COURSE CURRICULUM FOR ELECTRICAL ENGINEERING - 2019 BATCH

Semester VII & VIII (2019 batch)

- 1.Student has to earn 36 credits in the fourth year.
- 2.Student may choose to earn Zero or 6 or 12 credits through BTP/Co-op project.
- 3. The BTP/Co-op may be split in to two semesters (6 credits per semester)
- 4. The remaining credits should be earned through Electives.

Electives

S.No.	Department	Course Code	Course Name	Course Instructor (s)	Pre-requisites
242 (0 4		3345	0000011000	(8)	Exposure to
1		GG 204			Computer
1		CS 304	Operating Systems	Prof. Gayathri A	Architecture Exposure to
					Computer
2		CS 314	Operating Systems Lab	Prof. Gayathri A	Architecture
3		CS 323	Compilers	Prof. Nikhil Hegde	None
4		CS 316	Compilers Lab	Prof. Nikhil Hegde	None
5	CSE	CS 209	Artificial Intelligence	Prof. Kedar Khandeparkar	None
6		CS 214	Artificial Intelligence Lab	Prof. Kedar Khandeparkar	None
7		CS 205	Design Analysis of Algorithms	Prof. Sandeep RB	None
8		EE 440	Mathematics for Data Science	Prof. Prabhuchandran K J	
9		CS 627	Runtime Verification	Prof. Rajshekar K	
10		CS 410	Parallel Computing	Prof. Milind Chabbi Prof. Nikhil Hegde	
11		EE 608	Wireless Communication	Prof. Naveen M B	Signals and Systems, Probability (UG level), Principles/Fundame ntals of Communications
			Optimization Theory and		Calculus and Linear
12		EE 624	Algorithms	Prof. Rajshekhar Bhat	Algebra
13		EE 610	VLSI Design	Prof. Saroj Mondal	
14		EE 688	Physics of Transistors	Prof. Vigneshwara Raja	
15	EE	EE 687	Optimization Methods for Wireless Communication and Machine Learning	Prof. Rahul Pandya	
16		EE 633	Mixed signal VLSI design	Prof. Naveen K	
17		EE 626	VLSI Technology	Prof. Ruma Ghosh	Exposure to Electronic Devices
18		EE 629	Probability Models and Applications	Prof. Naveen M. B.	
19		EE 620	Neural Networks and Deep Learning	Prof. S. R. M. Prasanna	Exposure to basic concepts in calculus and probability
20		EE 446	Batteries for Electric Transportation (1st Half Sem)	Dr. Rajalakshmi Prof. Abhijit K	

		EE 447	Introduction to Electric Vehicle	Dr.Sid Das	
21		CC 44/	Architecture (2nd Half Sem)	Prof. Abhijit K	
21					Applied
22		ME 407	IC Engines	Prof. Surya Prakash R	Thermodynamics
			Geometric Modeling and		
23		ME 408	Computer Graphics	Prof. Samarth S. Raut	
25		ME 426	Introduction to Computational Fluid Dynamics	Prof. Dhiraj V. Patil	
26		ME 444	Aerodynamics	Prof. Keerthi M C	
20		WIL 444	Introduction to Aerospace	Tioi. Rectuii Wi C	
27		ME 445	Materials	Prof. Satyapriya Gupta	
28	MMAE	ME 646	Fracture Mechanics	Prof. Tejas Prakash G	
			Modeling of metal plasticity:	<u> </u>	
			discrete and continuum		
29		ME 645	approaches	Prof. Satyapriya Gupta	
30		ME 604	Multiphase Flow	Prof. Hiranya Deka	
31		ME 647	Advanced CAM	Prof. Rakesh Lingam	
32		ME 648	Design and Manufacturing of Composites	Prof. Somashekara M A, Prof. Tejas P G	
33		ME 435	Design of Mechatronic Systems	Prof. Sangamesh R	
34		PH 202	Classical Mechanics	Prof. Koushik Saha	None
35	PHYSIC S	PH 203	Quantum Mechanics - I	Prof. R Prabhu	PH101, MA101
36		PH 426	Special Theory of Relativity	Prof. D. Narasimha	None
37	MATHEMATI	MA 428	Introduction to Number Theory 2	Prof. N. S. N. Sastry	None
38	CS	MA 409	Algebraic Codes and Combinatorics	Prof. N. S. N. Sastry	None
39		HS-402	Technological Entrepreneurship	Prof. Raj Hirwani	Nil
40		HS 406	Introduction to Game Theory	Prof. Gopal Parashari	HS 201
41	HSS	HS 426	International Finance	Prof. Mohana Rao Balaga	HS 201
42		HS 404	Applied Ethics	Prof. Jolly Thomas	
43		HS 420	Introduction to Literature		

Electives Syllabus

CSE Department

Name of Academic Unit: Computer Science and Engineering

Level: B.Tech./DD
Programme: B.Tech./DD

i	Title of the course	Operating Systems
ii	Credit Structure (L-T-P-C)	(3 0 0 6)
iii	Type of Course	Core
iv	Semester in which normally to be offered	Spring
v	Whether Full or Half Semester Course	Full
vi	Pre-requisite(s) , if any (For the students) – <i>specify course number(s)</i>	Computer Architecture
vii	Course Content*	Process Management, Memory Management, Storage Management, Protection and Security, Virtual
viii	Texts/References	 Avi Silberschatz, Peter Baer Galvin, Greg Gagne, "Operating Systems Concepts" 9th edition. Wiley. Andrew S. Tanenbaum, Herbert Bos, "Modern Operating Systems", 4th edition. Pearson.
ix	Name(s) of Instructor(s) ***	-
X	Name(s) of other Departments/ Academic Units to whom the course is relevant	Electrical Engineering
xi	Is/Are there any course(s) in the same/ other academic unit(s) which is/ are equivalent to this course? If so, please give details.	No
хіі	Justification/ Need for introducing the course	Fundamental course in Computer Science and Engineering.

Level: B.Tech./DD
Programme: B.Tech./DD

i	Title of the course	Operating Systems Laboratory
ii	Credit Structure (L-T-P-C)	(0 0 3 3)
iii	Type of Course	Core
iv	Semester in which normally to be offered	Spring
V	Whether Full or Half Semester Course	Full
vi	Pre-requisite(s), if any (For the students) – specify course number(s)	Computer Architecture
vii	Course Content*	Laboratory Assignments related to the topics covered in the theory
		course: Process Management, Memory Management, Storage
		Management, Protection and Security, Virtual Machines, Distributed
		Systems
viii	Texts/References	 Avi Silberschatz, Peter Baer Galvin, Greg Gagne, "Operating Systems Concepts" 9th edition. Wiley. Andrew S. Tanenbaum, Herbert Bos, "Modern Operating
ix	Name(s) of Instructor(s) ***	Systems", 4th edition. <i>Pearson</i> .
X	Name(s) of other Departments/ Academic Units to whom the course is relevant	Electrical Engineering
xi	Is/Are there any course(s) in the same/ other academic unit(s) which is/ are equivalent to this course? If so, please give details.	No
xii	Justification/ Need for introducing the course	Fundamental course in Computer Science and Engineering.

Level: B. Tech./MS

Programme: B.Tech./MS

i	Title of the course	Compilers
ii	Credit Structure (L-T-P-C)	3-0-0-6
iii	Type of Course	Elective
iv	Semester in which normally to be offered	Spring
V	Whether full or half semester course	Full
vi	Pre-requisite(s), if any (for the	Exposure to Data Structures and Algorithms,
	students) – specify course number(s)	Computer Architecture, Automata Theory
vii	Course content	The compiled and interpreted execution models. Lexical analysis and parsing using lex and yacc. LR parsers, Scope and visibility analysis. Data layout and lifetime management of data. Runtime environment. Dynamic memory allocation and Garbage collection. Translation of expressions, control structures, and functions. Code generation and introduction to optimizations (local and global). Lattice Theory, Optimizations- dataflow, control flow, reaching definition, liveness analysis, code transformation-tiling, fusion.
viii	Texts/References	 Alfred V. Aho, Monica S. Lam, Ravi Sethi and Jeffrey D.Ullman: Compilers: Principles, Techniques, and Tools, 2/E, AddisonWesley 2007. Andrew Appel: Modern Compiler Implementation in C/ML/Java, Cambridge University Press, 2004 Dick Grune, Henri E. Bal, Cerial J.H. Jacobs and Koen G. Langendoen: Modern Compiler Design, John Wiley & Sons, Inc. 2000. Michael L. Scott: Programming Language Pragmatics, Morgan Kaufman Publishers, 2006. Fisher and LeBlanc: Crafting a Compiler in C.
ix	Name (s) of the instructor (s)	Nikhil Hegde
X	Name (s) of other departments / Academic Units to whom the course is relevant	EE
xi	Is/Are there any course(s) in the same/ other academic unit(s) which is/are equivalent to this course? If so, please give details.	No
xii	Justification/ Need for introducing the course	The knowledge on compilers helps to understand how programs written in a high-level language are converted to machine code. This helps programmers to write better programs.

Level: B.Tech./MS

Programme: B.Tech./MS.

i	Title of the course	Compilers Lab
ii	Credit Structure (L-T-P-C)	0-0-3-3
iii	Type of Course	Core
iv	Semester in which normally to	Spring
	be offered	~ [~ [~ [~ [~ [~ [~ [~ [~ [~ [
v	Whether full or half semester course	Full
vi	Pre-requisite(s), if any (for the	Exposure to Data Structures and
	students)	Algorithms, Computer Architecture,
	- specify course number(s)	Automata Theory, and a programming
		language such as C/C++/Java.
vii	Course content	Design and implementation of a scanner
		using scanner generator. Design and
		implementation of a parser using parser
		generator. Symbol table generation,
		Semantic actions for expressions, control
		structures, and functions. Implementing
		liveness analysis and applying it to register
		allocation.
viii	Texts/References	1. Alfred V. Aho, Monica S. Lam,
		Ravi Sethi and Jeffrey D.Ullman:
		Compilers: Principles, Techniques,
		and Tools, 2/E, AddisonWesley
		2007.
		2. Andrew Appel: Modern Compiler
		Implementation in C/ML/Java, Cambridge University Press, 2004
		3. Dick Grune, Henri E. Bal, Cerial
		J.H. Jacobs and Koen G.
		Langendoen: Modern Compiler
		Design, John Wiley & Sons, Inc.
		2000.
		4. Michael L. Scott: Programming
		Language Pragmatics, Morgan
		Kaufman Publishers, 2006.
		5. Fisher and LeBlanc: Crafting a
		Compiler in C.
ix	Name (s) of the instructor (s)	Nikhil Hegde
X	Name (s) of other departments /	EE
	Academic Units to whom the course	
	is relevant	
xi	Is/Are there any course(s) in the	No
	same/ other academic unit(s) which	
	is/ are equivalent to this course?	
	If so, please give details.	

xii	Justification/ Need for introducing	The knowledge on compilers helps to
	the course	understand how programs written in a high-
		level language is converted to machine
		codes. This helps programmers to write
		better programs.

Level: B.Tech.

