Course curriculum for Computer Science & Engineering for 2019 Batch

Semester VIII (2019 Batch)				
S.No	**Course Code**	**Course Name**	**Credits**	
1		Elective IV	6	
2		Elective V	6	
3		Elective VI / project	6	
Total credits			**18**	

Electives

S.No.	Department	Course Code	Course Name	Course Instructor (s)	Pre-requisites
1	CSE	CS 304	Operating Systems	Prof. Gayathri A	Exposure to Computer Architecture
2		CS 314	Operating Systems Lab	Prof. Gayathri A	Exposure to Computer Architecture
3		CS 323	Compilers	Prof. Nikhil Hegde	None
4		CS 316	Compilers Lab	Prof. Nikhil Hegde	None
5		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	EE 608	Wireless Communication	Prof. Naveen M B	Signals and Systems, Probability (UG level), Principles/Fundamentals of Communications
12		EE 624	Optimization Theory and Algorithms	Prof. Rajshekhar Bhat	Calculus and Linear Algebra
13		EE 610	VLSI Design	Prof. Saroj Mondal	
14		EE 688	Physics of Transistors	Prof. Vigneshwara Raja	
15		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	

21		EE 447	Introduction to Electric Vehicle Architecture (2nd Half Sem)	Dr.Sid Das Prof. Abhijit K	
22	**MMAE**	ME 407	IC Engines	Prof. Surya Prakash R	Applied Thermodynamics
23		ME 408	Geometric Modeling and 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	
27		ME 445	Introduction to Aerospace Materials	Prof. Satyapriya Gupta	
28		ME 646	Fracture Mechanics	Prof. Tejas Prakash G	
29		ME 645	Modeling of metal plasticity: discrete and continuum 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	**PHYSICS**	PH 202	Classical Mechanics	Prof. Koushik Saha	None
35		PH 203	Quantum Mechanics - I	Prof. R Prabhu	PH101, MA101
36		PH 426	Special Theory of Relativity	Prof. D. Narasimha	None
37	**MATHEMATICS**	MA 428	Introduction to Number Theory 2	Prof. N. S. N. Sastry	None
38		MA 409	Algebraic Codes and Combinatorics	Prof. N. S. N. Sastry	None
39	**HSS**	HS-402	Technological Entrepreneurship	Prof. Raj Hirwani	Nil
40		HS 406	Introduction to Game Theory	Prof. Gopal Parashari	HS 201
41		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) – *specify course number(s)*	**Computer Architecture**
vii	Course **Content***	Process Management, Memory Management, Storage Management, Protection and Security, Virtual
viii	Texts/References	1. **Avi Silberschatz, Peter Baer Galvin, Greg Gagne**, ``Operating Systems Concepts" 9th edition. *Wiley*. *2.* **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
xii	**Justification/ Need** for introducing the course	Fundamental course in Computer Science and Engineering.

Name of Academic Unit: 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	1. **Avi Silberschatz, Peter Baer Galvin, Greg Gagne**, ``Operating Systems Concepts" 9th edition. *Wiley*. *2.* **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
xii	**Justification/ Need** for introducing the course	Fundamental course in Computer Science and Engineering.

Name of Academic Unit: 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 students) – specify course number(s)**	Exposure to Data Structures and Algorithms, 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**	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 / 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.

Name of Academic Unit: Computer Science and Engineering
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 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 Data Structures and Algorithms, Computer Architecture, 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 / 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 is converted to machine codes. This helps programmers to write better programs.

Name of Academic Unit: Computer Science and Engineering
Level: B.Tech.
Programme: B.Tech.

i	**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,

viii	Texts/References	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 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 **Instructor(s)** ***	KK
x	Name(s) of **other Departments/ Academic Units to whom** the course is **relevant**	No
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
x	Justification	AI is taught traditionally as it is driving force behind many concepts in computer science and it is also precursor to advanced courses like machine learning.

