thecourse portal)

Reference Books :

1. Geographical Data Science and Spatial Data Analysis - An Introduction in R. By LexComber and Chris Brunsdon. SAGE Publications Ltd. 2020

E-book Links : Will be provided in Class as appropriate

Grading Plan :

Type of Evaluation	Weightage (in %)
Class Quizzes	**15.0**
Mid Sem Exams – 2	**20.0**
End Sem Exam	**30.0**
Paper reviews and Presentations byeach Student in Class	**10.0**

Project/Term paper demonstrating thePractical applications	**25.0**

Mapping of Course Outcomes to Program Objectives:

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

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

Teaching - Learning

Lectures
Guest
Lectures

Reading research papers

Class participation in Q&A,
discussionsOnline discussions over
MS Teams

Learning by doing

Short Presentation and Discussion led by
Student Course project on conceptualization
and implementationReal world applications

Multi-disciplinary approach

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

Title of the Course : Stability of Structures
NAME OF FACULTY : Sunitha Palissery
Name of the Academic Program: M. Tech in CASE
Course Code : CE1.612
L-T-P : 3-1-0
Credits : 4

1. Prerequisite Course / Knowledge: Design of RC and Steel Structures (Undergraduate course content)

2. Course Outcomes (COs):

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

CO-1. Develop knowledge and skills to mathematically formulate structural stability criteria of steel members

CO-2. Employ the computer application skills in developing structural models to perform buckling analysis and predict stability of frames

CO-3. Demonstrate problem solving skills for various instability modes and work towards a research-based approach to the stability design of steel frames

CO-4: Apply buckling and stability analysis methods, to address practical stability design problems

CO-5. Analyze ethical and effective structural design practices to preclude stability failure of steel structures and towards reasonably good behavior under extreme loading conditions

CO-6. Reorganize inter-personal skills required to manage possible negotiations with structural engineering design practitioners towards a stable steel structure

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

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

4.Detailed Syllabus:

Unit 1: Basic Concepts of Stability

Bifurcation Buckling- Methods of Stability Analysis-Post-buckling Behaviour-Large Deflection Analysis

Unit 2: Buckling of Columns and Frames

Differential Equations using Equilibrium, Large Deformation Theory, Effects of Imperfections, Inelastic Buckling – Tangent and Reduced Modulus Concepts, Shanley's theory of Inelastic Column Behaviour, Effects of Residual Stresses-Beam Columns; Modes of Buckling- Frame Stability Analysis-Non-sway and Sway Frames-Critical Load Estimation using Slope Deflection Equations

Unit 3: Torsional and Flexural-Torsional Buckling and **Buckling of Plates**

Thin-walled Open Cross-Sections-Columns-Beams-Beam Columns; Governing Differential Equations for Plate Buckling, Plates Subjected Loading Actions, Post-buckling Behaviour of plates

Unit 4: Introduction to behavior of Steel Beams and Beam Columns

Limit State Design; Classification of sections; Buckling classifications; Laterally Restrained and unrestrained beams, Effective Length of Columns- AISC Alignment Charts; stability index, Design Strength

Unit 5: Design of Beam Columns

Interaction equations, Design for combined axial and bending effects; computer analysis of rigid steel frames

Reference Books:

1. Alexander, C., *Principles of Structural Stability Theory*, Prentice-Hall Inc, New Jersey
2. Bažant,Z.P., and Cedolin,L., (2010), *Stability of Structures- Elastic, Inelastic, Fracture and Damage Theories*, World Scientific Publishing Co. Pvt. Ltd., Singapore
3. Bureau of Indian Standards (BIS), (2007), Indian Standard Code of Practice for General Construction in Steel, IS800;2007, New Delhi, India
4. Chen, W.F., and Lui,E.M., (1987), *Structural Stability: Theory and Implementation*, Elsevier Science Publishing Co., New York
5. Galambos,T.V., and Surovek,A.E., (2008), *Structural Stability of Steel: Concepts and Applications for Structural Engineers*, John Wiley & Sons, New Jersey
6. Gambhir,M.L., (2004), *Stability Analysis and Design of Structures*, Springer, New York
7. *Guide to Stability Design Criteria for Metal Structures*, Edited by Ziemian, R.D., (2010)
8. Kumar,A., (1998), *Stability of Structures*, Allied Publishers Limited, Mumbai
9. Timoshenko,S.P., and Gere,J.M., (1985), *Theory of Elastic Stability*, McGraw Hill International Book Company
10. Salmon, C.G., and Johnson,J.E., (1996), *Steel Structures Design and Behaviour*, Prentice Hall, NJ

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

1. Lectures by integrating ICT into classroom teaching
2. Tutorials involving mathematical formulation and graphical analysis of stability problems
3. Assignments involving analysing structural data to understand buckling behaviour of steel members and frames
4. Critical and active learning through projects, and project-based learning by doing term-projects which involves computer programming and hands-on use of software tools to investigate & predict stability behaviour of members and frames.