Programme: B.Tech.

i	mme: B.Tech. Title of the course	Artificial Intelligence
ii	Credit Structure (L-T-P-C)	(3-0-0-6)
iii	Type of Course	Core
iv	Semester in which normally to be offered	Spring
v	Whether Full or Half Semester Course	Full
vi	Pre-requisite(s), if any (For the students) – specify course number(s)	
vii	Course Content*	Search: Problem representation; State Space Search; A* Algorithm and its Properties; AO* search, Minimax and alpha- beta pruning, AI in games. Logic: Formal Systems; Notion of Proof, Decidability, Soundness, Consistency and Completeness; Predicate Calculus (PC), Resolution Refutation, Herbrand Interpretation, Prolog. Knowledge Representation: PC based Knowledge Representation, Intelligent Question Answering, Semantic Net, Frames, Script, Conceptual Dependency, Ontologies, Basics of Semantic Web. Leaning: Learning from Examples, Decision Trees, Neural Nets, Hidden Markov Models, Reinforcement Learning, Learnability Theory. Uncertainty: Formal and Empirical approaches including Bayesian Theory, Fuzzy Logic, Non-monotonic Logic, Default Reasoning. Planning: Blocks World, STRIPS, Constraint Satisfaction, Basics of Probabilistic Planning. Advanced Topics: Introduction to topics like Computer Vision, Expert Systems, Natural Language Processing,

		ain Text: Stuart J. Russel, Peter Norvig, Artificial	
		Intelligence: A Modern Approach (3rd ed.). Upper Saddle	
viii	T /D . C	River: Prentice Hall, 2010. Other references: N.J.	
	Texts/References	Nilsson, Principles of Artificial Intelligence, Morgan	
		Kaufmann, 1985. Malik Ghallab, Dana Nau, Paolo	
		Traverso, Automated Planning: Theory & Practice, The	
		Morgan Kaufmann Series in Artificial	
		Intelligence, 2004. Christopher Bishop, Pattern Recognition	
		and Machine Learning, Springer, 2006. Mark Stefik,	
		Introduction to Knowledge Systems, Morgan Kaufmann,	
		1995. E. Rich and K.Knight, Artificial Intelligence, Tata	
		McGraw Hill, 1992.	
ix	Name(s) of	KK	
IX	Instructor(s) ***	KK	
	Name(s) of other		
	Departments/		
X	Academic Units to	No	
	whom the course is		
	relevant		
	Is/Are there any		
	course(s) in the		
	same/ other		
xi	academic unit(s)	No	
12	which is/ are		
	equivalent to this		
	course? If so, please		
	give details.		
		AI is taught traditionally as it is driving force behind	
X	Justification	many concepts in computer science and it is also	
		precursor to advanced courses like machine learning.	

Level: B.Tech.

Programme: B.Tech.

i	Title of the course	Artificial Intelligence Lab
ii	Credit Structure (L- T-P-C)	(0-0-3-3)
iii	Type of Course	Core
	Semester in	
iv	which normally	Spring
	to be offered	
	Whether Full	
V	or Half	Full
	Semester	
	Pre-requisite(s),	
vi	if any (For the	
	students) –	
	specify course	
		The lab will closely follow and aim to elucidate the lessons
		covered in the theory course CS344. Implementation and study
	Course Content*	of A*, Usage of Prolog Inferencing, Expert System Shells,
vii		Neural Net Platforms, Prediction and Sequence Labeling using
		HMMs, Simulation of Robot Navigation and such exercises
		are strongly recommended.
		ain Text: Stuart J. Russel, Peter Norvig, Artificial Intelligence:
		A Modern Approach (3rd ed.). Upper Saddle River: Prentice
		Hall, 2010. Other references: N.J. Nilsson, Principles of
		Artificial Intelligence, Morgan Kaufmann, 1985. Malik
Viii	T 4 /D C	Ghallab, Dana Nau, Paolo Traverso, Automated Planning:
	Texts/References	Theory & Practice, The Morgan Kaufmann Series in Artificial
		Intelligence, 2004. Christopher Bishop, Pattern Recognition and
		Machine Learning, Springer, 2006. Mark Stefik, Introduction to
		Knowledge Systems, Morgan Kaufmann, 1995. E. Rich and
		K.Knight, Artificial Intelligence, Tata McGraw Hill, 1992.
ix	Name(s) of	KK
	Instructor(s) ***	
	Name(s) of other	
	Departments/	
X	Academic Units	No
	to whom the	
	course is	

	Is/Are there any		
	course(s) in the		
	same/ other	N	
:	academic unit(s)		
xi which is/ are No	NO		
	equivalent to this		
	course? If so,		
	please give		
		AI is taught traditionally as it is driving force behind many	
X	Justification	concepts in computer science and it is also precursor to	
		advanced courses like machine learning.	

Level: UG

Programme: B.Tech.

i	Title of the course	Design and Analysis of Algorithms
ii	Credit Structure (L-T-P-C)	(3-0-0-6)
iii	Type of Course	Core course
iv	Semester in which normally to be offered	Spring
V	Whether Full or Half Semester Course	Full
vi	Pre-requisite(s), if any (For the students) – specify course number(s)	Computer Programming and Utilization, Discrete Structures, Data Structures and Algorithms, Data Structures and Algorithms Laboratory
vii	Course Content* Texts/References	Syllabus is divided roughly 8 modules; each module roughly takes two weeks. Module 1: Introduction Examples and motivation. Asymptotic complexity: informal concepts, formal notation, examples Module 2: Searching in list: binary search, Sorting: insertion sort, selection sort, merge sort, quicksort, stability and other issues. Module 3: Divide and conquer: binary search, recurrence relations. nearest pair of points, merge sort, integer multiplication, matrix multiplication. Module 4: Graphs: Motivation, BFS, DFS, DFS numbering and applications, directed acyclic graphs, directed acyclic graphs, Shortest paths: unweighted and weighted, Single source shortest paths: Dijkstra, Minimum cost spanning trees: Prim's algorithm, Kruskal's Algorithm Module 5: Union-Find data structure, Priority queues, heaps. Heap sort. Dijstra/Prims revisited using heaps, Search Trees: Introduction Traversals, insertions, deletions Balancing Module 6: Greedy algorithms: Greedy: Interval scheduling, Proof strategies, Huffman coding. Module 7: Dynamic Programming: weighted interval scheduling, memoization, edit distance, longest ascending subsequence. matrix multiplication, shortest paths: Bellman Ford, shortest paths: Floyd Warshall Module 8: Intractability: NP completeness, reductions, examples, Misc topics. 1. Algorithms, by Sanjoy Dasgupta, Christos Papadimitriou and Umesh Vazirani, McGraw Hill Education, 2006. 2. Introduction to Algorithms, 3rd edition, by Cormen, Leiserson, Rivest and Stein, PHI Learning Pvt. Ltd., 2010. 3. Algorithm Design, 1st edition, by Kleniberg
	NT () CT () ()	and Tardos, Pearson, 2014.
ix	Name(s) of Instructor(s)	PRB

X	Name(s) of other Departments/ Academic	Nil
	Units to whom the course is relevant	
xi	Is/Are there any course(s) in the same/other	No
	academic unit(s) which is/ are equivalent to	
	this course? If so, please give details.	
xii	Justification/ Need for introducing the	Core Course for Computer Science
	course	undergraduate students.

Academic Unit: Computer Science and Engineering			
Level (underline any one): • UG • PG			
	,		
1	Title of the course	Runtime Verification	
2	Credit Structure* (L-T-P-C)	L: 3 T: 0 P: 0 C: 6 Semester(Full/Half)^:	
3	Pre-requisite courses(s) ** specify course code(s) %	Not-applicable	
4	Recommended ^{\$} prior exposure specify course code(s) or background / knowledge / skills %	Exposure to Logic, Automata Theory, Discrete Structures, Algorithms, Digital Systems	
5	Course content	 Overview of Runtime Verification, and its comparison with other Formal Verification approaches. Fundamentals: Propositional and First-Order Logic, Temporal Logics (Linear and Metric) Propositional LTL and its variants: specification of properties, runtime verification strategies, expressibility, and monitorability. First Order LTL and its variants: specification of properties, runtime verification strategies, expressibility, and monitorability. Discussion of various state-of-the-art tools and case studies. 	
6	Texts/References (Minimum 2/3)	 K. Havelund, D. Peled, "Runtime Verification: From Propositional to First Order Temporal Logic", Tutorial at International Conference on Runtime Verification, 2018. Ezio Bartocci, Yliès Falcone. "Lectures on Runtime Verification". Springer, 2018. ISBN: 978-3-319-75632-5 Michael Huth, Mark Ryan, "Logic in Computer Science: Modelling and Reasoning about Systems", Cambridge University Press, 2004. ISBN: 978-0521543101 Research publications on Runtime Verification 	

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Level: MS/PhD

i	Title of the course	Parallel Computing
ii	Credit Structure (L-T-P-C)	3-0-0-6
iii	Type of Course	Elective
iv	Semester in which normally to be offered	Spring
V	Whether full or half semester course	Full
vi	Pre-requisite(s), if any (for the students)— specify course number(s)	Exposure to C, C++ or Fortran programming
vii	Course content	Need for High Performance Computing (HPC) and applications. Sequential Computing model, Algorithms and their complexity. Taxonomy of computer architectures — SISD, SIMD (e.g. array processors), MISD (pipelined processing, vector processors), and MIMD (shared memory and distributed memory multiprocessors, computing clusters); dataflow computing; hardware accelerators (GPUs); interconnection

networks (bus, loop, mesh and hypercube); Memory hierarchy; Case Studies. Implications of computer architectures to algorithm design, synchronous processing, single program multiple data (SPMD) and multiple program multiple data (MPMD) processing; functional and data parallelism; memory hierarchies. Performance evaluation: communication and computing costs, speedup, efficiency, Amdahl's law, parallel scalability. Parallel algorithm design and case studies: numerical algorithms (linear algebra, matrixvector and matrix-matrix multiplications, finite difference method and PDEs, Monte Carlo method), and non-numerical algorithms (search, sorting, simple tree and graph algorithms) Parallel programming platforms, OpenMP and MPI programming, GPU programming. Programing Assignments: 1. Parallel computing lab environment (system architecture, log on, hello world 2. Editors, job submission, optimization techniques for serial code. 3. MPI and simple program(s) 4. MPI and matrix-matrix multiplication 5. OpenMP and matrix-matrix multiplication OpenMP 6. Introduction to GPU programming matrix-matrix multiplication. 1. Ananth Grama, Anshul Gupta, George viii Texts/References Vipin Kumar: Introduction Karypis, Parallel Computing, Addison Wesley 2003 2. Eric Aubanel, Elements of Parallel Computing, CRC Press, 2017. 3.https://computing.llnl.gov/tutorials/mpi/ 4.https://computing.llnl.gov/tutorials/open MP/

ix	Name (s) of the instructor (s)	Nikhil Hegde, Dhiraj Patil
X	Name (s) of other departments / Academic Units to whom the course is relevant	All Departments
xi	Is/Are there any course(s) in the same/ other academic unit(s) which is/ are equivalent to this course? If so, please give details.	No
xi i	Justification/ Need for introducing the course	High performance computing is needed in all branches of engineering. This course introduces HPC applications, architectures, platforms, and programming.

Electrical Engineering Department

Academic Unit: Electrical Engineering

Level: UG

i	Title of the course	Mathematics for Data Science
ii	Credit Structure (L-T-P-C)	3 0 0 6
iii	Type of Course	Elective
iv	Semester in which normally to be offered	Autumn
V	Whether Full or Half Semester Course	Full
vi	Pre-requisite(s), if any (For the students) – specify course number(s)	Exposure to basic concepts in calculus and linear algebra
viii	Course Content Texts/References	Introduction to Data science and Motivation for the course. Review of calculus, naTve set theory, notion of limits, ordering, series and its convergence. Introduction to Linear Algebra in Data science, notion of vector space, dimension and rank, algorithms for solving linear equations, importance of norms and notion of convergence, matrix decompositions and its use. Importance of optimization in data science: Birds view of Linear Regression, Multivariate Regression, Logistic Regression etc. Convex Optimization: Convex sets, convex functions, duality theory, different types of optimization problems, Introduction to linear program. Algorithms: Central of gravity method, Gradient descent methods,Nestrov acceleration, mirror descent/Nestrov dual averaging, stochastic gradient methods,Rmsprop,SIGNSGD, ADAMalgorithm etc. Non-convex optimization: Demonstration of convex methods on nonconvex problems; merits and disadvantages. 1. C. Bishop, "Pattern Recognition and Machine Learning," Springer, 2006. Cambridge university press, 2018 (reprint). for Machine Learning," Now publisher, 2017.
ix	Name(s) of Instructor(s)	

X	Name(s) of other Departments/ Academic Units	Computer Science and Engineering, Electrical
	to whom the course is relevant	Engineering and Mechanical Engineering
	T ('6' (' / NT 16 ' ())	
хii	Justification/ Need for introducing the course	Solving optimization problem is a key
		ingredient of any data science/Machine
		Learning (ML) task. It is important to
		understand how to state problem of practical
		interests in the language of optimization, and
		solve it. This course aims to achieve this goal
		by providing theory and algorithms to solve
		optimization problems that arise in typical ML
		problems.