Name of Academic Unit: Computer Science and Engineering
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
iv	Semester in which normally to be offered	Spring
v	Whether **Full or Half Semester**	Full
vi	**Pre-requisite(s)**, if any (For the students) – *specify course*	
vii	Course **Content***	The lab will closely follow and aim to elucidate the lessons covered in the theory course CS344. Implementation and study of A*, Usage of Prolog Inferencing, Expert System Shells, Neural Net Platforms, Prediction and Sequence Labeling using HMMs, Simulation of Robot Navigation and such exercises are strongly recommended.
Viii	Texts/References	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 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 **Instructor(s)** ***	KK
x	Name(s) of **other Departments/ Academic Units to whom** the course is	No

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	No
x	Justification	AI is taught traditionally as it is driving force behind many concepts in computer science and it is also precursor to advanced courses like machine learning.

Name of Academic Unit: Computer Science and Engineering
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***	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.
viii	**Texts/References**	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 and Tardos, Pearson, 2014.
ix	**Name(s) of Instructor(s)**	PRB

x	**Name(s) of other Departments/ Academic Units to whom the course is relevant**	Nil
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**	Core Course for Computer Science 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)^: Full
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**	1. Overview of Runtime Verification, and its comparison with other Formal Verification approaches. 2. Fundamentals: Propositional and First-Order Logic, Temporal Logics (Linear and Metric) 3. Propositional LTL and its variants: specification of properties, runtime verification strategies, expressibility, and monitorability. 4. First Order LTL and its variants: specification of properties, runtime verification strategies, expressibility, and monitorability. 5. Discussion of various state-of-the-art tools and case studies.
6	**Texts/References** (Minimum 2/3)	1. K. Havelund, D. Peled, "Runtime Verification: From Propositional to First Order Temporal Logic", Tutorial at International Conference on Runtime Verification, 2018. 2. Ezio Bartocci, Yliès Falcone. "Lectures on Runtime Verification". Springer, 2018. ISBN: 978-3-319-75632-5 3. Michael Huth, Mark Ryan, "Logic in Computer Science: Modelling and Reasoning about Systems", Cambridge University Press, 2004. ISBN: 978-0521543101 4. Research publications on Runtime Verification

7	**Need for introducing the course**	The world we live in is increasingly automated. However, systems are prone to misbehavior. Increasing complexity of systems and time-to-market pressures result in design bugs. Manufacturing at aggressively small technology nodes leads to defects and greater rate of wearing. Software and Hardware Trojans are increasingly being employed by malicious players to attack systems. Runtime verification is a young, promising class of techniques aimed at countering all of the above. This course will serve to detail the various capabilities and limitations of this class of techniques.
8	**Name (s) of other departments / Academic Units to whom the course is relevant** %	EE, Mathematics
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)	

Name of Academic Unit: Computer Science and Engineering
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, matrix-vector 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.
viii	**Texts/References**	1. Ananth Grama, Anshul Gupta, George Karypis, Vipin Kumar: Introduction to 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/openMP/

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
xii	**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
vii	**Course Content**	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 non-convex problems; merits and disadvantages.
viii	**Texts/References**	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 to whom the course is relevant**	Computer Science and Engineering, Electrical Engineering and Mechanical Engineering
xii	**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.

Name of Academic Unit: Electrical Engineering
Level: B. Tech. / MS(R) / PhD
Programme: B.Tech. / MS(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**	1) David Tse and Pramod Viswanath, "Fundamentals Of Wireless Communication," Cambridge University Press, 2005. 2) 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	1. *N. Weste and D. M. Harris, "CMOS VLSI Design, A circuits and systems perspective" Pearson, 2010* 2. *S. Kang and Y. Leblebici, "CMOS Digital Integrated circuits",* *Tata McGraw Hill edition, 2003* 3. *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)		
Academic Unit: Electrical Engineering **Level** (underline any one): ● UG ● <u>**PG**</u>		
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$ 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-k gate, 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).