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

Assignments in theory: 20 marks, Quizzes in theory: 10 marks, Mid Semester Examination in theory: 20 marks, Term-project: 20 marks, End Semester Examination in Theory: 30 marks

Title of the Course	: Statistical Methods in Artificial Intelligence
Course Code	: CS7.403
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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	1	3	2	2	3	2	2	2	2	2	2	1	2
CO2	3	3	3	3	1	3	2	3	1	2	2	3	1	3	2	2
CO3	1	2	2	2	2	1	2	1	1	1	2	3	3	2	2	3
CO4	2	2	2	3	3	1	1	1	1	1	2	3	3	2	2	3
CO5	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 Title : System and Network Security
Faculty Name : Dr. Ankit Gangwal
Name of the Program : MTech. in CSIS and Open Elective for B.Tech. in CSE
Course Code : CS8.403
Credits : 4
L - T - P : 3-1-0 (L - Lecture hours, T-Tutorial hours, P - Practical hours)
Semester, Year : Spring, 2022
Pre-Requisites : Data Structures and Algorithms and Principles of Information Security

Course Outcomes :

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

CO-1 Demonstrate a familiarity with concepts of computer attacks and core defense techniques

CO-2 Discuss various vulnerability testing schemes

CO-3 Apply the knowledge of cryptography to build secure and efficient communication channels

CO-4 Analyze and compare mobile platform security architecture of iOS and Android

CO-5 Design security modules against web and network attacks

CO-6 Develop a framework to test web applications' security

Course Topics :

Unit 1: Attacks and Vulnerabilities: Exploits and defenses in control hijacking attacks; principle of least privilege, access control, and operating systems security; isolation and sandboxing; vulnerability testing using fuzzing, static, and dynamic analysis; brief overview of cryptography.

Unit 2: Web Security: Basic web security mode; web application security; web session management; goals and pitfalls for HTTPS.

Unit 3: Network Security: Internet Protocol security; DoS and DDoS attacks; network defenses.

Unit 4: Security of Mobile Platforms: Mobile platform security architecture; Android and iOS security models; topics in Android security.

Unit 5: Low-level Architectural Security and Misc. Topics: Processor and microarchitecture security; Intel SGX and the Specter attack; privacy, anonymity, and censorship.

Preferred Text Books :

1. J. R. Vacca. "Network and System Security."
2. B. Menezes. "Network Security and Cryptography."

Reference Books :

1. W. Stallings. "Cryptography and Network Security: Principles and Practice." Research papers.

E-book Links :

Grading Plan :

Type of Evaluation	Weightage (in %)
Mid-term exams, quizzes	**20**
End-term exam	**30**
Assignments and projects	**50**

Mapping of Course Outcomes to Program Objectives:

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

Teaching-Learning Strategies in brief (4-5 sentences):
The main objective of this course is to enable students to have a good understanding of the fundamental principles of computer systems and network security. It is designed to help the students understand various attack and defense techniques. The course is especially useful for students who plan to do research and/or product development in the area of system building.

Course Title : The State in Colonial India
Course Code : HS3.302
Faculty Name : Aniket Alam
Credits : 4 (four)
L - T - P : 3 – 1 – 0
(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.