Level: B. Tech. / MS(R) / PhD
Programme: B.Tech. / MS(R) / PhD

	rogramme: b. rech. / Wis(R) / PhD	
i	Title of the course	Wireless Communication
ii	Credit Structure (L-T-P-C)	3-0-0-6
iii	Type of Course	Elective
iv	Semester in which normally to be offered	Autumn
v	Whether Full or Half Semester Course	Full
vi	Pre-requisite(s), if any (For the students) – specify course number(s)	Signals and Systems, Probability (UG level), Principles/Fundamentals of Communications
vii	Course Content	Review of fundamentals in probability theory, random processes, spectral analysis of deterministic and random signals; review of digital modulation schemes, optimal receiver design under additive white Gaussian noise (AWGN) and error rate performance; orthogonal frequency division multiplexing (OFDM); channel modeling, capacity and diversity techniques in wireless communication; multi-input multi-output (MIMO) systems and space time block codes (STBC); cellular communication systems, multiple-access and interference management.
viii	Texts/References	 David Tse and Pramod Viswanath, "Fundamentals Of Wireless Communication," Cambridge University Press, 2005. Andrea Goldsmith, "Wireless Communications," Cambridge University Press, 2005.
ix	Name(s) of Instructor(s)	Naveen M B
X	Name(s) of other Departments/ Academic Units to whom the course is relevant	Engineering Physics
xi	Is/Are there any course(s) in the same/ other academic unit(s) which is/ are equivalent to this course? If so, please give details.	None
xii	Justification/ Need for introducing the course	This is an elective course for Communications spine.

Name of Academic Unit: Electrical Engineering Level: UG

i	Title of the course	VLSI Design
ii	Credit Structure (L-T-P-C)	(3 0 0 6)
iii	Type of Course	Elective
iv	Semester in which normally to be offered	Autumn
V	Whether Full or Half Semester Course	Full
vi	Pre-requisite(s), if any (For the students) – specify course number(s)	Digital systems
vii	Course Content*	Review of MOS transistor models, Technology scaling, CMOS logic families including static, dynamic and dual rail logic. Integrated circuit layout; design rules, parasitics. low power design, high performance design, logical effort, Interconnect aware design, clocking techniques. VLSI design: data and control path design, floor planning, Design Technology: introduction to hardware description languages(VHDL), logic, circuit and layout verification.
Viii	Texts/References	 N. Weste and D. M. Harris, "CMOS VLSI Design, A circuits and systems perspective" Pearson, 2010 S. Kang and Y. Leblebici, "CMOS Digital Integrated circuits", Tata McGraw Hill edition, 2003 Jan M. Rabaey, A. Chandrakasan and B. Nikolic, "Digital Integrated circuits" Pearson, 2016
ix	Name(s) of Instructor(s) ***	
X	Name(s) of other Departments/Academic Units to whom the course is relevant	
xi	Is/Are there any course(s) in the same/ other academic unit(s) which is/ are equivalent to this course? If so, please give details.	No

SECTION A

	(To be filled by Department)		
Ac	Academic Unit: Electrical Engineering Level (underline any one): ● UG ● PG		
1	Title of the course	Physics of Transistors	
2	Credit Structure* (L-T-P-C)	L: 3 T: 0 P: 0 C: 6 Semester(Full/Half)^:Full	
3	Pre-requisite courses(s) ** specify course code(s) %	Not-applicable	
4	Recommended ⁵ prior exposure specify course code(s) or background / knowledge / skills %	Exposure to Electronic Devices	
5	Course content	Semiconductor Physics Review. The MOS transistor: MOS Capacitor Fundamentals, Fixed Oxide and Interface Charge Effects, Carrier Transport in MOS capacitor, Basic MOSFET operation, Measurement of MOS transistor parameters, Small Signal Equivalent Circuit, Non-ideal effects, MOSFET scaling and Short channel effects, Advanced MOSFET structures (High-kgate, SOI MOSFET and FinFET), Radiation and Hot-electron effects in transistors, MOSFET reliability, CMOS technology, Charged Coupled Device (CCD). Bipolar transistor: Basic BJT operation, Minority carrier distribution, Ideal current-voltage characteristics, Non-ideal effects, Base width modulation, High injection, Emitter bandgap narrowing, Current crowding, Nonuniform base doping, Breakdown voltage, Equivalent circuit models, Switching characteristics, Insulated-gate bipolar transistor (IGBT). Heterojunction Transistors: Heterostructure fundamentals, High electron mobility transistor (HEMT), and Heterojunction bipolar transistor (HBT).	

		References:
6	Texts/References (Minimum 2/3)	 Tsividis Y. and Mcandrew C., The MOS Transistor, New York, Oxford University Press, 2012. Taur Y. and Ning T. H., Fundamentals of Modern VLSI Devices, 2nd edition, New Delhi, Cambridge University Press, 2009. Sze S. M. and Ng K. K., Physics of Semiconductor Devices, 3rd edition, New Jersey, John Wiley & Sons, 2007. Shur M., Physics of Semiconductor Devices, Noida, Pearson, 2019. Neamen D. A., Semiconductor Physics and Technology: Basic Principles, 4th edition, New York, McGraw Hill, 2012
7	Need for introducing the course	The MOS transistor is the core element of integrated circuit (IC) technology "Heart of VLSI circuit". The bipolar transistors are used in amplifier, filter, and oscillator designs. The heterojunction transistors find applications in high-speed circuits, power switches, RF and Microwave electronics. These points signify the importance of studying the physics and technology of transistors.
8	Name (s) of other departments / Academic Units to whom the course is relevant %	NIL
9	Is there any course(s) in the same/ other academic unit(s) which is similar to this course? If so, please give details.%	NIL
10	DUGC or DPGC Approval Date (DD/MM/YYYY)	19/10/2022

	SECTION A (To be filled by Department)		
Ac	Academic Unit: Electrical Engineering Level (underline any one): ● UG ● PG		
1	Title of the course	Optimization Methods for Wireless Communication and Machine Learning	
2	Credit Structure* (L-T-P-C)	L: 3 T: 0 P: 0 C: 6 Semester(Full/Half): Full	
3	Pre-requisite courses(s) ** specify course code(s) %	Nil	
4	Recommended ^{\$} prior exposure specify course code(s) or background / knowledge / skills %	Exposure to the basics of Wireless Communication	

		-Introduction to properties of Vectors, Norms, Positive Semi-Definite matrices, Gaussian Random Vectors
		-Introduction to Convex Optimization – Convex sets, Hyperplanes/ Half-spaces, etc. Application : Power constraints in Wireless Communication Systems
		-Convex/ Concave Functions, Examples, Conditions for Convexity. Application : Beamforming in Wireless Systems, Multi-User Wireless, and Cognitive Radio Systems
		Convex Optimization problems, Linear Programs (interior point method), -Application: Power allocation in Multi-cell cooperative OFDM
		-QCQP, SOCP Problems, Application : Channel shortening for Wireless Equalization, Robust Beamforming in Wireless Systems
5	Course content	
		-Duality Principle and KKT Framework for Optimization.
		-Application: Optimization for MIMO Systems, OFDM Systems, and MIMO-OFDM systems
		-Optimization for signal estimation, LS, WLS, and Regularization.
		-Application: Wireless channel estimation
		-Application: Convex optimization for Machine Learning, Principal Component Analysis (PCA), Support Vector Machines
		-Application: Cooperative Communication, Optimal Power Allocation for cooperative Communication, Geometric Program, Communication Optimization
		-Application: Cooperative Communication, Optimal Power Allocation for cooperative Communication, Geometric Program

		References:
6	Texts/References (Minimum 2/3)	 Boyd S. and Vandenberghe B., Convex Optimization, Cambridge University Press, 2004. Tse D. and Viswanath P., Fundamentals of Wireless Communication, Cambridge University Press, 2005.
7	Need for introducing the course	This course aims to provide an overview of Applied Optimization in Wireless Communication and Machine Learning. The course briefly introduces optimization theory, and a significant portion of the course will be on the application of applied optimization in Wireless Communication and Machine Learning.
8	Name (s) of other departments / Academic Units to whom the course is relevant %	Electrical Engineering and Computer Science Engineering
9	Is there any course(s) in the same/ other academic unit(s) which is similar to this course? If so, please give details.%	Yes, Introduction to Optimization Theory is an introductory course and domain agnostic. However, the proposed course is an application area of Applied Optimization in Wireless Communication and Machine Learning. Hence, there is minimal overlap between the courses. The plan is to introduce optimization theory in about 25% of the course duration; the remaining 75 % will be focused on application areas of wireless communication and machine learning.
10	DUGC or DPGC Approval Date (DD/MM/YYYY)	25/10/2022

Level: PhD.

Programme: MS and PhD.

i.	Title of the Course	Mixed signal VLSI Design
ii.	Credit Structure	L T P C
		3 0 0 6
iii.	Prerequisite, if any	CMOS Analog VLSI Design
iv.	Course Content (separate sheet may be used, if necessary)	 CML logic for high speed mixed signal circuits Switch design and switched capacitor circuits Sampling theory and discrete-time signals Comparators Basics of data converters Nyquist rate ADC's: Parallel (single-step converters), algorithmic (multi-step converters) and pipelined ADC'Architectures and design of Nyquist rate ADC's High resolution data converters (Δ Σ data converters) Digital to analog converters Selected topics in mixed-signal VLSI circuits
V.	Texts/References (separate sheet may be used, if necessary)	 R.Jacob Baker, H.W.Li, and D.E. Boyce CMOS Circuit Design ,Layout and Simulation, Prentice-Hall of ,1998. R.Jacob Baker, CMOS: Mixed-Signal Circuit Design, Wiley (1 January 2008) Pavan, Shanthi, Richard Schreier, and Gabor C. Temes. Understandingdelta-sigma data converters.
vi.	Instructor (s)	Naveen Kadayinti
vii.	Name of departments to whom the course is relevant	Electrical Engineering
viii	Justification	This course discussed advanced topics in modern IC design which include both analog and digital circuit blocks in the same chip. The problems associated with such integrated circuits will be explored and the course will discuss the design of some typical applications of such kind. This exposure willbe necessary for any research in Mixed signal VLSI design.

Level: PG/UG

Programme: B. Tech/MS/PhD

1	Title of the Course	VLSI Technology
2	Credit Structure	L T P C
		3 0 0 6
3	Type of Course	Elective
4	Semesterin which	Even
	normally to be offered	
5	Whether Full or Half	Full semester
	Semester Course	
6		Evnogura to Floatronia Davisas
6 7	Prerequisite, if any	Exposure to Electronic Devices
'	Course Content	Introduction on VLSI Design, Bipolar Junction
	(separate sheet may be	Transistor Fabrication, MOSFET Fabrication for IC,
	used, if necessary)	Crystal Structure of Si, Defects in Crystal Crystal
		growth techniques - Bridgeman, Czochralski method,
		Floating- zone method
		Epitaxy – Vapour phase Epitaxy, Doping during Epitaxy,
		Molecular beam Epitaxy
		Oxidation – Kinetics of Oxidation, Oxidation rate
		constants, Dopant Redistribution, Oxide Charges, Oxide
		Layer Characterization
		Doping – Theory of Diffusion, Infinite Source, Actual
		Doping Profiles, Diffusion Systems, Ion-Implantation
		Process, Annealing of Damages, Masking during
		Implantation
		Lithography
		Etching – Wet Chemical Etching, Dry Etching, Plasma
		Etching Systems, Etching of Si, Sio2, SiN and other
		materials,
		Plasma Deposition Process
		Metallization – Problems in Aluminum Metal contacts,
		IC BJT – From junction isolation to LOCOS, Problems in
		LOCOS, Trench isolation, Transistors in ECL Circuits,
		MOSFET Metal gate vs. Self- aligned Poly-gate,
8	Texts/References	1. VLSI Technology by S. M. Sze
	(separate sheet may be	2. Silicon VLSI Technology by J.D.
	used, if necessary)	Plummer, M. Deal and P.D. Griffin
		3. VLSI Fabrication Principles by S. K. Gandhi
9	Instructor (s)	Ruma Ghosh
10	Name of departments to	Electrical Engineering
	whom the course is	
	relevant	
	1 CIC VAIIL	