6	**Texts/References** (Minimum 2/3)	**References:** 1. Tsividis Y. and Mcandrew C., **The MOS Transistor**, New York, Oxford University Press, 2012. 2. Taur Y. and Ning T. H., **Fundamentals of Modern VLSI Devices**, 2nd edition, New Delhi, Cambridge University Press, 2009. 3. Sze S. M. and Ng K. K., **Physics of Semiconductor Devices**, 3rd edition, New Jersey, John Wiley & Sons, 2007. 4. Shur M., **Physics of Semiconductor Devices**, Noida, Pearson, 2019. 5. 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)		
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

5	**Course content**	-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 -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

6	**Texts/References** (Minimum 2/3)	**References:** 1. Boyd S. and Vandenberghe B., **Convex Optimization**, Cambridge University Press, 2004. 2. 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

Name of Academic Unit: Electrical engineering

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)	1) CML logic for high speed mixed signal circuits 2) Switch design and switched capacitor circuits 3) Sampling theory and discrete-time signals 4) Comparators 4) Basics of data converters 5) Nyquist rate ADC's: Parallel (single-step converters), algorithmic (multi-step converters) and pipelined ADC'Architectures and design of Nyquist rate ADC's 6) High resolution data converters (Δ Σ data converters) 7) Digital to analog converters 8) Selected topics in mixed-signal VLSI circuits
v.	Texts/References (separate sheet may be used, if necessary)	1) R.Jacob Baker,H.W.Li, and D.E. Boyce CMOS Circuit Design ,Layout andSimulation, Prentice-Hall of ,1998. 2) R.Jacob Baker, CMOS: Mixed-Signal Circuit Design, Wiley (1 January 2008) 3) 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.

Name of Academic Unit: Electrical Engineering
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	**Semester in which normally to be offered**	Even
5	**Whether Full or Half Semester Course**	Full semester
6	**Prerequisite, if any**	Exposure to Electronic Devices
7	**Course Content (separate sheet may be used, if necessary)**	Introduction on VLSI Design, Bipolar Junction Transistor Fabrication, MOSFET Fabrication for IC, 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 (separate sheet may be used, if necessary)**	1. VLSI Technology by S. M. Sze 2. Silicon VLSI Technology by J.D. 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 whom the course is relevant**	Electrical Engineering

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

Name of Academic Unit: Electrical Engineering
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 (separate sheet may be used, if necessary)	**Introduction to** Probability theory. **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 may be used, if necessary)	1. Sheldon Ross "Introduction to probability models" 9th Ed., Elsevier AP 2. Sheldon Ross, 'Stochastic process', John Wiley, 2nd 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.

Name of Academic Unit: Electrical Engineering
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	1. B. Yegnanarayana, Artificial Neural Networks, PHI, 1999. 2. 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 Engineering	**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$ 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.

6	**Texts/References** (Minimum 2/3)	**References:** 1. Enge P., Enge N., and Zoepf S., **Electric Vehicle Engineering**, McGraw-Hill Education, 2021. 2. *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.
8	**Name (s) of other departments / Academic Units to whom the course is relevant** %	Mechanical Engg, Computer Science: 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

SECTION A (To be filled by Department)		
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 / skills %	Exposure to EE101 or equivalent.
5	**Course content**	**Overview** 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

6	**Texts/References** (Minimum 2/3)	**References:** 1. Warner J. T., **The Handbook of Lithium-Ion Battery Pack Design: Chemistry, Components, Types and Terminology**, Elsevier Science, 2015. 2. Plett G. L., **Battery Management Systems, Volume I: Battery Modeling**, Artech House, 2015. 3. 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.