Title of the Course **:** Ethics-2: Thinking through moral problems
Faculty Name **:** Ashwin Jayanti
Name of the Academic Programs:
Course Code **:** HS0.206
L-T-P **:** 3-0-0
CREDITS **:** 2
(L = Lecture hours, T = Tutorial hours, P = Practical hours)

1. Prerequisite Course / Knowledge: Basics of Ethics-1

2. Course Outcomes (COs):

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

CO-1: Identify and recognize normative standpoints in ethical arguments concerning pressing debates

CO-2: Analyze and evaluate the validity of arguments for and against each of these ethical debates

CO-3: Understand the significance of normative ethics as it applies to pressing ethical dilemmas and debates

CO-4: Evaluate the arguments from both sides of the debate and assess the limitations and implications of each of the positions

CO-5: Develop and synthesize arguments in the light of current evidence and considering multiple aspects of a particular course of action

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	-	-	3	2	3	2	3	1	3	-	-	1	1
CO2	-	-	1	-	-	3	2	2	-	-	-	3	-	-	1	1
CO3	-	-	1	-	-	3	2	2	-	1	-	3	-	-	1	1
CO4	-	-	2	1	-	3	3	3	1	2	-	3	-	-	1	1
CO5	-	1	3	3	-	3	3	3	1	2	-	3	-	-	1	1

4. Detailed Syllabus:

Unit I – Introduction to applied ethics; animal rights; animal rights and equality; Argument from marginal cases, unequal value thesis

Unit II: Environmental ethics; biocentric ethics; distributive and corrective justice, individual moral obligations

Unit III: Economic Justice and inequality; Rawls-Nozick debate

Unit IV: Genetic engineering; genetic engineering and perfection; genetic engineering and enhancement; GMOs

PREFERRED TEXTBOOK

Shafer-Landau, R. 2019. *Living Ethics: An Introduction with Readings*. Part 2: Moral Problems. Oxford University Press.

REFERENCE BOOKS

Cohen, Andrew I. And Wellman, Chrisopher Heath. 2005. *Contemporary Debates in Applied Ethics*. Blackwell Publishing

Vaughn, L. 2019. *Doing Ethics: Moral Reasoning, Theory and Contemporary Issues* 5th Edition. W W Norton and Co.

Singer, Peter. 1986. *Applied Ethics.* Oxford University Press

5. Teaching-Learning Strategies in Brief

This course aims at reading, critically evaluating, and thinking through contemporary debates in applied ethics. For this purposes, the main strategy is to share the readings and resource material beforehand for the students to acquaint themselves with the topics and use the class time to discuss and evaluate the implications of the various positions respective to each topic. Continuous assessment methods will be employed to make sure the students have acquired the requisite conceptual understanding to explicate and argue for their position with greater nuance and logical rigor.

6. Assessment Methods and Weightages in Brief

Continuous assessment in the form of written assignments will carry the major weightage of the evaluation, with the rest of the weightage assigned to class participation in the ensuing discussions. The assigned weightage is as follows: Assignments: 90 marks, class participation: 10 marks.

Type of Evaluation	Weightage (in %)
Class Participation	10
Assignments (1000 words)	60 (3 x 20)
Review Essay (1500 words)	30

Title of the Course : Time Frequency Analysis
Name of the Academic Program: B. Tech. in ECE
Course Code **:** EC5.402
L-T-P :3-1-0
Credits :4

Typical Course Design

Prerequisite Course / Knowledge:
Should have taken Signal Processing course.

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

CO-1 : Demonstrate usability of joint time-frequency transforms and distributions insignal processing.

CO-2: Apply principles of time & frequency fundamentals to understand uncertaintiesin joint time-frequency representation.

CO-3: Developing mathematical foundation for joint time-frequency representation.

CO-4: Analyzing signals with Wavelet theory of signal processing.

CO-5: Explaining the application of advanced transforms for signal analysis.

CO-6: Designing the algorithms for modeling non-stationary signals.

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

	PO 1	P O2	P O3	PO 4	PO 5	PO 6	PO 7	P O 8	PO 9	PO 10	P O 11	PO 12	PS O1	PS O2	PS O3	PS O 4
CO 1	2	2	1	1	1	1	1	1	2	1	1	2	-	3	-	-
CO 2	3	2	1	1	1	1	1	1	2	1	1	2	-	3	-	-
CO 3	3	2	2	1	1	1	1	1	2	1	1	2	-	3	-	-
CO 4	3	2	2	1	1	2	1	1	2	1	1	2	-	3	-	-
CO 5	2	3	2	2	1	2	2	1	2	1	1	3	-	3	-	-
CO 6	2	3	3	3	2	2	2	1	3	2	2	3	-	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: Introduction to Vector Space, Basis Functions, Basis, Frames. Review ofFourier series and transform.

Unit 2: Fundamentals of time and frequency. Time-bandwidth product. Uncertaintyprinciple.

Unit 3: STFT, Wavelet theory of signal processing, multi-resolution analysis.

Unit 4: Wigner Ville distribution, HHT and S-transform.