11	Justification	VLSI is the process of integrating millions of
		components (transistors, resistors etc.) in a single small
		chip. This course introduces different concepts related
		to the processes and steps involved in fabrication of
		electronic devices and integrated circuits. This course
		develops an understanding of the limitations and
		strength of different fabrication techniques which in
		turn affect the device

Level: PG/UG

Programme: B. Tech/MS/PhD

	Title of the Course	Probability Models and Applications
ii.	Credit Structure	L T P C 3 0 0 6
iii.	Prerequisite, if any	Data analysis and Introduction to probability (6 credits course that all batches are currently doing as core)
iv.	Course Content	Introduction to Probability theory.
	(separate sheet may be used, if necessary)	Review of sample space, events, axioms of probability, introduction to probability as a measure, Random variables, Notion of independence and mutually exclusive events
		Probability Space, limits and sequence of events, continuity of probability, measurable functions, notions of induced measures, connection with cdf, change of measure, conditional probability and conditional expectation, simulating discrete and continuous random variables - accept-reject method, importance sampling.
		Random vectors and Stochastic processes: Introduction to random vectors, Gaussian vectors, notion of i.i.d random variables introduction to elementary stochastic processes like Bernoulli process and Poisson process.
		Markov Process. Discrete time and continuous time Markov chains, classification of states, notion of stationary distribution.
		Simulating stochastic processes like Gaussian process, Poisson process, Markov chains and Brownian motion.
		Introduction to Markov chain monte carlo methods, Hidden Markov chain and Markov decision process, Introduction to Brownian motion and stationary process.
		Statistics: MLE, MAP and Bayesian Estimation, sufficient statistics, Cramer-Rao bound
V.	Texts/References (separate sheet	 Sheldon Ross "Introduction to probability models" 9th Ed., Elsevier AP
	may be used, if necessary)	2. Sheldon Ross, 'Stochastic process', John Wiley, 2 nd Ed., April 1996.
		3. David Stirzaker, 'Stochastic process and models', Oxford press.
vi.	Instructor (s)	
Vii.	Name of dept to whom the course is relevant	Computer Science and Engineering, Electrical Engineering and Mechanical Engineering.

Viii	Justification	A thorough knowledge of probability theory is a requisite for
		developing a strong foundation in ML While the course on data
		analysis and intro to probability (done in second year) introduces the
		students to concepts in probability, a deeper understanding of the subject
		is needed to appreciate the nuances in courses such as Reinforcement
		learning, deep learning, pattern recognition etc. This course would act
		as a bridge in laying down a firm foundation in probability.

Level: PG/UG

Programme: B. Tech/MS/PhD

i.	Title of the Course	Neural Networks And Deep Learning (NNDL)
ii.	Credit Structure	L T P C
		3 0 0 6
iii.	Prerequisite, if any	Exposure to basic concepts in calculus and probability
iv.	Course Content (separate sheet may be used, if necessary)	Introduction to Artificial Neural Networks (ANN) and Deep Learning (DL): Motivation, basics of ANN, overview of PRML, evolution deep learning and different architectures. Applications of ANN vs DL. Feedforward Neural Networks (FFNN): Working principle, basic architecture, analysis of FFNN for different PRML tasks. Feedback Neural Networks (FBNN): Working principle, basic architecture, Boltzmann machine, analysis of FFNN for different PRML tasks.
		Competitive learning Neural Networks (CLNN): Working principle, basic architecture, analysis of CLNN for different PRML tasks.
V.	Texts/References (separate sheet may be used, if	 B. Yegnanarayana, Artificial Neural Networks, PHI, 1999. Ian Goodfellow, Yoshua Bengio, and Aaron Courville, Deep Learning, MIT Press, 2016.
vi.	Instructor (s)	S. R. Mahadeva Prasanna
vii.	Name of departments to whom the course is	Computer Science and Engineering, Electrical Engineering and Mechanical Engineering
viii	Justification	This course aims at providing an overview to the neural networks and deep learning areas. NNDL being an application area of probability, pattern recognition and machine learning, the same will be suitable for both electrical engineering and computer science and engineering students. The course contents include introduction to review of key neural networks concepts, limitations of them, detailed study of mostly deep architectures. Comparison of NN and DL architectures on different applications like speech processing, image processing and NLP.

	SECTION A		
(To be filled by Department)			
Academic Unit: Electrical Enginee		eering Level (underline any one): • UG • PG	
1	Title of the course	Introduction to Electric Vehicle Architecture	
2	Credit Structure* (L-T-P-C)	L: 3 T: 0 P: 0 C: 3 Semester(Full/Half): Half	
3	Pre-requisite courses(s) ** specify course code(s) %	Nil	
4	Recommended ⁵ prior exposure specify course code(s) or background / knowledge / skills %	Exposure to EE101 or equivalent	
5	Course content	Introduction to Electric Vehicles: EV Technology Roadmap, history and context. EV Technology Building Blocks: Vehicle Hardware and software components, mechanical and electrical subsystems; structural, battery and drive systems; Supply chain and regulatory complexities. Battery Technology: Cells, modules and Pack, battery components; battery chemistries, configurations; thermal management, manufacturing tech, Structural components, emerging technologies, BMS, BMU and battery interconnects. Homologation: Overview, Segments, Battery testing, Vehicle testing Structural Elements: Design principles, CAD based design, manufacturing processes, stress testing. Powertrains and Electric Drives: Types of Power Trains, transmission types, design consideration, motor types, technology and specifications; Control systems and hierarchy; CAN system; HMI; Power converters (DC/DC); Isolation and safety Steering, Braking and Auxiliary Systems: Power Trains, transmission types, design consideration, motor. Charging Systems: Power Trains, transmission types and its design. Other topics: Ergonomics from the users' perspective, data collection, telemetry, telematics, commercials, business models and policy issues.	

		References:
6	Texts/References (Minimum 2/3)	 Enge P., Enge N., and Zoepf S., Electric Vehicle Engineering, McGraw-Hill Education, 2021. Other sources: Latest application notes, Technical reports and industry publications (will be provided at the beginning of the course).
7	Need for introducing the course	There is currently no other course covering a general introduction of EVs for the general EE audience.
	Name (s) of other departments /	Mechanical Engg, Computer Science:
8	Academic Units to whom the	Relevant to students interested in electric vehicles
	course is relevant %	
	Is there any course(s) in the same/	None
9	other academic unit(s) which is	
	similar to this course? If so, please	
	give details.%	
10	DUGC or DPGC Approval Date (DD/MM/YYYY)	14/10/2022

	SECTION A		
	(To be filled by Department)		
Ac	Academic Unit: Electrical Engineering Level (underline any one): <u>● UG</u> ● PG		
1	Title of the course	Batteries for Electric Transportation	
2	Credit Structure* (L-T-P-C)	L: 3 T: 0 P: 0 C: 3 Semester(Full/Half):Half	
3	Pre-requisite courses(s) ** specify course code(s) %		
4	Recommended ^{\$} prior exposure specify course code(s) or background / knowledge / s kills %	Exposure to EE101 or equivalent.	
5	Course content	History and evolution of battery technology, Batteries for Electric Vehicle and application specific requirements, battery types, status of EVs and EV batteries around the world; Past, Present and Future Lead Acid Batteries Earlier development, Present Challenges, Manufacturing methods, Opportunities Lithium Based Chemistry Lithium in context of EVs – overview; Battery design methods, Present Scenario, Opportunities and Challenges Design Issues, Performance and Characterisation Battery parameters (Voltage, Current, Power, Energy, SOC, SOH, life etc.); Primary /Secondary battery systems; Series/Parallel combinations; Design principles Other battery systems for transportation	

		References:
6	Texts/References (Minimum 2/3)	 Warner J. T., The Handbook of Lithium-Ion Battery Pack Design: Chemistry, Components, Types and Terminology, Elsevier Science, 2015. Plett G. L., Battery Management Systems, Volume I: Battery Modeling, Artech House, 2015. Plett G. L., Battery Management Systems, volume 2, Artech House, 2015.
7	Need for introducing the course	There is currently no other course covering a general introduction of battery technology for Evs / transportation for the general EE audience at UG level.
8	Name (s) of other departments / Academic Units to whom the course is relevant %	Mechanical Engg, Computer Science, Physics and Chemistry. Relevant to students interested in electric vehicles.
9	Is there any course(s) in the same/ other academic unit(s) which is similar to this course? If so, please give details.%	None
10	DUGC or DPGC Approval Date (DD/MM/YYYY)	14/10/2022

MMAE Department

Name of Academic Unit: Mechanical Engineering

Level: B. Tech.

Programme: B.Tech.

Tiug	ramme: B. Iech	•	
i	Title of the course		I.C. Engines
ii	Credit Structure (L-T-P-C)		3-0-0-6
iii	Type of Course		Elective
iv	Semesterin which normally		Even
v	Whether Full or Half		Full
vi	Pre-requisite((s), if any –	
vii	Content Closed circuit, Compression Reciprocating connecting re Engine block, length, Fuel charger, Ignition Recall of the internal combin cycle (6 hr) Fuel-air syst of part throttle tuning, Turbo- theory, Fuel in Valve train overhead cam design, Cams		epts: Fundamental Operating Procedures - Open circuit, Internal combustion, External combustion, Spark ignit ion, gnition (2 hr) engine technology: 2-stroke, 4-stroke, Pistons, ds and crankshaft, Valve train, camshaft and timing gear, cylinder and head geometry, Manifold, surface finish, track systems, carburettors, fuel injection, Turbo- and superon, timing and spark advance (4 hr) rmodynamics - Definition and comparison of common stion cycles, Otto cycle, Diesel cycle, Dual cycle, Atkinson operation, Air intake systems, Intake manifold design and charging, Super-charging, Fuel management and control fection, ECU operation, Sensors and instrumentation (6 hr) and timing: Operation, Arrangement Push-rod; Single shaft (SOHC) design; Dual-overhead cam shaft (DOHC) aft function and design considerations, Valve timing, sign considerations; Component and Event Timing - Valve ng, Valve timing diagram, Spark ignition event and ression ignition injection event and timing (6 hr)
viii	Texts/ References	1. Internal 2. Fundame Smith, F 3. Internal	Combustion Engines – V Ganesan entals of Internal Combustion Engines Gill P W., J H. E J. Ziury Combustion Engine Fundamentals – John B Heywood les: Combustion and Emissions – B. P. Pundir
ix	Name(s) of Instructor(s)		Surya Prakash R.
Х	Name(s) of other Departments/ Academic Units to whom the		

xi	Is/Are there any course(s) in the same/ other academic unit(s) which is/ are equivalent to this course? If so, please give details.	NA
xii	Justification/ Need for introducing the course	Transportation is the basic need for humanity – IC Engines are the prime movers in today's world. A mechanical engineer has to have the knowledge of this subject to be relevant to the industry, especially the automobile sector.

Name of Academic Unit: Mechanical Engineering

Level: Undergraduate

Programme: B.Tech./M.S./PhD

i	Title of the course	Geometric Modeling and Computer Graphics
ii	Credit Structure (L-T-P-C)	2-0-2-6
iii	Type of Course	Elective
iv	Semesterin which	Even
v	Whether Full or Half	Full
vi	Pre-requisite(s), if any – specify course number(s)	Knowledge of basic mathematics concepts, Exposure to hands-on Programming in C++
vii	Course Content	Section I: 3D Geometric Curves, Surfaces and Volume (10 hr) Implicit/explicit/parametric representation Geometric continuity de Castelau algorithm and Bezier curve B-Splines and Bezier surface patch, NURBS Interpolation techniques - Lagrangian, Cubic, Hermite, Bilinear Principal curvature and Gaussian curvature Constructive Solid Geometry, Sweeping, Revolutions Section II: 3D Surfaces for Complex Geometries (10 hr) Boundary Representation (B-Reps) Tessellation primitives Medial axis Voronoi diagram and Delaunay triangulation Level Sets, Isosurfaces, and Marching Cube
vii i	Texts/Ref.	algorithm 1. Mathematics for 3D Game Programming and Computer Graphics by Eric Lengyel, 3 rd Edition, Course Technology PTR Cengage Learning. (Textbook)
		2. Curves and Surfaces For CAGD by G. Farin, 5 th
ix	Name(s) of Instructor(s)	Samarth S. Raut
Х	Name(s) of other Departments/	Electrical Engineering, Computer Science & Engineering
xi	Is/Are there any course(s) in the same/ other academic unit(s)	NA

xii	Justification/ Need for introducing the course	Computer Graphics, CAD, and advanced methods for computational analysis need a robust understanding of
	introducing the course	the underlying foundations of the 3D modeling of an object geometry. This course covers the core concepts involved in 3D geometric curves and surfaces and the arbitrary surfaces typically involved in Gaming and biomedical modeling. Knowledge of mathematical and topological primitives and relevant model refinement operations will enable students to take a deeper dive into respective fields of Computer Graphics, CAD, and relevant fields dealing with 3D visualization and operations on 3D model of man-made (engineered) and natural objects.