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	**Semester in which normally**	Even
v	**Whether Full or Half**	Full
vi	**Pre-requisite(s), if any –**	
vii	**Course Content**	**General concepts**: Fundamental Operating Procedures - Open circuit, Closed circuit, Internal combustion, External combustion, Spark ignition, Compression ignition (2 hr) **Reciprocating engine technology**: 2-stroke, 4-stroke, Pistons, connecting rods and crankshaft, Valve train, camshaft and timing gear, Engine block, cylinder and head geometry, Manifold, surface finish, track length, Fuel systems, carburettors, fuel injection, Turbo- and super-charger, Ignition, timing and spark advance (4 hr) **Recall of thermodynamics** - Definition and comparison of common internal combustion cycles, Otto cycle, Diesel cycle, Dual cycle, Atkinson cycle (6 hr) **Fuel-air systems**: Fuel Delivery Systems - Fuel delivery, The problem of part throttle operation, Air intake systems, Intake manifold design and tuning, Turbo-charging, Super-charging, Fuel management and control theory, Fuel injection, ECU operation, Sensors and instrumentation (6 hr) **Valve train and timing**: Operation, Arrangement -- Push-rod; Single overhead cam shaft (SOHC) design; Dual-overhead cam shaft (DOHC) design, Camshaft function and design considerations, Valve timing, Valve-train design considerations; Component and Event Timing - Valve actuation timing, Valve timing diagram, Spark ignition event and timing, Compression ignition injection event and timing (6 hr)
viii	**Texts/ References**	1. Internal Combustion Engines – V Ganesan 2. Fundamentals of Internal Combustion Engines -- Gill P W., J H. Smith, E J. Ziury 3. Internal Combustion Engine Fundamentals – John B Heywood 4. IC Engines: Combustion and Emissions – B. P. Pundir
ix	**Name(s) of Instructor(s)**	Surya Prakash R.
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.**	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	**Semester in 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 algorithm
viii	**Texts/ Ref.**	1. Mathematics for 3D Game Programming and Computer Graphics by Eric Lengyel, 3rd Edition, Course Technology PTR Cengage Learning. (Textbook) 2. Curves and Surfaces For CAGD by G. Farin, 5th
ix	**Name(s) of Instructor(s)**	Samarth S. Raut
x	**Name(s) of other Departments/ Academic Units to**	Electrical Engineering, Computer Science & Engineering
xi	**Is/Are there any course(s) in the same/ other academic unit(s) which is/are equivalent**	NA

xii	Justification/ Need for introducing the course	Computer Graphics, CAD, and advanced methods for computational analysis need a robust understanding of 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**	1. "An Introduction to Computational Fluid Dynamics", by H. W. Versteeg and W. Malalasekera; 2nd edition, Pearson Education Ltd., 2007. (ISBN: 9780131274983) 2. "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)		
Academic Unit: ___________________	**Level** (underline any one): ● UG ● 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. .

6	**Texts/References** (Minimum 2/3)	**Text books:** 1. 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:** • Abbott, I. H., and A. E. von Doenhoff. “Theory of Wing Sections, 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.
7	**Need for introducing the course**	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 study of aerodynamics is essential to design and analyze various components of aircraft and automobile systems as well as certain civil structures, with the 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.
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.**%	No.
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.

SECTION A (To be filled by Department)		
Academic Unit: MMAE		**Level** (underline any one): ● UG ● 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$ 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

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:** 1. Material Selection in Mechanical Design by Michael F. Ashby, (2017) 5th Edition, ISBN: 9780081006108, 9780081005996 2. 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 - Rice-Rosengren Analysis, Hutchinson's Analysis; Crack-Tip Constraints: T Stress 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, K-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, 3rd Revised Edition, Springer Netherlands, 1982, 3. Maiti S.K, Fracture Mechanics: Fundamentals and Applications. – 1st 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 academic 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 **Level** (underline any one): ● UG ● PG		
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)

5	**Course content**	**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 ParaDis, Simulation procedure, Basic simulation examples (Frank-Read 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,
6	**Texts/Ref.** (Minimum 2/3)	▪ Ryan B. Sills, William P. Kuykendall, Amin Aghaei, Wei Cai, Fundamentals of Dislocation Dynamics Simulations, Multiscale Materials Modeling for Nanomechanics. Vol. 245. Springer ▪ 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 University Press, 2011