Unit-5: Applications in signal and image processing.

Reference Books:

1. Time - Frequency Analysis, L. Cohen, Prentice Hall, 1997.
2. A wavelet tour of signal processing, S. Mallat, Third edition, Academic Press,2009.
3. Fourier and wavelet signal processing, Kovacevic, J., Goyal, V.K. and Vetterli,M., 2013.

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

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

demonstration of mathematical concepts learned. Advanced concepts applicationsare studied by doing course projects.

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

Assignments -- 20%
Mid exams -- 30%
End Project -- 15%
End exam -- 35%

Title of the Course : Topics in Coding Theory
Faculty Name : Prasad Krishnan
Name of the Academic Program: B. Tech in Electronics and Communication Engineering
Course Code : ECE537
L-T-P :3-1-0
Credits :4
(L= Lecture hours, T=Tutorial hours, P=Practical hours)

1.Prerequisite Course / Knowledge:

1. Linear Algebra over field of Complex Numbers: Vector Spaces, Bases, Dimension, Subspaces, Connectionbetween Linear Operators and Matrices, Diagonalizability of Hermitian Operators/Matrices **(Mandatory)**
2. Basics of Linear Algebra over Finite Fields and Linear Block Codes **(Highly preferable but not mandatory)**

2. Course Outcomes (COs) :

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

CO-1: Describe the basic postulates of Quantum Mechanics (Quantum bits (qubits) to represent information,transformations on qubits via Unitary operators, Quantum Measurements

CO-2: Describe the effects on noise on qubits such as bit flip and phase flip errors, and the relevance ofquantum error correction codes (QECCs).

CO-3: Demonstrate understanding of basic principles of QECCs [the role of pauli matrices], their encodingand decoding techniques [via the Shor Code, a 1 qubit QECC that corrects bit and phase flip errors]

CO-4: Analyze the Calderbank Shor Steane code via the Stabilizer formalism of QECCs and understand therelationship of these to classical codes.

CO-5: Demonstrate ability to understand recent topics of research in QECCs and their applications in codingtheory domain.

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	-	-	-	-	-	-	-	-	-	2	-	3	1	-
CO2	2		2	-	-	-	-	-	-	-	-	-	2	-	3	1	-
CO3	2		2	-	-	-	-	-	-	-	-	-	2	-	3	1	-
CO4	3		1	-	2	-	-	-	-	-	-	-	2	-	3	2	-

CO 5	3		2	-	-	3	-	-	-	-	-	-	2	-	3	-	-

4.Detailed Syllabus:

Unit 1 : Linear Algebra Refresher (Vector spaces over C, Operators on Vector spaces, Eigen values, vectors and Diagonalization , Tensor Products), Postulates of Quantum Mechanics – Qubits, Measurements, Operators, Errors and their representation via Pauli Matrices**,** Basics of Quantum Circuits required for QECCS**Unit 2:** Principles of Quantum Error Correcting Codes, Quantum Noise (bit flip, phase flip, depolarizating), Knill Laflamme Conditions

Unit 3: Bit-flip & Phase-flip correcting Shor Code, Review of Classical Linear Block Codes, Bounds for QECCs **Unit 4:** Stabilizer Formalism, encoding, decoding and the Calderbank-Shor-Steane Construction, Connectionto classical codes to CSS Codes, Important QECC examples - Steane code [[7,1,3]], and [[15,1,5]] quantum Reed-Muller code.

Unit 5: Further constructions of QECCS beyond CSS codes (Topological Codes, Subsystem Codes), Applications of Quantum computation in recent problems in communication/coding theory.

Reference Books

1. **M. Nielsen and I. Chuang, Quantum Computation and Quantum Information, CambridgeUniversity Press, 2000, ISBN 978-1-107-00217-3 (10th edition).**
2. Quantum Information Processing and Quantum Error Correction: An Engineering Approach,Ivan Djordjevic, Academic Press (23 May 2012), ISBN-13 : 978-0123854919
3. **Quantum Error Correction, Lidar D.A., Brun T.A, Cambridge University Press, Year: 2013, 978-0-521-89787-7**

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

The course is on learning the basics of Quantum error correcting codes, constructions of Quantum error correction, performance analysis, and decoding. The material will be covered via lectures which are systematically prepared and delivered considering the prerequisite knowledge of the students. The tutorial sessions will be engaging the students via a number of problems that are linked to the theory sessions covered in the class. The evaluation plan of the course involves written exam, home assignments and term paper presentation. As this is a course meant for research-oriented students, 40% of the weightage is sharedbetween home assignments and term paper presentations. The term paper presentation will involve a presentation of a recent research paper individually or group-wise. The mid term and end semester exams have cumulatively 60% of

the remaining weightage will examine the students' understanding in the topics covered in the class via various problems.