Name of Academic Unit: Mechanical Engineering

Level: B. Tech.
Programme: B.Tech.

i	Title of the course	Introduction to Computational Fluid Dynamics
ii	Credit Structure (L-T-P-C)	3-0-0-6
iii	Type of Course	Elective
iv	Semester in which normally to be offered	Autumn
V	Whether Full or Half Semester Course	Full
vi	Pre-requisite(s), if any – specify course number(s)	ME 203 Fluid Mechanics; Numerical Analysis; Computer Programming
vii	Course Content	1. Review of Governing Equations: General conservation equation; specific mass, momentum, energy conservation equations.
		2. Fundamentals of Numerical Methods: Direct and iterative solvers for linear equations; PDE, Classification, Basics of finite-difference, finite-volume finite-volume methods; Notion of accuracy, consistency, stability, convergence; Verification and validation.
		3. Diffusion Equation: 1-D steady conduction; Source terms and non-linearity; 2-D steady conduction; Unsteady conduction; Non-trivial boundary conditions.
		4. Advection-Diffusion Equation: Steady 1-D advection-diffusion equation; Upwinding, numerical diffusion, higher-order schemes; 2-D advection-diffusion equation
		5. Incompressible Navier-Stokes equations, Incompressibility and pressure-velocity coupling; Staggered vs collocated grids; SIMPLE and PISO algorithms.
		6. Special Topics: Non-Cartesian coordinate systems; Curvilinear grids; Unstructured grids; Advanced linear solution methods such as multigrid methods, preconditioning; Use of numerical libraries; Introduction to parallel programming for CFD.
		7. Mesoscopic approaches to discrete simulation of fluid dynamics
		8. Tutorial on a commercial CFD code & an open-source code (e.g. OpenFOAM).

viii	Texts/References	 "An Introduction to Computational Fluid Dynamics", by H. W. Versteeg and W. Malalasekera; 2nd edition, Pearson Education Ltd., 2007. (ISBN: 9780131274983) "Introduction to Computational Fluid Dynamics: Development, Application and Analysis", by Atul Sharma; Wiley, 2016. (ISBN: 9781119002994)
ix	Name(s) of Instructor(s)	Dhiraj V Patil
X	Name(s) of other Departments/ Academic Units to whom the course is relevant	Departments of Mathematics, Chemical, Civil, Physics
xi	Is/Are there any course(s) in the same/ other academic unit(s) which is/ are equivalent to this course? If so, please give details.	NA
xii	Justification/ Need for introducing the course	CFD is an integral part of the design process in mechanical, aerospace, and chemical industries, as well as a topic of active research. Training at the undergraduate and early-postgraduate level will enable students to take advantage of opportunities in these areas. The course aims to provide an introduction to discretization and solution of the equations of fluid dynamics and heat transfer. Students will gain an appreciation of the principles of the finite-volume method, experience in writing and debugging scientific codes, and solving and analysing a problem using a commercial/open-source package. Students should expect to devote significant time to learning via coding assignments and project.

	SECTION A (To be filled by Department)		
Aca	demic Unit:	Level (underline any one): ● <u>UG</u> ● PG	
1	Title of the course	Aerodynamics	
2	Credit Structure* (L-T-P-C)	L: 3 T: 0 P: 0 C: 6 Semester(Full/Half)/ F Typically offered in even semester	
3	Pre-requisite courses(s)** specify course code(s) %		
4	Recommended [§] prior exposure specify course code(s) or background / knowledge / skills %	ME 203 Fluid Mechanics	
5	Course content	Introduction: relevance of aerodynamics and applications. Review of mathematical background: vector calculus, tensor notation and algebra; Kinematics and dynamics of fluid motion; Governing equations of fluid motion; Potential flow: elementary potential flows, Kutta-Joukowski theorem, conformal transformation, source panel method; Flow over airfoils: airfoil nomenclature and characteristics, thin airfoil theory, vortex panel method; Finite wing aerodynamics: Prandtl lifting line theory, lifting surface theory and vortex lattice method; execution of relevant numerical technique(s) using scientific computing tools; Compressible flows: governing equations of compressible flow, elements of supersonic flows, subsonic compressible flow over airfoils; Boundary layers: solutions to the boundary layer equation, boundary layer separation.	

		Text books:
		Houghton, E. L., and P. W. Carpenter, "Aerodynamics for engineering students," Elsevier, 2015.
		2. Anderson Jr., John D, "Fundamentals of aerodynamics," McGraw-Hill
		Education, 2017.
		,
		References:
	Texts/References	Abbott, I. H., and A. E. von Doenhoff. "Theory of Wing Sections,"
6	(Minimum 2/3)	Including a Summary of Airfoil Data." Dover Publications Inc., 1959.
		Bertin, John H., and Russel M. Cummings, "Aerodynamics for
		Engineers," Pearson, 2014.
		Anderson Jr., John D. "Modern Compressible Flow: with Historical
		Perspective." McGraw-Hill Education, 2021.
		Anderson Jr., John D. "Introduction to Flight (SI Units)." McGraw-Hill
		Education, 2017.
		Van Dyke, Milton. "An Album of Fluid Motion." Parabolic Press, 1982.
		Aerodynamics is the study of the air flowing over a body, which is typically an
		aircraft or automobile, to determine the forces and moments acting on it. The
	Need for introducing the	study of aerodynamics is essential to design and analyze various components
		of aircraft and automobile systems as well as certain civil structures, with the
7	course	aim to propose alternate designs with improved performance. Learners of this
		course will understand the fundamental concepts of aerodynamics and use
		them to calculate the aerodynamic forces acting on simplified as well as
		realistic geometries.
	Name (s) of other departments	Civil and Infrastructure Engg
8	/ Academic Units to whom the	
	course is relevant %	
	Is there any course(s) in the	No.
9	same/other academic unit(s)	
	which is similar to this course?	
	If so, please give details.%	
10	DUGC or DPGC Approval Date	18/11/2022 approved by DUGC (through email circulation). Also sent to PG-
	(DD/MM/YYYY)	APEC for further approval on 22/11/2022.

SECTION A (To be filled by Department)		
Academic Unit: MMAE		Level (underline any one): ● <u>UG</u> ● PG
1	Title of the course	Introduction to Aerospace Materials
2	Credit Structure* (L-T-P-C)	L: 3 T: 0 P: 0 C: 6 Semester(Full/Half) Full Typically offered in even semester
3	Pre-requisite courses(s)** specify course code(s) %	
4	Recommended ^s prior exposure specify course code(s) or background / knowledge / skills %	Basic understanding of Materials Science and Engineering and strength of Materials is a plus but not required.
5	Course content	 Importance of Aerospace Materials Selection, Aerospace Materials: Past Present & Future, Critical requirements of Aerospace Materials: Mechanical, Physical and Chemical Properties, Strengthening Mechanisms of Aerospace Alloys, Mechanical testing and Durability of aerospace materials, Production and casting of aerospace metals, Processing and machining of aerospace metals Aluminium alloys for aircraft structures, Aluminium-Lithium Alloys, Titanium alloys for aerospace structures and engines, Magnesium alloys for aerospace structures, Steels for aircraft structures, Single crystal Ni-based superalloys for turbine blade, Nickle and Cobalt based Superalloys for gas turbine engines, Refractory Metals for Aerospace Applications, Stealth materials Polymers for Aerospace Structures, Fiber reinforced Polymeric composites, Metal & Ceramic Matrix Composite, transparent materials, Coating material and technologies Fracture processes of aerospace materials, Fatigue, Corrosion and Creep in Aerospace Materials, Non-destructive inspection and health monitoring of, aerospace materials, Ashby plots

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6	Texts/References (Minimum 2/3)	Text books: 1. Aerospace Materials and Material Technologies, Volume 1: Aerospace Materials, Editor: N. Eswara Prasad, R. J. H. Wanhill, Springer Singapore, doi: https://doi.org/10.1007/978-981-10-2134-3, 2017 2. Introduction to Aerospace Materials, Editor(s): Adrian P. Mouritz, Woodhead Publishing, 2012, Pages 1-14, ISBN 9781855739468, https://doi.org/10.1533/9780857095152.1 3.Introduction to Aerospace Structures and Materials by René Alderliesten, Publisher: TU Delft Open, 2018, https://open.umn.edu/opentextbooks/textbooks/647 References:
		 Material Selection in Mechanical Design by Michael F. Ashby, (2017) 5th Edition, ISBN: 9780081006108, 9780081005996 Additive Manufacturing for the Aerospace Industry, Editor(s): Francis Froes, Elsevier, 2019, ISBN 9780128140628, https://doi.org/10.1016/B978-0-12-814062-8.00001-7
7	Need for introducing the course	This course provides an introduction to the science and engineering of the materials used in aircraft, helicopters and spacecrafts, Rockets etc. The topic of aerospace materials is core to aerospace engineering. The focus of this course is the structural materials used in the main structures (e.g. fuselage, wings, landing gear, control surfaces) and the propulsion systems (e.g. jet engines, helicopter rotor blades). The reason to focus on structural materials is due to their major influence on the cost, performance and overall safety of the aircraft.
8	Name (s) of other departments / Academic Units to whom the course is relevant %	Civil and Infrastructure Engg
9	Is there any course(s) in the same/ other academic unit(s) which is similar to this course? If so, please give details.%	
10	DUGC or DPGC Approval Date (DD/MM/YYYY)	18/11/2022 approved by DUGC (through email circulation). Also sent to PG-APEC for further approval on 22/11/2022

i	Title of the course	Fracture Mechanics		
ii	Credit Structure (L-T-P-C)	3-0-0-6		
iii	Type of Course	Elective		
iv	Semester in which normally to be offered	Even/Odd		
V	Whether Full or Half Semester Course	Full		
vi	Pre-requisite(s), if any – specify course number(s)	Theory of Elasticity or equivalent		
vii	Course Content	Module 1: Background Kinds of Failure; Historical Aspects; Brittle and Ductile Fracture; Modes of Fracture Failure		
		Module 2: LEFM Griffith's Theory of Brittle Fracture; Irwin-Orowan Modification; Stress Intensity Factor (SIF) Approach; Concepts of Strain Energy and Potential Energy Release Rates;		
		Determination of Crack-Tip Stress and Displacement Field - Airy Stress Function Approach, Westergaard Stress Function Approach, Williams' Eigenfunction Expansion.		
		Determination of Stress Intensity Factors: Analytical Methods, Numerical and Experimental Methods. Mixed Mode Brittle Fracture: Theory based on Potential Energy Release Rates, Maximum Tangential Stress Criterion, Maximum Tangential Principal Stress Criterion, Strain Energy Density Criterion		
		Module 3: Anelastic Deformation at Crack Tip Irwin Plastic Zone Size Correction; Dugdale-Barenblatt Model for Plastic Zone Size; Crack-Tip Mode I, II and III Plastic Zone Shape; Thickness Dependence of Fracture Toughness KC; Crack Opening Displacement; Rice's Path-Independent Integral J; Resistance Curve; Stability of Crack Growth		
		Module 4: Elastic Plastic Fracture Mechanics Crack Opening Displacement Criterion; Mode I Crack-Tip Field - Ric Rosengren Analysis, Hutchinson's Analysis; Crack-Tip Constraints: T Stre and Q Factor; Crack Propagation and Crack Growth Stability		
		Module 5: Fatigue Crack Growth Fatigue Crack Growth Rate under Constant Amplitude Loading; Factors Affecting Fatigue Crack Propagation; Crack Closure; Life Estimation Using Paris Law; Variable Amplitude Cyclic Loading		
		Module 6: Experimental Measurement of Fracture Tougness Data Measurement of Plane Strain Fracture Toughness KIC, Critical COD δC Resistance Curve - Linear Elastic Material and Elastic Plastic Material		
viii	Texts/ References	Text-books: 1. T. L. Anderson, Fracture Mechanics: Fundamentals and Applications, 4th ed. – Boca Raton 2017. 2. D. Broek, Elementary Engineering Fracture Mechanics, 3 rd Revised Edition, Springer Netherlands, 1982, 3. Maiti S.K, Fracture Mechanics: Fundamentals and Applications. – 1 St Edition, Delhi: Cambridge University Press, 2015. References: 1. Prashant Kumar, Elements of Fracture Mechanics, Tata McGraw-Hill. Education, 2009, 2. CT Sun, Fracture Mechanics, Academic press, 2012, 3. T. Kundu, Fundamentals of Fracture Mechanics, CRC Press, 2008.		

ix	Name(s) of Instructor(s)	TPG, AKG
X	Name(s) of other Departments/ Academic Units to whom the course is relevant	
xi	Is/Are there any course(s) in the same/ other acade mic unit(s)	Nil
xii	Justification/ Need for introducing the course	Development of fault-tolerant philosophy in design of aircrafts, structures and machines necessitates understanding of structural behaviour with cracks. This course is an introduction to the subject in context of engineering applications. The course begins with LEFM and then covers anelastic deformation at the tip. Subsequently, EPFM and fatigue behaviour of a structure with crack are explored. Numerical techniques (FE) & experimental techniques in context of fracture mechanics are then discussed.