7	**Need for introducing the course**	Metal plasticity is inherently a multiscale phenomenon where information bridges must be established between different length and time scales for the accurate description of the deformation behavior of 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.
8	**Name (s) of other departments / Academic Units to whom the course**	-
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)	18-02-2022

Name of Academic Unit: Mechanical Engineering
Level: UG/PG
Programme: M.Tech./MS/Ph.D./B. Tech.

i	**Title of the course**	**Multiphase Flow**
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
v	**Whether Full or Half Semester Course**	Full
vi	**Pre-requisite(s), if any – specify course number(s)**	None
vii	**Course Content**	• **Introduction and overview :** History, Motivation and Application • **Transport phenomena :** Introduction, Reynolds transport theorem, Continuity equation, Momentum equation • **Fluid mechanics with interface :** Interfacial tension and its role in multiphase flow, Surface energy and capillary forces, Measurement of surface tension, Laplace pressure and Young's law, Curvature computation, Capillary rise, Capillary force on floating bodies, Wetting, Wetting of a rough surface, Contact angle hysteresis, Singularities • **Boundary conditions in multiphase flows :** Kinematic and dynamic boundary conditions, Stress conditions at fluid interfaces, Stress on deforming surfaces • **Scaling analysis :** Introduction, Buckingham's theorem and dimensionless numbers for multiphase flow systems, Dimensional analysis and physical similarity, Self-similarity • **Introduction of asymptotic analysis :** Asymptotic expansion, Pulsatile flow : Analytical and asymptotic solution, Domain perturbation method • **Lubrication model/Thin film approximation :** Derivation of basic equation of lubrication theory, Thin film approximation with free surfaces: Derivation of governing equations and boundary conditions, Self-similar solution, Application of lubrication theory • **Flow instabilities:** Fluid jets, Rayleigh-Plateau Instability, Fluid sheets, Rupture of soap film and derivation of Taylor-Culick velocity, Rayleigh-Taylor Instability, Kelvin-Helmholtz instability • **Numerical solution of Navier-Stokes equation:** Time integration, Spatial discretization, Marker and Cell method, Boundary conditions • **Advection of fluid interfaces:** Fundamentals, Numerical definition of interface, Heaviside function, Advection of color function, Volume of fluid method, Level set method, Numerical model of surface tension driven flows • **Applications:** Bubbly flows, drop collision and splashing, Breakup and Atomization
viii	**Texts/ References**	<u>TEXTBOOKS</u> 1. L. Gary Leal, Advanced Transport Phenomena, First Edition, 2007, CUP. 2. G. Tryggvason, R. Scardovelli, and S. Zaleski, Direct numerical simulations of gas-liquid multiphase flows, First Edition, 2011, Cambridge University Press <u>REFERENCE</u> 1. P.G. de Gennes, F. Brochard-Wyart and D. Quéré, Capillarity and Wetting Phenomena : Drops, Bubbles, Pearls, Waves, First Edition, 2003, Springer Publication 2. E. J. Hinch, Purterbation Methods, First Editions, 1991, Cambridge University Press 3. G. I. Barenblatt, Scaling, First Edition, 2003, Cambridge University Press. 4. J. Eggers & M.A. Fontelos, Singularities: Formation, structure & propagation, 1st Ed., 2015, CUP
ix	**Name(s) of Instructor(s)**	HD
x	**Name(s) of other Departments/ Academic Units to whom the course is relevant**	Chemical 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**	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)		
Academic 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$ prior exposure** specify course code(s) or background / knowledge / skills %	Exposure to any programming language, preferably object-oriented programming.
5	Course content	**Geometric modeling:** ***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 industry4.0 concepts.
8	**Name (s) of other departments / Academic Units to whom the course is relevant** %	CSE, EE, C&I
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)	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)		
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)^: Full
3	**Pre-requisite courses(s)** ** specify course code(s) %	
4	**Recommended$ prior exposure** specify course code(s) or background / knowledge / skills %	Mechanics of Materials/ Manufacturing process 1 / 2/ Relevant.
5	Course content	**Design:** Micromechanics of Composites: Density; Mechanical properties – Prediction of elastic constants, Micromechanical approach, Halpin-Tsai equations, Transverse stresses; Thermal properties – COTE for composites, Thermal conductivities, Hygral and thermal stresses; Mechanics of load transfer from matrix to fibre. Macromechanics of composites -Elastic constants of an isotropic material and lamina, Variation of lamina properties with orientation; Laminated composites; Stresses and strains in laminated composites, Interlaminar stresses and edge stresses; Monotonic strength and Fracture: Tensile strength of uni-direction FRC; Max strain theory, Tsai-Hill criterion, Quadratic interaction. Fatigue and Creep: S-N curves-FCP tests, Fatigue of composites. Creep **Traditional and Additive Manufacturing**: Thermosets and Thermoplastic; Fiber Reinforcement, Lay-up processes, Spray up process; Fiber placement process and Traditional Manufacturing of composites. Various Additive Manufacturing technologies for composites and comparison, Thermoforming Metal and ceramic matrix composites: **Composites for Industrial Applications:** Material requirements for applications, Aerospace applications, Automotive and Road transportation applications, Architectural / building applications, Wind energy applications, Marine transportation and ship building applications, Defence applications, Advancements in composites, New Technologies.

6	**Texts/References** (Minimum 2/3)	**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 3) T. W. Clyne, D. Hull, An Introduction to Composite Materials,3rd 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
7	**Need for introducing the course**	Composites play a pivotal role as engineering materials. A course exposing 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.
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.**%	Nil
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.

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 the course**	**Design of Mechatronic Systems**
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)**	
vii	**Course Content**	Introduction: Elements of mechatronics system: Sensor, actuator, plant, and controller. Applications of mechatronics system. Systems like CDROM, scanner opened to see whats there inside and why?. Integrated mechanical-electronics design philosophy. Examples of real life systems. Smart sensor concept and utility of compliant mechanisms in mechatronics. Microprocessor building blocks, combinational and sequential logic elements, memory, timing and instruction execution fundamentals with example of primitive microprocessor. Microcontrollers for mechatronics: Philosophy of programming interfaces, setting sampling time, and Getting started with TIVA programming Microcontroller programming philosophy emphasis on TIVA, programming different interfaces PWM, QEI etc. Mathematical modeling of mechatronic systems, Modeling friction, DC motor, Lagrange formulation for system dynamics. Dynamics of 2R manipulator, Simulation using Matlab, Selection of sensors and actuators. Concept of feedback and closed loop control, mathematical representations of systems and control design in linear domain, Basics of Lyapunov theory for nonlinear control, notions of stability, Lyapunov theorems and their application Trajectory tracking control development based on Lyapunov theory, Basics of sampling of a signal, and signal processing Digital systems and filters for practical mechatronic system implementation. Research example/ case studies of development of novel mechatronics system: 3D micro-printer, Hele Shaw system for microfabrication.
viii	Texts/ References	• Devdas Shetty, Richard A. Kolk, "Mechatronics System Design," PWS Publishing company • Boukas K, Al-Sunni, Fouad M "Mechatronic,Systems Analysis, Design and Implementation," Springer, • 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 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.**	Nil
xii	**Justification/ Need for introducing the course**	This 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

Academic Unit: Department of Physics		**Level** (underline any one): ● UG ● 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$ 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)	1. Classical Mechanics: H. Goldstein, C. P. Poole, and J. Safko, Pearson 2011. 2. Classical Mechanics: N. C. Rana and P. S. Joag, Tata McGraw Hill, 2017. 3. Introduction to Classical Mechanics: David Morin, Cambridge University Press, 2008. 4. Mechanics: L.D. Landau and E. M. Lifshitz, Butterworth-Heinemann, 3rd edition, 1982. 5. Mechanics: From Newton's Laws to Deterministic Chaos, F. Scheck, Springer, 5th edition, 2010. 6. 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.
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/MM/YYYY)	19/10/2021

Academic Unit: Department of Physics **Level** (underline any one): ● UG 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)^: Full
3	**Pre-requisite courses(s)** ** specify course code(s) %	PH101 MA101
4	**Recommended$ 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)	1. Introduction to Quantum Mechanics, D. J. Griffiths and D. F. Schroeter, Cambridge University Press, 3rd edition, 2019. 2. Modern Quantum Mechanics, J. J. Sakurai, Cambridge University Press, 2017. 3. Principles of Quantum Mechanics, R. Shankar, Springer, 2014. 4. Quantum Physics, S. Gasiorowicz, John Wiley, 2000. 5. 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/MM/YYYY)	19/10/2021

Name of Academic Unit: Department of Physics
Level: UG
Programme: B.Tech.

i	**Title of the Course**	**PHXXX: Special Theory of Relativity**
ii	**Credit Structure**	L: 2, T: 1, P: 0, C: 6
iii	**Type of Course**	Elective course
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)*	PH101, PH102
vii	**Course Content**	*Experimental Background*: Galilean Transformation, Michelson-Morley Experiment, Postulates of Special Relativity, *Relativistic Kinematics*: Lorentz Transformations, Addition of Velocities, Aberration and Doppler Effects, *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. Introduction to General Relativity.
viii	**Texts/References (separate sheet may be used, if necessary)**	1. Introduction to Special Relativity, R. Resnick Wiley India, (2005). 2. Special Relativity, A. French, C R C Press, (2017).
ix	**Name(s) of Instructor(s)**	Faculty, Department of Physics
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 equivalent to this course? If so, please give details.	
viii	**Justification/ Need for introducing the course**	It introduces theory of Special Theory of Relativity which the generalization of laws of Physics in the near speed of light limit. It is essential to consider Special and General Relativistic corrections for GPS to work and thus would be useful also for Engineers.

Academic Unit: Mathematics		Level (underline any one): ● UG ● ~~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.**%	No
10	**DUGC or DPGC Approval Date** (DD/MM/YYYY)	

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.

i	**Title of the course**	**Technological Entrepreneurship**
ii	**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
vi	**Pre-requisite(s), if any (For the students) – specify course number(s)**	NIL
vii	**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 course**	The Government of India has rolled out Start-up India 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, 2nd 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	**Justification/ Need 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) – *specify course number(s)*	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	1. Gandolfo, G. (2013). *International Economics II: International Monetary Theory and Open-Economy Macroeconomics*. Springer Science & Business Media. 2. Gopinath, G., Helpman, E., & Rogoff, K. (Eds.). (2014). *Handbook of International Economics*. Elsevier. 3. Krugman, P., Obstfeld, M. & Melitz,M. (2012). *International Economics: Theory and Policy*. New Delhi: Pearson Education. 4. Rogoff, K. S., & Reinhart, C. (2009). *This Time Is Different: Eight Centuries of Financial Folly*. Princeton, NJ: Princeton University Press. 5. Salvatore, D. (2016). *International Economics: Trade and Finance*. John Wiley International Student Edition. 6. Sodersten, B., & Reed, G. (1994). *International Economics*. Palgrave Macmillan. 7. 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*	--
Course Content	**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.
Texts/References	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 academic 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.

i	**Title of the course**	Introduction to Literature
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**	Autumn
v	**Whether Full or Half Semester Course**	Full
vi	**Pre-requisite(s), if any (For the students)** – ***specify course number(s)***	--
vii	**Course Content**	What is Literature, Genres of Literature, Literary Texts and Co Major Themes in Literature
viii	**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)
ix	**Name(s) of Instructor(s)**	Prof. Ridhima Tewari
xii	**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.