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

Type of Evaluation	Weightage (in %)
Home Assignments (Problem Sets 3-4)	20%
Mid term (1)	20%
End Semester Examination	40%
Term paper presentation	20%

Title of the Course : Topics in Deep Learning
Faculty Name : Charu Sharma and Makarand Tapaswi
Name of the Program : Honors, DD, MTech, PhD
Course Code : CSE
Credits :4
L - T - P : 3-1-0
(L - Lecture hours, T-Tutorial hours, P - Practical hours)
Semester, Year : Spring, 2022

Max. no. of students: 50

Pre-Requisites :

Mandatory: SMAI course and linear algebra.

Nice to have basics of graph theory, computer vision, and natural language processing.

Course Outcomes:

Recently, graph representation learning has gained prominence in the area of Deep Learning in a wide variety of tasks as there is a lot of graph data available in different forms from several domains such as social network, biological network, chemical compounds, citation network, retail network, transaction network, drug network, etc. Machine learning for graphs aims to solve various problems such as graph classification, node classification, link prediction, relation prediction, graph/ node clustering, etc. This is a research-driven course that intends to describe variety of tasks, representation learning methods and itsapplications in the emerging field of machine learning for graphs. The aim of the course is to make students understand the theoretical and research aspects of the topics (CO1) so that they can analyze andevaluate the research ideas behind the existing methods (CO2). The students will also be able to look at the problem from different perspectives (CO3) and extend or design a method/ algorithm for a real-worldproblem (CO4). Students can relate to the real-world problem and apply the existing methods as well (CO5).

Course Topics : Following topics are subject to minor changes.

1. Introduction, Fundamentals and Significance
   A. Introduction to ML for Graphs, Applications, Problem Definition
   B. Basics of Networks and Graphs
   C. Node and Graph Embeddings
2. Problems in Graph ML
   A. Node and Graph Classification
   B. Link Prediction and Relation Prediction
   C. Clustering and Community Detection
   D. Graph/Subgraph Matching
   E. Applications
3. Embedding Methods
   A. Heuristic Methods, Graph Kernel-based Methods
   B. Random Walk-based Methods: DeepWalk, Node2vec
   C. Graph Laplacian and Spectral Methods
   D. Applications
4. Graph Neural Networks
   A. Popular GNNS and its Variants: GCN, GraphSAGE, GIN, DGCNN, etc.
   B. Applications of GNNs

5. Knowledge

Graphs

A. KG Embeddings
   B. Applications of KG Embedding Methods
6. Other GNNs
   A. Attention Model: GAT
   B. Graph Transformers
   C. Graph Generation: Deep Generative Models

Preferred Text Books for machine learning and deep learning basics:

Christopher Bishop. Pattern Recognition and Machine Learning.

Ian Goodfellow and Yoshua Bengio and Aaron Courville. Deep Learning.

Reference Books : There is an e-book (Graph Representation Learning) that came recently by William Hamilton (link mentioned under e-book links). Useful links, class notes and/or references will be providedfor classes.

E-book Links:

https://www.cs.mcgill.ca/~wlh/grl_book/files/GRL_Book.pdf

Tentative Timetable

Wednesday		Saturday	
5 Jan		8 Jan	
12 Jan		15 Jan	
19 Jan	Lecture topic	22 Jan	
26 Jan	Holiday	29 Jan	Topic Assignment 1
2 Feb	Quiz 1	5 Feb	Project topics discussion
9 Feb		12 Feb	Felicity
16 Feb		19 Feb	Project proposal due
23 Feb		26 Feb	
2 Mar	Time to work on your projects No mid-sem exam	5 Mar	Time to work on your projects No mid-sem exam
9 Mar		12 Mar	R&D Showcase
16 Mar	Topic Assignment 2	19 Mar	
23 Mar		26 Mar	
30 Mar	No classes due to Quiz 2	31 Mar	
6 Apr		9 Apr	
13 Apr		16 Apr	
20 Apr		May week	Project poster session
27 Apr	Project presentations	30 Apr	Project presentations