Academic Unit: MMAE L		Level (underline any one): • UG • <u>PG</u>		
1	Title of the course	Modeling of Metal Plasticity: Discrete and Continuum approaches		
2	Credit Structure* (L-T-P-C)	L: 3 T: 0 P: 0 C: 6 Semester(Full/Half)^: Full		
3	Pre-requisite courses(s) ** specify course code(s) **	NIL		
4	Recommended prior exposure specify course code(s) or	Prior undergraduate-level understanding of solid mechanics and mathematics is a plus but not required (There will be a quick review of fundamentals before jumping into the topic itself)		

		Introduction: Importance of Metal Plasticity, Plasticity as
		multiscale phenomenon, Different approaches to model
		plasticity
		Plasticity at discrete dislocation level
		Module 1 Fundamentals of dislocation mechanics: Classification
		of defects, line defects, Dislocation and its Characteristics,
		classification of dislocations, Dislocation as source of plasticity
		Module 2 Discrete Dislocation Dynamics method: Stress field of a
		dislocation, Volterra construction, Dislocation motion, Driving force
		on a dislocation, Evaluation of dislocation velocity, Discretization
		and adaptive remeshing of dislocation lines, Time integration of
		equations of motion, Dislocation reactions
		Module 3 Dislocation dynamics code and examples: Introduction to
_	Course content	ParaDis, Simulation procedure, Basic simulation examples (Frank-Read
5	Course content	source, Strain Hardening simulation, dislocation relaxation)
		Plasticity at Continuum scale
		Module 4 Structure and Properties of Metals and Introductory
		Mechanics: Crystal structure, slip systems, elastic and plastic
		deformation, anisotropy
		Stress and strain tensors, principle stresses, Yield criteria
		Module 5 Small and Large deformation theory: Infinitesimal strain
		theory, Kinematics, Deformation gradient, Different
		stress and strain measures, Velocity gradient,
		Ryan B. Sills, William P. Kuykendall, Amin Aghaei, Wei Cai,
	Texts/Ref. (Minimum 2/3)	Fundamentals of Dislocation Dynamics Simulations, Multiscale
6		Materials Modeling for Nanomechanics. Vol. 245. Springer
J		Franz Roters, Philip Eisenlohr, Thomas R. Bieler, Dierk
		Raabe Crystal Plasticity Finite Element Methods: In
		Materials Science and Engineering, John Wiley & Sons,
		2011
		Ellad B. Tadmor, Ronald E. Miller, Modeling Materials -
		Continuum, Atomistic and Multiscale Techniques, Cambridge

		Metal plasticity is inherently a multiscale phenomenon where
	Need for introducing the course	information bridges must be established between different length and
		time scales for the accurate description of the deformation behavior of
7		metals and alloys suitable for engineering applications. In the same spirit,
		this course is designed to provide a brief introduction to plasticity at two
		different length scales i.e. discrete dislocation dynamics and continuum
		plasticity models currently used to simulate dislocation mediated
		plasticity in metals and alloys. In addition, a special emphasis is given
		on the explicit scale bridging between these two length scales.
	Name (s) of other	-
8	departments / Academic	
	Units to whom the course	
9	Is there any course(s) in the	-
9	same/ other academic	
	unit(s) which is similar to	
	this course? If so, please	
	give details. [%]	
10	DUGC or DPGC Approval Date (DD/MM/YYYY)	18-02-2022

Name of Academic Unit: Mechanical Engineering

Level: UG/PG

Programme: M.Tech./MS/Ph.D./B. Tech.

i	Title of the	he course		Multiphase Flow	
ii	Credit St	tructure (L-T-P-C)		3-0-0-6	
iii	Type of C	Course		Elective course	
iv	Semester in which normally to be offered			Spring	
v	Whether	Full or Half Semester Course		Full	
vi	Pre-requ	isite(s), if any – specify course nu	ımber(s)	None	
vii	Course	• Introduction and overview :]	History, Mot	ivation and Application	
	Content	• Transport phenomena : In Momentum equation	troduction,	Reynolds transport theorem, Continuity equation,	
		energy and capillary forces, M	easurement ary rise, Cap	cial tension and its role in multiphase flow, Surface of surface tension, Laplace pressure and Young's law, billary force on floating bodies, Wetting, Wetting of a gularities	
		Boundary conditions in mu Stress conditions at fluid interfa-	_	ows: Kinematic and dynamic boundary conditions, on deforming surfaces	
		· ·		gham's theorem and dimensionless numbers for ysis and physical similarity, Self-similarity	
		• Introduction of asymptotic a asymptotic solution, Domain po		symptotic expansion, Pulsatile flow: Analytical and nethod	
		theory, Thin film approximati	ion with fre	ation: Derivation of basic equation of lubrication be surfaces: Derivation of governing equations and Application of lubrication theory	
				ateau Instability, Fluid sheets, Rupture of soap film ity, Rayleigh-Taylor Instability, Kelvin-Helmholtz	
		Numerical solution of Navi Marker and Cell method, Boun		equation: Time integration, Spatial discretization, ons	
			function, Vo	entals, Numerical definition of interface, Heaviside lume of fluid method, Level set method, Numerical	
		• Applications: Bubbly flows, d	rop collision	and splashing, Breakup and Atomization	
viii	Texts/ Referen ces	feren 1. L. Gary Leal, Advanced Transport Phenomena, First Edition, 2007, CUP.			
		 P.G. de Gennes, F. Brochard-Wyart and D. Quéré, Capillarity and Wetting Phenomena: Drops, Bubbles, Pearls, Waves, First Edition, 2003, Springer Publication E. J. Hinch, Purterbation Methods, First Editions, 1991, Cambridge University Press G. I. Barenblatt, Scaling, First Edition, 2003, Cambridge University Press. J. Eggers & M.A. Fontelos, Singularities: Formation, structure & propagation, 1st Ed., 2015, CUP 			
ix	Name(s)	of Instructor(s)	HD		
Х	x Name(s) of other Departments/ Academic Units to whom the course is relevant		Chemical Eng	gineering	

xi	Is/Are there any course(s) in the same/ other academic unit(s) which is/are equivalent to this course? If so, please give details.	No
xii	Justification / Need for introducing the course	This is a postgraduate level course that covers few fundamental aspects of multiphase flows. Understanding multiphase flow is essential in many industrial applications. For example, starting from the petroleum industry, food processing industry, ink-jet printing to the manufacturing of self-cleaning devices, painting and coating processes involve multiphase flow. The course can be offered as an elective course in B.Tech/M.Tech. /MS/Ph.D. to Mechanical and Chemical Engineering Departments.

	SECTION A (To be filled by Department)					
Ac	ademic Unit:MMAE	_ Level (underline any one): ● UG _ ● PG				
1	Title of the course	Advanced CAM				
2	Credit Structure* (L-T-P-C)	L: 3 T: 0 P: 0 C: 6 Semester(Full/Half)/ Full				
3	Pre-requisite courses(s)** specify course code(s) %	None				
4	Recommended ^s prior exposure specify course code(s) or background / knowledge / skills %	Exposure to any programming language, preferably object-oriented programming.				
5	Course content	Representation of curves: wireframe models, wireframe entities, analytic curves, synthetic curves - cubic splines, Bezier curves, B-Spline curves. Representation of surfaces: surface models, surface entities, analytic surfaces, synthetic surfaces Representation of solids: solid models, solid entities, fundamentals of solid modeling, boundary representation (B-rep), constructive solid geometry (CSG) . CAD/CAM data exchange: evolution of data exchange formats, STL, IGES, STEP formats Numerical control: principles of numerical control, numerical control systems, NC controllers. NC part programming: manual part programming, computer assisted part programming, sculptured surface machining/forming/deposition, path verification. Digital manufacturing science: system of digital manufacturing science, manufacturing informatics, intelligent manufacturing, key technology in digital manufacturing, impact of digital manufacturing in industrial transformation. Digital twins: concept of digital twin, digital twin modeling, digital twin driven smart manufacturing, cyber physical fusion in digital twin, digital twin and big data. Industry 4.0 cases studies of manufacturing.				

6	Texts/References (Minimum 2/3)	Textbook: 1. Ibrahim Zeid, R. sivasubramanian. CAD/CAM theory and practice, 2nd edition, McGrawHill, 2019 2. TS chang. Computer aided manufacturing, 3rd edition, Pearson Prentice Hall 2005 3. Zude Zhou, Shane Xie, Deju Chen. Fundamentals of digital manufacturing science, Springer series in advanced manufacturing, SpringerLink, 2013 4. A.Y.C. Nee, Fei Tao, Meng Zhang. Digital twin driven digital manufacturing, 1st edition, Academic press, 2019
7	Need for introducing the course	This course introduces the mathematical aspects of the computer aided manufacturing and topics in industry 4.0. The course is deisgned to impart practical knowledge through hands on implementation of the concpets being taught in the class. This course imparts the skills required for the implementation of industry 4.0 concepts.
8	Name (s) of other departments / Academic Units to whom the	CSE, EE, C&I
0	course is relevant %	
	Is there any course(s) in the same/other academic unit(s)	Nil
9	which is similar to this	
	course? If so, please give	
	details.%	
10	DUGC or DPGC Approval Date (DD/MM/YYYY)	17/11/2022 approved by DUGC (through email circulation). Also sent to PG-APEC for further approval on 22/11/2022

	SECTION A (To be filled by Department)				
Ac	Academic Unit: MMAE Level (underline any one): ● UG ● PG				
1	Title of the course	Design and Manufacturing of Composites			
2	Credit Structure* (L-T-P-C)	L: 3 T: 0 P: 0 C: 6 Semester(Full/Half)^:			
3	Pre-requisite courses(s)** specify course code(s) %				
4	Recommended ^s prior exposure specify course code(s) or background / knowledge / skills %	Mechanics of Materials/Manufacturing process 1 / 2/ Relevant.			
5	Design: Micromechanics of Composites: Density; Mechanical properti Prediction of elastic constants, Micromechanical approach, Halpin equations, Transverse stresses; Thermal properties – COTE for compos Thermal conductivities, Hygral and thermal stresses; Mechanics of I transfer from matrix to fibre. Macromechanics of composites -Ela constants of an isotropic material and lamina, Variation of lar properties with orientation; Laminated composites; Stresses and strain laminated composites, Interlaminar stresses and edge stresses; Monotonic strength and Fracture: Tensile strength of uni-direction of Max strain theory, Tsai-Hill criterion, Quadratic interaction. Fatigue Creep: S-N curves-FCP tests, Fatigue of composites. Creep				

		Textbook:		
		1) Krishan K. Chawla, Composite Materials Science and		
		Engineering · Springer International Publishing, 2016		
		2) M. Balasubramanian, Composite Materials and Processing, 1st		
		edition CRC Press		
6	Texts/References	3) T. W. Clyne, D. Hull, An Introduction to Composite Materials,3rd		
	(Minimum 2/3)	edition Cambridge University Press.		
		References:		
		1. Krishan Chawla, Fibrous materials, Cambridge university press,		
		2016.		
		2. Krishan Chawla, Ceramic matrix composites, Springer Science &		
		Business Media, 2013		
		Composites playa pivotal role as engineering materials. A course exposing		
7	Need for introducing the course	to the overall ideas in design, manufacturing, industrial applications and		
'		advancements of composites with new ideas for research projects will help		
		in appreciate this pivotal role of composites.		
	Name (s) of other departments /	Civil and Infrastructure Engg.		
8	Academic Units to whom the			
	course is relevant %			
	Is there any course(s) in the	Nil		
9	same/other academic unit(s)			
9	which is similar to this course?			
	If so, please give details.%			
10	DUGC or DPGC Approval Date	17/11/2022 approved by DUGC (through email circulation). Also sent to		
10	(DD/MMYYYY)	PG-APEC for further approval on 22/11/2022.		

Name of Academic Unit: Mechanical, Materials and Aerospace Engineering

Level: <u>UG-PG</u>
Programme: B.Tech./M. Tech./M.S./PhD

i	Title of t	Title of the course		Design of Mechatronic Systems	
ii	Credit S	tructure (L-T-P-C)	3-0-0-6		
iii	Type of 0	Type of Course		Elective	
iv	Semester	Semester in which normally to be offered		Even/Odd	
v	Whether	Full or Half Semester Course	Full		
vi	Pre-requ	isite(s), if any - specify course number(s)			
vii	Course Content				
		Integrated mechanical-electronics design ph concept and utility of compliant mechanisms		s of real life systems. Smart sensor	
		Microprocessor building blocks, combination instruction execution fundamentals with example 1.00 miles and 1.00			
		Microcontrollers for mechatronics: Philosop and Getting started with TIVA programming		g interfaces, setting sampling time,	
	Microcontroller programming philosophy emphasis on TIVA, programming different inter PWM, QEI etc. Mathematical modeling of mechatronic systems, Modeling friction, DC n Lagrange formulation for systemdynamics.				
		Dynamics of 2R manipulator, Simulation us	ing Matlab, Selecti	on of sensors and actuators.	
	Concept of feedback and closed loop control, mathematical representations of systems an design in linear domain, Basics of Lyapunov theory for nonlinear control, notions of Lyapunov theorems and their application			•	
		Trajectory tracking control development bas and signal processing	ed on Lyapunov the	eory, Basics of sampling of a signal,	
		Digital systems and filters for practical med case studies of development of novel mechasor for microfabrication.			
viii	Texts/ References	• Devoas Snelly Richard A Kolk Wechalronics System Design PwS Pliblishing company			
		 Sabri Cetinkunt, "Mechatronics with Experiments," 2nd Edition, Wiley Janschek, Klaus, "Mechatronic Systems Design," Springer 			
ix	Name(s)	of Instructor(s) SDR, MM			
x	Name(s)	of other Departments/ Academic Units to whom th	e course is relevant	EE	
xi		ere any course(s) in the same/other academic unit at to this course? If so, please give details.	(s) which is/ are	Nil	
xii	Justification/Need for introducing the course is geared towards developing skills of candidates towards conceiving new mechatronics products based on raw ideas and develop them. The course focuses on hands-on experience along with a project, and offers a lot of practical tips to make theory work in practice. Furthermore, the course catalyzes integrated thinking in mechanical and electronics domain, which is crucial to successful product design and development.				

Physics Department

Aca	demic Unit: Department of Phy	ysics Level (underline any one): ● <u>UG</u> ● PG	
1	Title of the course	PHxxx: Classical Mechanics	
2	Credit Structure* (L-T-P-C)	L: 2 T: 1 P: 0 C: 6 Semester(Full/Half)^: Full	
3	Pre-requisite courses(s) ** specify course code(s) %	Nil	
4	Recommended ^s prior exposure specify course code(s) or background/knowledge/skills [%]	None	
5	Course content	Review of Newtonian Mechanics - Newton's Laws of Motion and Conservation Laws. Principles of Canonical Mechanics - Constraints and generalized coordinates, Alembert's principle, Lagrange's equation, Hamilton's variational principle, canonical systems, symmetries and conservation laws, Noether's theorem, Liouville's Theorem. Central Force: Equations of motion Virial Theorem, Kepler's Laws, Scattering in a Central Force Field. Rigid Body: Euler angles, Coriolis Effect, Euler equations, moment of inertia tensor, motion of asymmetric top. Small Oscillations: Eigen value problem, frequencies of free vibrations and normal modes, forced vibration, dissipation. Special Theory of Relativity: Newtonian relativity, Michelson-Morley experiment, Special theory of relativity, Lorentz transformations and its consequences, addition of velocities, variation of mass with velocity, mass-energy relation, Minkowski four-dimensional continuum, four vectors. Hamiltonian Equation, Gauge transformation, canonical transformation, Infinitesimal transformation, Poisson brackets, Hamilton-Jacobi equations, Separation of variables. Lagrangian and Hamiltonian formulation of continuous systems.	

6	Texts/References (Minimum 2/3)	 Classical Mechanics: H. Goldstein, C. P. Poole, and J. Safko, Pearson 2011. Classical Mechanics: N. C. Rana and P. S. Joag, Tata McGraw Hill, 2017. Introduction to Classical Mechanics: David Morin, Cambridge University Press, 2008. Mechanics: L.D. Landau and E. M. Lifshitz, Butterworth-Heinemann, 3rd edition, 1982. Mechanics: From Newton's Laws to Deterministic Chaos, F. Scheck, Springer, 5th edition, 2010. Introduction to Classical Mechanics, R G Takwale and P S Puranik, Tata McGraw Hill, 2008. 	
7	Need for introducing the course	Classical Mechanics is a mature field in Science describing the motion of macroscopic objects. Consequently, content of this course will be useful for all kinds of Engineers.	
	Name (s) of other departments	Physics and All Engineering	
8	/ Academic Units to whom the course is relevant %		
	Is there any course(s) in the	No	
9	same/other academic unit(s)		
	which is similar to this course? If so, please give details.%		
10	DUGC or DPGC Approval Date (DD/MMYYYY)	19/10/2021	

Aca	Academic Unit: Department of Physics Level (underline any one): ● <u>UG</u> PG				
1	Title of the course	PHxxx: Quantum Mechanics-1			
2	Credit Structure* (L-T-P-C)	L: 2 T: 1 P: 0 C: 6 Semester(Full/Half)^			
3	Pre-requisite courses(s)** specify course code(s) %	PH101 MA101			
	Recommended ^s prior exposure specify course code(s) or background /	None			
5	Course content	Review of Wave mechanics, Schrodinger equation, Uncertainty principle, wave packets, group velocity and phase velocity. Postulates of quantum mechanics, probability and probability current density, operators, eigenvalues and eigenfunctions. Bound states, delta-function potential, and harmonic oscillator. Formalism: Hilbert space, Observables, Eigenfunctions of Hermitian operator, Dirac's notation, matrix representations of vectors and operators, parity operation, matrix theory of harmonic oscillator. Theory of Angular Momentum: Spherical harmonics, eigenvalues of L^2 and Lz, addition of angular momentum, commutation relations, degeneracies. Hydrogen atom, quantum numbers, two particle systems.			
6	Texts/References (Minimum 2/3)	 Introduction to Quantum Mechanics, D. J. Griffiths and D. F. Schroeter, Cambridge University Press, 3rd edition, 2019. Modern Quantum Mechanics, J. J. Sakurai, Cambridge University Press, 2017. Principles of Quantum Mechanics, R. Shankar, Springer, 2014. Quantum Physics, S. Gasiorowicz, John Wiley, 2000. Quantum Mechanics, L. D. Landau and E.M. Lifshitz, Pergamon press, 1965 			

7	Need for introducing the course	This course concentrates on developing the postulates that governs the quantum physics, some necessary tools to understand the behavior of quantum systems, introduces the Dirac's formalism to quantum mechanics, and addresses the understanding of some physical systems at quantum level. In the first course of quantum physics, through PH101, the students are introduced to various basic aspects of quantum systems. Which was more generic in nature, however, this course tries to make the learning of quantum mechanics streamlined and deal with exact physics systems.
8	Name (s) of other departments / Academic Units to whom the course is relevant %	Physics and All Engineering
9	Is there any course(s) in the same/other academic unit(s) which is similar to this course? If so, please give details.%	No
10	DUGC or DPGC Approval Date (DD/MMYYYY)	19/10/2021

Name of Academic Unit: Department of Physics

Level: UG

Programme: B.Tech.

i	Title of the Course	PH	XXX: S	pe cial '	Theor	of Relativity
ii	Credit Structure	L	T	P	C	
		2	1	0	6	
iii	Type of Course	Ele	ctive co	urse		
iv	Semester in which normally to be offered		Autumn/Spring			
V	Whether Full or Half Semester Course	Full				
vi	Pre-requisite(s), if any (For the students) – specify course number(s)	PH	101, PH	102		
vii	Course Content	_			_	and: Galilean Transformation, Michelson-Morley Special Relativity,
			<i>ativistic</i> erration			Lorentz Transformations, Addition of Velocities, ffects,
			Relativistic Dynamics: Relativistic Momentum, Mass, Force Law and their Transformation Properties,			
		Relativity and Electromagnetism: Transformation of electric and magnetic fields, Field of uniformly moving charge and current-carrying wire, Forces between moving charges, Invariance of Maxwell's equations.				
		Geometric Representation of Space-Time: Spacetime Diagram, Simultaneity, Contraction, Dilation, Time order and space separation of events.				
		Intr	oduction	to Gen	neral R	elativity.
viii	Texts/References (separate sheet may be used, if necessary)					Relativity, R. Resnick Wiley India, (2005). French, C R C Press, (2017).
ix	Name(s) of Instructor(s)	Fac	ulty, De	partme	nt of Pl	hysics
X	Name(s) of other Departments/ Academic Units to whom the course is relevant	NA				
xi	Is/Are there any course(s) in the same/other academic unit(s)	No				

	which is/are e quivalent to this course? If so, please give details.	
viii	Justification/ Need	It introduces theory of Special Theory of Relativity which the generalization of
VIII	for introducing the	laws of Physics in the near speed of light limit. It is essential to consider Special
	course	and General Relativistic corrections for GPS to work and thus would be useful
		also for Engineers.

Aca	demic Unit: Mathematics	Level (underline any one): ● <u>UG</u> ● PG
1	Title of the course	Introduction to Number Theory 2
2	Credit Structure* (L-T-P-C)	L: T: P: C: Semester(Full/Half)/
3	Pre-requisite courses(s)** specify course code(s) %	None
4	Recommended [§] prior exposure specify course code(s) or background / knowledge / skills %	None
5	Course content	Prime integers, Fundamental Theorem of Arithmetic, some elementary results about prime numbers and their distribution. An explanation of the Riemann Zeta function and the relation of Riemann hypothesis to the distribution of primes. Some standard Arithmetic functions like \phi(n), \mu(n), d(n), \sigma(n), r(n); their generating functions, orders of their magnitudes, perfect integers. Partitions of integers, Euler's recursive formula, partition identities of Ramanujan. Waring's problem. Some applications to cryptography
6	Texts/References (Minimum 2/3)	1) T. M. Apostol, Introduction to Analytic number theory, Springer International student edition, 2) I. Niven and H. S. Zukerman, An introduction to the Theory of Numbers, Wiley, New York, 1980, Fourth Edition
7	Need for introducing the course	Number theory is one of the cornerstones of modern mathematics which has important applications in areas like Computer Science. This course will cover some aspects of basic number theory assuming zero prerequisites. Any student can credit this course and get ready for a higher level course on the same topic.
8	Name (s) of other departments / Academic Units to whom the course is relevant %	Computer Science & Electrical Engineering
9	Is there any course(s) in the same/other academic unit(s) which is similar to this course? If so, please give details.% DUGC or DPGC Approval Date	No
10	(DD/MMYYYY)	

Name of Academic Unit: Mathematics

Level: UG

Programme: B. Tech

i	Title of the course	Algebraic codes and Combinatorics
ii	Credit Structure (L-T-P-C)	(3-0-0-6)
iii	Type of Course	Elective
iv	Semester in which normally to be offered	Spring
v	Whether Full or Half Semester Course	Full
vi	Pre-requisite(s), if any (For the students) – specify course number(s)	
vii	Course Content	Syllabus: Algebraic codes: Definition and motivation, parameters, parity check matrix of an algebraic code, basic inequalities, Macwilliams' identity, Perfect codes, Hamming codes, Golay codes, cyclic codes, relation to factorisation of X^{n}-1; MDS codes Combinatorics: t-designs, Fischers inequality, Finite projective planes, Bruck-Ryser theorem, extensions of Witt designs, ovals in projective planes Eigen value techniques in graph theory, expander graphs, Ramanujan graphs
viii	Texts/References	1) J.H. Van Lint, Introduction to coding theory, 3rd edition, Graduate texts in Maths, 86, Springer 2) J.H. Van Lint and R.M. Wilson, A course in Combinatorics, Cambridge Univ. Press, 2001 3) P. J. Cameron and J.H. Van Lint, Graphs, Codes and designs (Revised edition og Graph theory, Coding theory and block designs)London Math Society 43, CUP 19890
ix	Name(s) of Instructor(s)	NSNS
X	Name(s) of other Departments/ Academic Units to whom the course is relevant	Common for all
xi	Is/Are there any course(s) in the same/ other academic unit(s) which is/ are equivalent to this course? If so, please give details.	Nil
xii	Justification/ Need for introducing the course	

HSS Department

Name of Academic Unit: Humanities and Social Sciences

Level: UG

Programme: B. Tech.

	Trogramme. B. Teen.				
1	Title of the course	Technological Entrepreneurship			
11	Credit Structure (L-T-P-C)	3-0-0-6			
iii	Type of Course	Elective			
iv	Semester in which normally to be offered	Fall / Spring			
V	Whether Full or Half Semester Course	Full			
Vİ	Pre-requisite(s), if any (For the students) – specify course number(s)	NIL			
Vİİ	Course Content	Introduction to Entrepreneurship - Characteristics of an Entrepreneur, Understanding Self, Phases of Entrepreneurship, Understanding the Business Context of Technological Entrepreneurship; Identifying and Evaluating Opportunities, Understanding Problem-solution Fit, Product-Market Fit, Value Proposition, Business Model Canvas, Understanding and creating Minimum Viable Product, Agile Product Development and Developing a Proof of Concept; IP for Entrepreneurs - Patents, Trade Marks, Copyrights, Design Protection, Domain Names and Trade Secrets; Preparing a Business Plan: Finding Funding-Bootstrapping, Crowdfunding, Angel Investing, Venture Capital, Bank Loans, Competition and Awards, Pitching for funding; Finance and Accounts; Market Research and Competitive Analysis, Going to market for Technology /Products / Services, Sales & Marketing, Customer Development; Technology Venture Creation and Management - How to start a Start-up and scale up, Role of Incubators and Accelerators, Operation Management; Legal Matters and Commercial Knowledge: Creativity, Motivation, Team Building & Leadership, Role of Mentors and Consultants: Social Innovations and Entrepreneurship : Success and Failure Stories. This course introduces entrepreneurship through lectures, seminars, case studies, readings and assignments to broadly expose students to the area. Some of the topics will be covered, with experience sharing from practitioners and investors. Students may choose the seminars, readings and assignments of their interests and can work on live cases including opportunity discovery and evaluation, validation, market research and competitive analysis, business plan preparation, start-up creation, financing, social entrepreneurship and innovation, etc.			

Viii	Texts/References	Reading material and case studies will be provided.
ix	Name(s) of Instructor(s)	Prof. R. R. Hirwani
X	Name(s) of other Departments/ AcademicUnits to whom the course is relevant	All the departments
xi	Is/Are there any course(s) in the same/ otheracademic unit(s) which is/ are equivalent to this course? If so, please give details.	Nil
XII	Justification/ Need for introducing	The Government of India has rolled out Start-up India
	the course	initiative with several programs with the objective of
		supporting entrepreneurs, building a robust start-up
		ecosystem and transforming India into a country of job
		creators instead of job seekers. It is therefore felt
		necessary to enable every engineering student to have
		the opportunity to integrate entrepreneurial and
		business studies into their technical degreeprogram and
		prepare them to see opportunities to create and
		grow innovative new technology ventures.

Introduction to Game Theory

i	Title of the course	Introduction to Game Theory	
ii	Credit Structure (L-T-P-C)	(3-0-0-6)	
iii	Type of Course	Elective course	
iv	Semester in which normally to be offered	Spring/Autumn	
V	Whether Full or Half Semester	Full	
vi	Pre-requisite(s), if any (For the students) – specify course number(s)	Nil	
vii	Course Content*	Definition of games, normal form and strategies, Best response, dominance, Nash equilibrium, Iterated elimination of dominated strategies, Mixed strategies. Applications: oligopoly, tariffs, crime, conflict, voting and auctions. Bayesian games and applications. Extensive form games, backward induction and sub game perfect equilibrium and applications. Perfect Bayesian equilibrium. Repeated games. Bargaining games and applications.	
Viii	Texts/References	1.An Introduction to Game Theory by M. O. Osborne, Indian ed. (2012), Oxford UniversityPress. 2.Game Theory by Drew Fudenberg& Jean Tirole, MIT Press(1991) 3.Strategy: An Introduction to Game Theory by Joel Watson, 2 nd ed.(2013), VivaBooks.	
ix	Name(s) of Instructor(s) ***	Gopal Sharan Parashari	
X	Name(s) of other Departments/ Academic Units to whom the course is relevant	NA	
xi	Is/Are there any course(s) in the same/ other academic unit(s) which is/are equivalent to this course? If so, please give details.	NA	
xii	for introducing the course	This course provides basic to intermediate level of essential concepts in applied game theory. Game theory issued to model strategic interactions and finds its use in computer science, economics, politics, electrical and electronics engineering, biology etc.	

Name of Academic Unit: HSS Dept.

Level: Undergraduate **Programme:** B.Tech.

i	Title of the Course	International Finance
ii	Credit Structure (L-T- P-C)	(3-0-0-6)
iii	Type of Course	Elective Course
iv	Semester in which normally to be offered	Spring/Autumn
V	Whether Full or Half Semester Course	Full
vi	Pre-requisite(s) , if any (For the students) – <i>specify course number(s)</i>	Nil
vii	Course Content*	International Trade Vs. International Finance; What is International Finance all about?; Balance of Payments—Principles; Disequilibrium in BOP; BOP Crisis in India in 1991; Functions of the Foreign Exchange Markets; Foreign Exchange Markets and Exchange Rate Determination; Purchasing Power Parity (PPP); Monetary Approach to Balance of Payments (Exchange Rate Determination); Asset Market Approach to Exchange Rate Determination; Dornbusch's Overshooting Model; Covered & Uncovered Interest Rate Parity; Open-Economy Macroeconomics and the International Monetary Policy; Adjustment Mechanisms with Flexible and Fixed Exchange Rates; Elasticities and absorption approaches; Management of Capital Inflows and Impossible Trinity; Issues with respect to Financial Liberalisation and
viii	Texts/References	 Gandolfo, G. (2013). International Economics II: International Monetary Theory and Open-Economy Macroeconomics. Springer Science & Business Media. Gopinath, G., Helpman, E., & Rogoff, K. (Eds.). (2014). Handbook of International Economics. Elsevier. Krugman, P., Obstfeld, M. & Melitz,M. (2012). International Economics: Theory and Policy. New Delhi: Pearson Education. Rogoff, K. S., & Reinhart, C. (2009). This Time Is Different: Eight Centuries of Financial Folly. Princeton, NJ: Princeton University Press. Salvatore, D. (2016). International Economics: Trade and Finance. John Wiley International Student Edition. Sodersten, B., & Reed, G. (1994). International Economics. Palgrave Macmillan. Appleyard, D. R., & Field Jr, A. J. (2001). International Economics. McGraw-Hill, New York.

ix	Name(s) of Instructor(s) ***	Balaga Mohana Rao
X	Name(s) of other Departments/ Academic Units to whom the course is relevant	NA
xi	Is/Are there any course(s) in the same/ other academic unit(s) which is/ are equivalent to this course? If so, please give details.	NA
xii	Justification/ Need for introducing the course.	The aim of this course is to provide students with a strong foundation in the principles of international finance which will help them to understand the theories and associated policies adopted in various countries. The course will enable students to understand the impact of the globalization on income, employment, and social standards in the current international scenario.

Applied Ethics

Title of the course	Applied Ethics		
Credit Structure (L-T-P-C)	(3-0-0-6)		
Type of Course	Elective Course		
Semester in which normally to be offered	Spring		
Whether Full or Half Semester Course	Full		
Pre-requisite(s), if any (For the students) – specify course			
Texts/References	Normative Ethics consists of fundamental theories of morality. The central question in Normative Ethics is the following. What is the standard/norm to decide the rightness or wrongness of an action? Or what gives an act a moral worth? The following are the main approaches to such questions. a. Consequentialist Theories b. Immanuel Kant's Deontological Ethics c. Virtue Ethical Theories Using the theoretical frameworks in Normative Ethics, some actual ethical issues are studied. Thus, we have some issues or problems in Applied Ethics. Under Applied Ethics, the following topics will be covered. Business ethics, institutional ethics, ethics of the media, issues of medical ethics and environmental ethics. 1.MacKinnon, Barbara, and Andrew Fiala. 2015. Ethics Theory and Contemporary Issues. CT: Cengage Learning, Stamford, USA 2.Sher, George (ed.) 2012. Ethics: Essential Readings in Moral Theory. Routledge. New York. 3.Cohen, Andrew I, and Christopher Heath Wellman (eds.) 2005. Contemporary Debates in Applied Ethics. Blackwell Publishing, Oxford, UK. 4.Frey R. G, and Christopher Heath Wellman (eds) 2005. A Companion to Applied Ethics. Wiley-Blackwell, Oxford, UK. 5.Peter, Singer (Ed.).1986. Applied Ethics, OUP, UK.		
Name(s) of Instructor(s)	Prof. Jolly Thomas		
Name(s) of other Departments/ Academic Units to whom the course is relevant	NA		
Is/Are there any course(s) in the same/other acade mic unit(s) which is/are equivalent to this course? If so, please give details.	No		
Justification/ Need for introducing the course	The main objective is to look at some of the actual ethical issues and see how one can make philosophical arguments regarding such issues. Such philosophical arguments would be stronger or would have more clarity if one can distinguish between normative ethical concerns from applied ethical concerns. In other words, to be able to critically think and examine any actual problem mentioned in the applied ethics, primarily one should be able to distinguish the normative ethical concerns from applied ethical concerns. Thus, the objective is to see various approaches in normative ethics. After		

Name of Academic Unit: Humanities and Social Sciences

Level: B.Tech.
Programme: B.Tech.

Title of the course Credit Structure (L-T-P-C) Type of Course Semester in which normally to be offered Whether Full or Half Semester Course	Introduction to Literature (3-0-0-6) Core course Autumn			
Type of Course Semester in which normally to be offered Whether Full or Half Semester	Core course			
Semester in which normally to be offered Whether Full or Half Semester				
offered Whether Full or Half Semester	Autumn			
Comst	Full			
Pre-requisite(s), if any (For the students) - specify course number(s)				
Course Content	What is Literature, Genres of Literature, Literary Texts and Co Major Themes in Literature			
Texts/References	Glossary of Literary Terms by MH Abrams, The Norton Antho of Poetry edited by Margaret Ferguson, Animal Farm by Geor Orwell, The Penguin Book of Modern Indian Short Stories- Stephen Alter, Oxford Book of English Short Stories Reissue Edition (English, Paperback, A. S. BYATT), Three Theban Pl Antigone; Oedipus the King; Oedipus at Colonus (English, Paperback, Sophocles)			
Name(s) of Instructor(s)	Prof. Ridhima Tewari			
Justification/ Need for introducing the course	The course is aimed at introducing students to literature- its rea appreciation, and its relation to contemporary world, knowledge systems and contexts.			
	Name(s) of Instructor(s) Justification/ Need for			