Grading Plan **:** The evaluation below is subject to minor changes

Type of Evaluation	Weightage (in %)
Quiz-1	10
Assignment - 1	10
Assignment - 2	10
Project (proposal + presentation + report + work)	60 (10 + 10 + 10 + 30)
Others (class activity, surprise quiz, scribing, etc.)	10

Project evaluation:

- Teams of 3 members.
- 10 points: Proposal: 1 page + refs; Write about what you want to do, something achievable in 3months.
- 10 points: Final report: 2 pages + analysis figures + proofs + refs; Describe the main contribution.Reference previous work for everything else.
- 10 points: Final presentation (5 slides) / video (4 minutes) / poster (1 A0 size)
- Core research work, upto 30 points obtainable. If you do more, this may offset scoring in otherparts of the project evaluation.
    - (15 points max) Re-implementation of code + main experiment, or re-creation of severalexperiments using existing code
    - (5 points max) Additional interesting ablations, experiments, analysis
    - (10 points max) New ideas that unfortunately did not work

- (15 points max) New working idea, publishable in a conference like ICVGIP, required forhighest grade.

For Office Use Only (starts on a new page)

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

https://iiitaphyd-my.sharepoint.com/:w:/r/personal/dyacad_iiit_ac_in/Documents/NBA-2020- 21/Course%20Content/IIIT-CSE-ECE.docx?d=w111f0effcaea41b3a4d1e8a3fbc6332d&csf=1&web=1&e=z1Khby

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

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

The plan is to use the slides in general to explain the problem and methods. This would includethe handwritten notes or using white-board whenever required to describe the topics mathematically. The outline has quite a few topics from research papers and would be presented like a paper in detail. Coding sessions (using graph data) would be conducted to make the topics/papers easier to understand.

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

Course Title : Topics in Signal Processing
Course Code : EC5.401
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, Linear Algebra

Course Outcomes :

1. Apply concepts from traditional signal processing for the study of graph signals and their processing
2. Apply Laplacian and Adjacency matrices from spectral graph theory to transform and interpret vertex-domain graph signals infrequency-domain
3. Analyze graph signals to perform the signal processing operations of filtering, denoising, sampling, and reconstruction
4. Analyze the connections between traditional signal processing and graph signal processing to develop abstract mathematical intuition for modeling and problem solving
5. Design and execute a project which applies graph signal processing to solve a problem using the tools learned in the course

Course Topics :

This offering of Topics in Signal Processing will focus on Graph Signal Processing (GSP).

In contrast to traditional signals which defined over regular domains such as time (e.g., speech), space (e.g., images) and space-time (e.g., video), graph signals are signals defined over an irregular domain of graph. Relation between various components of traditional time and space domain signals are captured by the temporal (past, present, future) and spatial (left, right, etc.) relations respectively. For graph signals, this relation is specified by the accompanying graph i.e., the vertices (nodes) and connections between the vertices (edges).

Review – brief review of relevant signal processing and linear algebra concepts

Graph and graph signals – definition and descriptors of a graph (Laplacian and Adjacency matrices), spectral graph theory in brief, examples of graphs, signals over the graph domain Signal processing over graphs–shift operation, notion of frequency and smoothness, graph Fourier transform (GFT), vertex-domain and frequency-domain representation of graph signals, graph filters and convolution Signal processing over graphs – band-limited graph signals, sampling and reconstruction of graph signals, uncertainty principles, denoising, compression, learning graph structure from signals, joint time-vertex signal processing Applications – image processing, sensor networks, brain signals, etc.

Preferred Text Books:

Online resources and reference papers will be shared Reference Books : --

E-book Links : --

Grading Plan :

(The table is only indicative)

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

Course Title **:** User Research Methods
Course Code **:**CS9.501
Faculty **:** Priyanka Srivastava

Program : M.Tech I Year I Semester – Product Design and Management*
L-T-P : 3-1-0
(L= Lecture hours, T=Tutorial hours, P=Practical hours)Credits: 2

1. Prerequisite Course / Knowledge:
No prerequisites are required

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

(Ex: Spring, 2022)

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

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

CO-1: Will be able to use common experience research methods, like 3-dimensional framework using attitudinal and behavioural, qualitative and quatitative, and context of use; conduct field studies, stakeholder interviews, log analysis; affinity wall etc.

CO-2: Learn to understand users' need and pain points by creating user stories, empathy maps, personas, user journey maps

CO-3: Identify and recognize the problem and gaps, generate possible solutions to user problems

CO-4: Ethics of conducting study and observations

CO-5: User research data presentation and summary

4.Detailed Syllabus:

Unit 1: Understanding User

Unit 2: Lab and Field, Quantitative and Qualitative

methodsUnit 3: Ethics in User Research

Unit 4: Statistics – How to present User Research Results

Unit 1	Unit 2	Unit 3	Unit 4
Understanding User	Observation Techniques	Ethics	Data Visualization andresentation
Introduction and Qualitative Research Overview – foundation of user experience, key terms, highlight the hall of shame, why user-centric design and control is important; attitudinal and behavioural dimension	Conducting studies in usability lab, Lab studies – eye-tracking, behavioural observations, control design observations	Code of conduct; Participants Rights, Privacy -data safety, Respect – individual rights, time and effort, Sensitive and Empathetic; Risk analysis; Informed Consent	Qualitative Analysis – Thematic, values, product quality etc. organize and summarise data

User need assessments, Qualitative research method,	Field study, site visits, naturalistic observations, controlled field		Quantitative Analysis – count, accuracy, response time or time
Interview protocols followed up with activities. Know your user – age, gender, cognitive / psychological perspectives, people with disability or accessibility, role of persona in understanding user, empathy and journey map	experiment, individual and group survey and focused interviews, customer satisfaction, remote testing		taken to complete the task or speed analysis, visualization, learning curve,
How to conduct interview, make observations, and extract data from interview, ethics and consent, user research protocols, survey-based observations	Industry practice - A/B and Multivariate testing, card sorting or tree testing, qualitative and quantitative method, How to deliver user research results		
Affinity Wall and Analysis – Qualitative and quantitative analysis, log, survey and questionnaire analyses and affinity diagram to cluster and bundle ideas/ facts/ experience together	Secondary research – literaturereviews, market research		

Reference Books:

1. Elizabeth Goodman and Mike Kunaivsky (2012), Observing the User Experience: A Practitioner's Guideto User Research, 2nd Edition, publisher: Morgan Kaufmann

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

- The course will offer primarily lecture and activity-based learning course.
- Students will be required to participate in activities and discuss the observations with their peers in classand will be asked to present their observations.
- Students will be encouraged to take assignments inspired from their everyday experiences and will be askedto evaluate the event/phenomenon/ processes critically and scientifically using user research methods.
- These activities will be performed either as individual or as a team, where they will be asked to demonstratethe individual contribution to the team activities.

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

1.	Class/Home activities	N= 6	18%
2.	Project in Group – with 3-4 students	N=1	40%
3.	Assignment	N=1	14%
4.	Final Exam	N=1	20%
5.	Others		8%
		TOTAL	**100%**

TITLE : Values, Ethics and AI
CREDITS : 3-0-0-2 (half course)
TYPE-WHEN : Spring (H2)
FACULTY NAME : Rajeev Sangal and Shatrunjay Rawat
PRE-REQUISITE : Basic understanding of Ethics

OBJECTIVE : To understand connect between human values and ethics, and explore their relevance and applications on IT Systems in general and AI in particular.

COURSE TOPICS :

1) Universal Values (based on Co-Existential Philosophy)
    a) Values in individual
    b) Values in relationship
    c) Values in society
2) Relating Values with ethics
    a) Relationship between values and ethics
    b) Trusteeship principle
3) Ethics of technology – Dimensions
    a) Development and empowerment of
        i) User
        ii) Family
        iii) Society
    b) Sustainability with nature
4) AI and big data
    a) Issues
    b) Privacy of Individuals
    c) Ownership of my personal data: Who? Exploitation
    d) Explainability
    e) Empowerment

The course will be primarily driven by class room discussions and assignments.
PREFERRED TEXT BOOKS: No single text book. Required study material will be shared/identified as course progresses.

REFERENCE BOOKS: Will be identified as course progresses

PROJECT: TBD

GRADING: Based on class participation, assignments, quiz/end semester evaluation, etc.

1) Class Participation: 20%
2) Assignments: 20%
3) Quiz: 25%
4) End semester evaluation: 35%

OUTCOME: Understanding of basic human values, its connect with ethics, and their application in the domain of IT Systems, AI, Big Data. Student will develop the basic ability to identify whether an IT System is aligned to basic human values and adhere to ethical norms.

REMARKS: