Course curriculum for Electrical Engineering -2020 Batch

Semester V (2020 Batch)			
S. No	**Course code**	**Course name**	**Instructor**
1	EE 323	Microprocessors and microcontrollers	Prof. Saroj Mondal
2	EE 319	Microprocessors and microcontrollers Lab	Prof. Saroj Mondal Prof. Naveen Kadayinti
3	EE 321	Digital Signal Processing (First Half Semester)	Prof. S R M Prasanna
4	EE 315	Digital Signal Processing Lab (Second Half Semester)	Prof. S R M Prasanna
5	EE 311	Electrical Machines and Power Electronics Lab	Prof. Pratyasa Bhui Prof. Abhijit Kshirsagar
6	HS	HSS Elective	
7		Elective 1	
8		Elective 2	

Electives for EE V Semester

S. No	Department	Course code	Course name	Instructor	Pre-requisite(s)
1	CSE	CS 601	Software development for Scientific Computing	Prof. Nikhil Hegde	Exposure to Data Structures and Algorithms, C / C++ / Java / Matlab
2		CS 603	Approximation Algorithms	Prof. Sandeep R B	Data Structures and Algorithms (CS201) & Exposure to Design and analysis of algorithms (CS 205)
3		CS 423	Advanced Topics in Embedded Systems	Prof. Gayathri Ananthanarayanan	CS 301 (Computer Architecture). Exposure to Operating Systems is preferred.
4		CS 305	Software Engineering	Prof. Raghu Hudli	Data structures and algorithms, Programming in C,C++ and Java.
5		CS 433	Cloud Software Development	Prof. Rajshekar K.	Desirable: Exposure on Operating System, Database, Cloud Programming language (Java, .Net, NodeJS, HTML/CSS, etc.)
6		CS 402	Distributed Systems	Prof. Kedar Khandeparkar	Operating Systems, Data Structuresand Algorithms, Programming in C++

7	**Electrical**	EE 327	Digital Communication and coding theory	Prof. Naveen M B	Signals and Systems, Introduction to CommunicationSystems, Introduction to Probability
8		EE 403	Power system dynamics and control	Prof. Pratyasa Bhui	Power System, Electrical Machines
9		EE 433	Next Generation Wireless Systems / Wireless Networks	Prof. Rahul J Pandya	Principles/Fundamentals of Communications
10		EE 406	Speech Processing	Prof. Samudra Vijaya K	Exposure to probability concepts
11		EE 405	Pattern Recognition and Machine Learning (PRML)	Prof. S. R. Mahadeva Prasanna	Exposure to basic concepts in calculus and probability
12		EE 323	Analog Circuits	Prof. Naveen Kadayinti	Analog Circuits
13	**Mechanical**	ME 421	Turbomachines	Prof. Sudheer Siddapureddy Prof. Dhiraj Patil	Fluid Mechanics; Thermodynamics
14		ME 412	Energy and Environment Lab	Prof. Dhiraj Patil Prof. Sudheer Siddapureddy	-
15		ME 505	Advanced Solid Mechanics	Prof. Tejas Gotkhindi	-
16		ME 507	Advanced Mechanisms and Dynamics of Mechanical Systems	Prof. Sangamesh Deepak R	-
17		ME 509	Advanced Fluid Mechanics and Heat Transfer	Prof. Dhiraj Patil	Fluid Mechanics and Heat Transfer
18		ME 501	Additive and Forming Manufacturing Processes	Prof. Somashekara M A Prof. Rakesh Lingam	-
19	**Chemistry**	CH 405	Our health and medicine	Prof. Nilkamal Mahanta	None
20		CH 305	Introduction to sophisticated Characterization techniques	Prof. Rajeswara Rao M, Prof. Tejas Gotkhindi Prof. Ruma Ghosh	None
21		CH 403	Quantum Field Theory	Prof. B L Tembe	Exposure to Physics, Chemistry and Mathematics
22	**HSS**	HS 301	Philosophy	Prof. JollyThomos	Nil
23		HS 321	Energy Economics and Policy	Prof. Gopal Sharan Parashari	None
24		HS 304	Intellectual Property Management	Prof. R.R. Hirwani	Nil
25		HS 405	Innovation and Social Entrepreneurship	Prof. R.R. Hirwani	Nil
26		HS 403	Happiness and Well-being	Prof. B L Tembe	Nil

27	**Mathematics**	MA 403	Introduction to Number Theory	Prof. N S N Sastry	None
28		MA 501	Measure Theory	Prof. Dhirithi Ranjan Dolai	Real Analysis
29		MA 405	Functional Analysis	Prof. Dhirithi Ranjan Dolai	Basic topological concepts, Metric spaces, Measure theory
30	**Physics**	PH 201	Electrodynamics	Prof. Kavita Devi	PH 102
31		PH 402	Astrophysics	Prof. D. Narasimha	Successfully finishing first 3 semesters
32		PH 404	Introduction to Quantum Information and Quantum Computation	Prof. R. Prabhu	PH101 – Quantum Physics and Application MA102 - Linear Algebra

Core courses Syllabus

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

i	**Title of the course**	EE 323 Microprocessors and Microcontrollers
ii	**Credit Structure (L-T-P-C)**	(3-0-0-6)
iii	**Type of Course**	Core course
iv	**Semester in which normally to beoffered**	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**	Block diagram view of a general purpose processor; elements of hardware and software architectures; introduction to concepts of data and control paths, registers and memory organization. Instruction set basics and assembly language programming: instruction structure and addressing modes, instruction encoding, and study of 8085A instruction set, hardwarearchitecture and interrupts. Introduction to microcontrollers. 8051 hardware and instruction set architecture, timers/counters, interrupts and serial interface (including multi-processor communication). Interfacing basics using examples of I/O devices: parallelport, serial ports, keypad, display, etc. Introductory discussion on processor performance evaluation and design using a RISC ISA (including concepts of pipelining, pipelining hazards, cache, virtual memory and parallelism).
viii	**Texts/References**	• R.S. Ganorkar, Microprocessor Architecture,Programming, and Applications with the 8085, Penram International Publishing, Fifth Edition,2011. • J.H. Hennessy, and D.A. Patterson, Computer Architecture: A Quantitative Approach, MorganKaufmann Publishers, Fourth Edition, 2006. • Kenneth J. Ayala, The 8051 Microcontroller, Architecture, Programming and Applications, Penram International Publishing, 1996.
ix	**Name(s) of Instructor(s)**	NK
x	**Name(s) of other Departments/ Academic Units to whom the course isrelevant**	CSE
xi	**Is/Are there any course(s) in the same/other academic unit(s) which is/ are**	No

	equivalent to this course? If so, pleasegive details.	
xii	**Justification/ Need for introducingthe course**	This course deals with the fundamentals of microprocessors and microcontrollers which are used in almost all embedded electronic systems.

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

i	**Title of the course**	EE 319 Microprocessors and microcontrollers lab
ii	**Credit Structure (L-T-P-C)**	(0-0-3-3)
iii	**Type of Course**	Core course
iv	**Semester in which normally to beoffered**	Autumn
v	**Whether Full or Half SemesterCourse**	Full
vi	**Pre-requisite(s), if any (For the students) – *specify course number(s)***	--
vii	**Course Content**	Software experiments using an 8085 Kit to learn its instruction set. Hardware experiments for the use of peripherals like 8251 (USART). Experiments using a development board to learn the instruction set and assembly programming for 8051 family of microcontrollers. Experiments to learn Port IO, control of on chip peripherals such as timers, interfacing with off chip peripherals such as LCD displays, Key boards, Stepper motors and ADC chips. Experiments for the use of other microcontrollers such as PIC using developmentboards.
viii	**Texts/References**	• R. S. Gaonkar, Microprocessor Architecture:Programming and Applications with the 8085/8080A, Penram International Publishing,1996. • Kenneth J. Ayala, The 8051 Microcontroller,Penram International Publishing, 1996.
ix	**Name(s) of Instructor(s)**	NK
x	**Name(s) of other Departments/ Academic Units to whom the courseis relevant**	CSE
xi	**Is/Are there any course(s) in the same/ other academic unit(s) whichis/ are equivalent to this course? If so, please give details.**	No
xii	**Justification/ Need for introducingthe course**	This lab course will reinforce the concepts taught inthe Microprocessors and microcontrollers theory course. Students will do practical experiments using microcontroller boards to learn how the interfacing is done and how the devise are programmed.

Name of Academic Unit: Electrical Engineering
Level: **B. Tech.**

Programme: B.Tech.

i	**Title of the course**	EE 321 Digital Signal Processing
ii	**Credit Structure (L-T-P-C)**	3-0-0-3
iii	**Type of Course**	Core
iv	**Semester in which normally to be offered**	Autumn
v	**Whether Full or Half Semester Course**	Half
vi	**Pre-requisite(s), if any (For the students) – specify course number(s)**	Signals and Systems
vii	**Course Content**	Review of basic signal processing, and sampling, introduction to DSP, Z transform, DFT, FFT, Implementation of discrete time systems, and Introduction to digital filters.
viii	**Texts/References**	1. Proakis and Manolokis, "Digital Signal Processing," 4th edition, Prentice Hall, 2006. 2. S K Mitra, "Digital Signal Processing,"McGraw Hill, Inc., 4th edition, 2017. 3. Alan V Oppenheim, "Digital SignalProcessing," Prentice Hall, 1975.
ix	**Name(s) of Instructor(s)**	S. R. M. Prasanna
x	**Name(s) of other Departments/ Academic Units to whom the course is relevant**	Computer science, physics, mechanical 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**	In the current world, most of the systems are digital. Thus, it is important to understand the requirement for such a system, and how one can efficiently process the signals, and design systems inthe digital domain; this course lays foundation for these aspects.

Name of Academic Unit: Electrical Engineering

Level: B. Tech.

Programme: B.Tech.

i	**Title of the course**	EE 315 DSP Lab
ii	**Credit Structure (L-T-P-C)**	0-0-4-2
iii	**Type of Course**	Core (Lab)
iv	**Semester in which normally to beoffered**	Autumn
v	**Whether Full or Half SemesterCourse**	Half
vi	**Pre-requisite(s), if any (For the students) – specify course number(s)**	DSP
vii	**Course Content**	● Overview of DSP kit ● generation of waveform ● Convolution and correlation ● DFT and FFT ● Design of digital filters
viii	**Texts/References**	1. Proakis and Manolokis, "Digital Signal Processing," 4th edition, Prentice Hall, 2006. 2. S K Mitra, "Digital Signal Processing,"McGraw Hill, Inc., 4th edition, 2017. 3. Alan V Oppenheim, "Digital SignalProcessing," Prentice Hall, 1975.
ix	**Name(s) of Instructor(s)**	SRM Prasanna
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 introducingthe course**	This course provides a hands-on experience of various topics discussed in the "DSP" course. The aforementioned theory course and this lab course will enable the student to have a strong background on the basics of digital signal processing on hardware.

Name of Academic Unit: Electrical Engineering
Level: B. Tech.
Programme: B.Tech.

i	**Title of the course**	EE 311: Electrical Machines and Power Electronics Laboratory
ii	**Credit Structure (L-T-P-C)**	(0-0-3-3)
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)***	Nil
vii	**Course Content**	Experiments reinforcing concepts learnt in EE206
viii	**Texts/References**	
ix	**Name(s) of Instructor(s)**	AM
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.**	No
xii	**Justification/ Need for introducing the course**	To reinforce the learning of the concepts related to Electrical Machines and Power Electronics through first-hand experience

Electives Syllabus

CSE Department

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

i	**Title of the course**	CS 601 Software Development for Scientific 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**	Autumn
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, C / C++ / Java / Matlab
vii	**Course content**	Algorithmic Patterns in Scientific Computing: dense and sparse linear algebra, structured and unstructured grid methods, particle methods (N-body, Particle-Particle, Particle-in-cell, Particle-in-a-mesh), Fast Fourier Transforms, Implementing PDEs, C++ standard template library (STL), Introduction to debugging using GDB, GMake, Doxygen, Version Control System, Profiling and Optimization, asymptotic analysis and algorithmic complexity. Mixed-language programming using C, Fortran, Matlab, and Python, Performance analysis and high-performance code, Data localityand auto tuning, Introduction to the parallel programming world.
viii	**Texts/References**	- Stroustrup C++ Language Reference (https://www.stroustrup.com/4th.html) - Suely Oliveira, David Steward: Writing Scientific Software: AGuide to Good Style. Cambridge University Press, 2006 - Web references to GNU Make, GDB, Git, GProf, Gcov. - Code Complete: A Practical Handbook of Software Construction - https://www2.eecs.berkeley.edu/Pubs/TechRpts/2006/EECS-2006-183.html
ix	**Name (s) of the instructor (s)**	Nikhil Hegde
x	**Name (s) of other departments / Academic Units to whom the course is relevant**	EE, ME
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**	Creating software in Computational Science and Engineering requires

	introducing the course	skills and tools from many disciplines. This course focuses on how the skills and tools are applied towards larger software development goals inthe context of dominant algorithmic patterns or *motifs* found in scientificcomputing. The aim of the course is to provide knowledge on how advanced numerical methods and complex algorithms in Scientific Computing can be implemented using C++ to engineer larger systems through software development principles of refactoring, composition, correctness and performance analysis, and debugging. The course initiates students into CS305: Software engineering, a rigorous study of software development principles. Also, the course provides a base for subsequent parallelization optimizations, which is the subject of CS410: Parallel Computing that focuses on parallelizing scientific code (often) using different parallel programming paradigms.

Academic Unit: Computer Science and Engineering		**Level** (underline any one): ● UG ● PG
1	**Title of the course**	Approximation algorithms
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) %	Data Structures and Algorithms (CS201)
4	**Recommended$ prior exposure** specify course code(s) or background / knowledge / skills %	Design and analysis of algorithms (CS205)
5	**Course content**	Introduction, approximation schemes, design and analysis of approximation algorithms - combinatorial algorithms, linear programming based algorithms. Hardness of approximation.
6	**Texts/References** (Minimum 2/3)	*Textbook:* *(1) Approximation algorithms. Vazirani, Vijay V. Berlin: springer, 2001.* *Reference:* *(1) The design of approximation algorithms. Williamson, David P., andDavid B. Shmoys. Cambridge university press, 2011.*

7	**Need for introducing the course**	Many of the real world problems are NP-hard. This implies that there exist no algorithms running in polynomial-time to solve such problems, unless P = NP. Approximation algorithms provide a way to tame such problems by running in polynomial-time and obtaining near-optimal solutions with provable guarantees. This course is relevant not only for students in theoretical computer science but also for those who work with computational problems in other domains.
8	**Name (s) of other departments / Academic Units to whom the course is relevant** %	None
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)	20/01/2022 approved by DUGC (through email circulation). Also sent to PG-APEC for further approval on 20/01/2022

Name of the Academic Unit: Computer Science & Engineering
Level: UG/PG.
Programme: B. Tech.

i	**Title of the course**	**CS 423 Advanced topics in Embedded 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**	July to December (Odd)
v	**Whether Full or Half Semester Course**	Full
vi	**Pre-requisite(s), if any (For the students) – specify course number(s)**	CS 301 (Computer Architecture). Exposure to Operating Systems is preferred.
vii	**Course Content**	Introduction to systems software in embedded platforms Boot loader, Embedded Linux kernel (Processes, Threads, Interrupts), Device Drivers, Scheduling Policies (includingReal Time), Memory Management, Optimizations (Data level and Memory level), Embedded Systems Security, Introduction to Embedded GPUs and Accelerators, Embedded Heterogeneous Programmingwith Open CL Application Case Study on Embedded Platforms – e.g. Neural Network inferencing on Embedded Platforms, Advanced Driver Assistance Systems
viii	**Texts/References**	Building Embedded Linux Systems, 2nd Edition by Gilad Ben-Yossef, Jon Masters, Karim Yaghmour, Philippe Gerum,O'Reilly Media, Inc. 2008 Linux Device Drivers, Third Edition By Jonathan Corbet, Alessandro Rubini, Greg Kroah-Hartman, O'Reilly Media, Inc. 2005 Embedded Systems: ARM Programming and Optimization by Jason D Bakos, Elsevier, 2015 Learning Computer Architecture with Raspberry Pi by Eben Upton, Jeff Duntemann, Ralph Roberts, Tim Mamtora, Ben Everard, Wiley Publications, 2016 Real Time Systems by Jane S. Liu, 1 edition, Prentice Hall; 2000 Practical Embedded Security: Building Secure Resource-Constrained Systems by Timothy Stapko, Elsevier, 2011
ix	**Name(s) of Instructor(s)**	Dr. Gayathri Ananthanarayanan
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

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

i	**Title of the course**	**CS 305 Software Engineering**
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**	**Introduction** What is Software Engineering. **Software Development Life-cycle** Requirements analysis, software design, coding, testing, maintenance, etc. **Software life-cycle models** Waterfall model, prototyping, interactive enhancement, spiral model. Role of Management in software development. Role of metrics and measurement. **Software Requirement Specification** Problem analysis, requirement specification, validation, metrics, monitoring and control. **System Design** Problem partitioning, abstraction, top-down and bottom-up design, Structured approach. Functional versus object-oriented approach, design specification and verification metrics, monitoring and control. Software Architecture **Coding** Top-down and bottom-up, structured programming, information hiding, programming style, and internal documentation. Verification, Metrics, monitoring and control. **Testing** Levels of testing functional testing, structural testing, test plane, test cases specification, reliability assessment. **Software Project Management** Cost estimation, Project scheduling, Staffing, Software configuration management, Quality assurance, Project Monitoring, Risk management, etc. including tools for software development to release, supporting the whole life cycle.

viii	**Texts/References**	1. Software Engineering: A Practioner's approach, R.S. Pressman, McGraw Hill, 8th edition 2. Introduction to Software Engineering, Pankaj Jalote,
		Narosha Publishing 3. The Unified Software Development Process, I. Jacobson, G. Booch, J. Rumbaugh, Pearson Education 4. Software Architecture in Practice, L. Bass, P. Clements, R. Kazmann, 3rd ed., Addison Wesley
ix	**Name(s) of Instructor(s)**	NLS
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
xii	**Justification/ Need for introducing the course**	To teach students the engineering approach to software development starting from understanding and documenting user requirements to the design, development, testing and release management where we all take into account non-functional requirements and engineer them explicitly. The course brings out various lifecycle activities in the conventional as well as agile methodologies. It emphasizes modern practices and tools for a successful engineering of a usable and maintainable product.

Name of Academic Unit: Computer Science
Level: B.Tech./MS/PhD
Program: B.Tech. /MS/PhD

i	**Title of the course**	**CS 433 Cloud Software Development**
ii	**Credit Structure (L-T-P-C)**	1.5-0-0-3
iii	**Type of Course**	Elective
iv	**Semester in which normally to beoffered**	Autumn
v	**Whether Full or Half Semester Course**	Half
vi	**Pre-requisite(s), if any (For the students) – *specify course number(s)***	**Desirable**: Exposure on Operating System, Database, CloudProgramming language (Java, .Net, NodeJS, HTML/CSS, etc.)
vii	**Course Content**	*Module 1 - Introduction to Cloud Computing Landscape* ● *Understand how industries rely on the cloud computing global infrastructure, Identify the applications and use cases* ● *Identify the principles and characteristics of Cloud Computing - IaaS, PaaS, SaaS* ● *Validate the different patterns of cloud computing adoption including public cloud services, private and hybrid approaches* ● *Identify common challenges associated with the adoption of cloud computing solutions and associated myths* ● *Compare and contrast with on-premise/traditional versus cloud* ● *Understand in-country data regulations, data sovereignty considerations* *Module 2 - Cloud Computing Technology* ● *Understand Virtualization Concepts - data, compute, network, operating system, HCI* ● *Understand Cloud Infrastructure -Backup, Restore, Migration, DC/DR, HA use cases* ● *Understand Programming concepts Cloud-native apps, Serverless, Containers* ● *Learn Containers– Kubernetes, Docker, containers* *Module 3 - Using Managed Cloud Services*

		• *Learn 12-factor Application Architecture, api, Microservices, databases - sql, no-sql, object store* • *Application and Microservice Security- OAuth, access tokens* • *Understand Autoscale - horizontal and vertical scaling, logging and monitoring aspects of apps and infrastructure* • *Learning DevOps frameworks - toolchains, ci/cd, blue/green deployment, canary deployment* *Module 4 - Case Studies - Public Cloud Provider – aws, azure,ibmcloud*
viii	**Texts/References**	Text Books: - Thomas Erl, Zaigham Mahmood, Ricardo Puttini, "Cloud Computing Concepts, Technology & Architecture", Pearson, 2013. Reference Books: - Boris Scholl, Trent Swanson, Peter Jausovec, "Cloud Native", O'Reilly, 2019. Resources from Internet: - Public Cloud Documentations: - https://learning.oreilly.com/library/view/cloud- computing-concepts/9780133387568/ - https://www.amazon.in/Cloud-Computing-Concepts- Technology-Architecture/dp/0133387526/ Class Notes/Lectures
ix	**Name(s) of Instructor(s)**	Girish Dhanakshirur Supported by Rajshekar K
x	**Name(s) of other Departments/ Academic Units to whom the courseis relevant**	EE
xi	**Is/Are there any course(s) in the same/ other academic unit(s) whichis/ are equivalent to this course? If so, please give details.**	No
xii	**Justification/ Need for introducingthe course**	The course aims at preparing the students for the next technology frontier - Cloud computing. While the field is vast, this course prepares students in core cloud concepts, architectures, programming languages, frameworks, deployments, etc., with

		hands-on labs. The course will act as a foundation for further research or certification. Many Public Cloud vendors offer free students access to get hands-on experience on what they learn in thecourse. Students will complete few labs using those Public Cloud platforms.

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

i	**Title of the course**	**CS 402 Distributed 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**	VII
v	**Whether Full or Half Semester Course**	Full
vi	**Pre-requisite(s), if any (For the students) – specify course number(s)**	Operating Systems, Data Structures and Algorithms, Programming in C++
vii	**Course Content**	• Introduction to distributed systems, Message Passing, Leader Election, Distributed Models, Causality and Logical Time • Logical Time, Global State & Snapshot and Distributed Mutual Exclusion-Non-Token and Quorum based approaches • Distributed Mutual Exclusion-Token based approaches, Consensus & Agreement, Checkpointing & Rollback Recovery • Deadlock Detection, DSM and Distributed MST • Termination Detection, Message Ordering & Group Communication, Fault Tolerance and Self-Stabilization, Gossip Style communication, chord, pastry • Concurrency and Replication Control, RPCs, Transactions • Distributed Randomized Algorithms, DHT and P2P Computing • Case Studies: GFS, HDFS, Map Reduce and Spark

viii	**Texts/References**	1. Distributed Computing: Principles, Algorithms, and Systems- Ajay D. Kshemkalyani and Mukesh Singhal 2. Distributed Computing: Fundamentals, Simulations and Advanced Topics-Hagit Attiya and Jennifer Welch 3. Distributed Algorithms-Nancy Lynch 4. Elements of Distributed Computing-Vijay K. Garg 5. Advanced Concepts in Operating Systems-Mukesh Singhal, Niranjan G. Shivaratri
ix	**Name(s) of Instructor(s)**	Dr. Kedar Khandeparkar
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
xii	**Justification/ Need for introducing the course**	Technologies such as Hadoop, Cassandra, Spark, etc., that have emerged in the recent times are mainly based on the principles of distributed systems. This course aims to develop an in-depth understanding of the various distributed algorithms and discuss some use cases.

EE Department

Name of Academic Unit: Electrical EngineeringLevel: B. Tech.
Programme: B.Tech.

i	**Title of the course**	**EE 323 Digital Communication and Coding Theory**
ii	**Credit Structure (L-T-P-C)**	2-0-2-6
iii	**Type of Course**	Elective
iv	**Semester in which normally to be offered**	Autumn
v	**Whether Full or Half SemesterCourse**	Full
vi	**Pre-requisite(s), if any (For the students) – specify course number(s)**	Signals and Systems, Introduction to Communication Systems, Introduction to Probability.
vii	**Course Content**	Digital Modulation - Signal constellations, Nyquist'sSampling Theorem and Criterion for ISI Avoidance,Linear modulation Optimal Demodulation – Review of Hypothesis Testing, ML and MAP decision rules, Signal Space Concepts, Optimal Reception in AWGN and performance analysis of various modulation schemes. Source Coding - Entropy, Shannon's source coding theorem (without proof), Huffman Codes Channel Coding – Mutual information, Shannon's channel coding theorem (without proof), Linear codes, soft decisions and introduction to cyclic codes Lab Component: Practical experiments in-line with the content of "Digital Communication and Coding Theory" course covering transmission and reception mechanisms corresponding to digital communication. ● Digital modulation and demodulation – PSK and QAM ● Channel Modelling ● Performance analysis of Huffmancoding Performance Analysis of linear and cyclic codes

viii	**Texts/References**	1. Upamanyu Madhow, ``Introduction to Communication Systems," Cambridge university press, 2008 edition. 2. Cover and Thomas, "Elements of Information Theory," Wiley India Pvt. Ltd., 2006.
ix	**Name(s) of Instructor(s)**	Naveen M B
x	**Name(s) of other Departments/ Academic Units to whom the course is relevant**	None
xi	**Is/Are there any course(s) in the same/other academic unit(s) which is/ are equivalent to this course? If so, pleasegive details.**	No
xii	**Justification/ Need for introducing the course**	The current and next generation wireless communication technologies use digital communication. The underlying procedures inthese systems mainly involve digital modulation and source coding and channel coding. This course enables the student to understand the basic principles behind these topics. The lab component provides a hands-on experience of various topics covered in the theory course. Together, they will enable the student to have a strong background of the basics of digital communication.

Name of Academic Unit: Electrical Engineering
Level: B. Tech. / MS(R) /PhD
Programme: B.Tech. / MS(R) / PhD

i	**Title of the course**	Power System Dynamics and Control
ii	**Credit Structure (L-T-P-C)**	2-0-1-6
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)**	Power System, Electrical Machines
vii	**Course Content**	Modelling of Synchronous Machines, Modelling of Exciters, Small Signal Stability Analysis, Modelling of Turbine and Governors, Simulation of Power System Dynamic Response, Improvement of Stability, Sub-synchronous Oscillations.
viii	**Texts/References**	1. Power System Dynamics and Stability: With Synchrophasor Measurement and Power System Toolbox, 2nd Edition 2. Power System Stability and Control: Prabha Kundur Mc GrawHill 3. Power System Dynamics and Stability, J Machowski; J Bialek, J Bumby, John Wiley & Sons
ix	**Name(s) of Instructor(s)**	Pratyasa Bhui
x	**Name(s) of other Departments/ Academic Units to whom the course is relevant**	None
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 an elective course for Power Systems Spine

i	**Title of the course**	Next Generation Wireless Systems / **Wireless Networks**
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)**	Principles/Fundamentals of Communications
vii	**Course Content**	Theory, design techniques, and analytical tools for characterizing next generation wireless systems. Performance analysis of digital communication systems over fading channels, rate and power adaptation, and multi-user diversity techniques; study of the fourth generation (4G) long term evolution (LTE) standard, its air interface, physical and logical channels, and physical layer procedures; introduction to fifth generation (5G) wireless communication and the 5G new radio (NR) standard, survey of non-orthogonal multiple access (NOMA) and the internet-of-things (IoT) related changes in 4G/5G.
viii	**Texts/References**	1. Stefaniz Sesia, Issam Toufik, Matthew Baker, "LTE - The UMTS Long Term Evolution," John Wiley and Sons, 1st ed., 2009. 2. 3GPP technical specifications available online at http://www.3gpp.org/ 3. David Tse and Pramod Viswanath, "Fundamentals Of Wireless Communication," Cambridge University Press, 2005. 4. **QUEUEING SYSTEMS, VOLUME 1: THEORY by Leonard Kleinrock John Wiley & Sons, Inc., New York, 1975**
ix	**Name(s) of Instructor(s)**	
x	**Name(s) of other Departments/ Academic Units to whom the course is relevant**	Computer Science
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 course introduces wireless communication networks using the protocols in the popular 4G LTE and the 5G NR standards. The student will not only be able to understand the theoretical limits of communication networks, but also appreciate the practical constraints involved in developing real world systems.**

Name of Academic Unit: Electrical Engineering
Level: PG/UG
Programme: B. Tech/MS/PhD

i	**Title** of the course	**EE 406 Speech Processing**
ii	Credit Structure (**L-T-P-C**)	**(3 0 0 6)**
iii	**Type** of Course	Elective course
iv	Semester in which normally tobe offered	Autumn or Spring
v	Whether **Full or HalfSemester** Course	Full
vi	**Pre-requisite(s)**, if any (For thestudents) – *specify course number(s)*	Exposure to probability concepts.
vii	Course **Content***	**Introduction:** Speech production and perception, nature of speech;short-term processing: need, approach, time, frequency and time- frequency analysis. **Short-term Fourier transform (STFT):** overview of Fourierrepresentation, non-stationary signals, development of STFT, transform and filter-bank viewsof STFT. **Cepstrum analysis:** Basis and development, delta, delta-delta andmel-cepstrum, homomorphic signal processing, real and complex cepstrum. **Linear Prediction (LP) analysis:** Basis and development, Levinson-Durbin's method, normalized error, LP spectrum, LPcepstrum, LP residual. **Sinusoidal analysis:** Basis and development, phase unwrapping,sinusoidal analysis and synthesis of speech. **Applications:** Speech recognition, speaker recognition, speech synthesis, language and dialect identification and speech coding.
Viii	Texts/References	1. L.R. Rabiner and R.W. Schafer, Digital Processing ofSpeechSignals Pearson Education, Delhi, India, 2004 2. J. R. Deller, Jr., J. H. L. Hansen and J. G. Proakis, Discrete-TimeProcessing of Speech Signals, Wiley-IEEE Press, NY, USA, 1999. 3. D. O'Shaughnessy, Speech Communications: Human andMachine, Second Edition, University Press,2005. 4. T. F. Quatieri, "Discrete time processing of speechsignals",Pearson Education, 2005.

		5. L. R. Rabiner, B. H. Jhuang and B. Yegnanarayana,"Fundamentals of speech recognition", Pearson Education, 2009.
ix	Name(s) of **Instructor(s)** ***	S R Mahadeva Prasanna
x	Name(s) of **other Departments/Academic Units to whom** the course is **relevant**	CS
xii	Justification/ Need for introducing the course	This course aims at providing an overview to the speech processing area. Speech processing being an application area of probability, signal processing and pattern recognition, the same will be suitable for both electrical engineering and computer science and engineering students. The course contents include introduction to speech processing, speech signal processing methods like short term Fourier transform, Cepstral analysis, linear prediction analysis, sinusoidal analysis. Some of the applications like speech recognition and speech synthesis will also be taught.

Name of Academic Unit: Electrical Engineering
Level: PG/UG
Programme: B. Tech/MS/PhD

i.	Title of the Course	**Pattern Recognition and Machine Learning (PRML)**
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)	**Overview of** Probability Theory, Linear Algebra, Convex Optimization. **Introduction:** History of pattern recognition & machine learning, distinction infocus of pattern recognition and machine learning. **Regression**: Linear Regression, Multivariate Regression, Logistic Regression. **Clustering:** Partitional Clustering, Hierarchical Clustering, Birch Algorithm CURE Algorithm, Density-based Clustering **PCA and LDA:** Principal Component Analysis, Linear Discriminant Analysis. **Kernel methods:** Support vector machine **Graphical Models**: Gaussian mixture models and hidden Markov models **Introduction to Bayesian Approach:** Bayesian classification, Bayesian Learning, Bayes Optimal Classifier, Naive Bayes Classifier and Bayesian Network..
v.	Texts/References (separate sheet may be used, if necessary)	1. C. Bishop, "Pattern Recognition and Machine Learning," Springer, 2006. 2. S. Theodoridis and K. Koutroumbas, "Pattern Recognition" Second Edn, Elsivier, 2003 3. B. Yegnanarayana, "Artificial Neural Networks", PHI, 1999. 4. Simon Hayking, "Neural Networks and Learning Machines",Pearson, 1999.
vi.	Instructor (s)	S. R. Mahadeva Prasanna

vii.	Name of departments to whom the course is relevant	Computer Science and Engineering, Electrical Engineering and Mechanical Engineering
viii	Justification	Pattern Recognition and Machine Learning (PRML) has become an integral tool to solve real world challenges in many engineering fields. This course gives an exposure to topics in pattern recognition and machine learning.

Name of Academic Unit: Electrical Engineering
Level: B. Tech
Programme: B. Tech.

i	Title of the course	**Analog Circuits**
ii	Credit Structure (L-T-P-C)	(2 0 2 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 (For the students) – *specify course number(s)*	Analog Circuits
vii	Course Content*	● Review of Single stage amplifiers and differential amplifier ● Cascode amplifiers ● 2 stage amplifiers (opamp) and its stability and compensation ○ Non-idealities of opamps ● NMOS output and PMOS output voltage regulators ● Current and voltage references ● Opamp based circuits ○ Howland Current source ○ Instrumentation amplifiers ○ Logarithmic amplifiers ○ Non-linear circuits ○ Multivibrators ○ A/D and D/A converters, sample and hold circuits ● Lab component will contain experiments on Simulation of amplifier and regulator circuits using NGSpice and breadboard based experiments on current sources, log amplifiers and voltage regulators using opamps and discrete transistors.
Viii	Texts/References	1) J.V.Wait, L.P.Huelsman and GA Korn, Introduction to Operational Amplifier theory and applications, 2nd edition, McGraw Hill, New York, 1992. 2) J. Millman and A. Grabel, Microelectronics, 2nd edition,McGraw Hill, 1988. 3) Ramakant Gayakwad, Op-amps and Linear Integrated Circuit, 4th edition, Pearson, 2000. 4) P. Horowitz and W. Hill, The Art of Electronics, 2nd edition, Cambridge University Press, 1989.

		5) Microelectronics, Behzad Razavi
ix	Name(s) of Instructor(s) ***	Naveen K
x	Name(s) of other Departments/ Academic Units to whom the course is relevant	None
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 an elective course which introduces advanced topics in analog circuits, amplifiers and their applications. This course will give the basis for advanced courses in VLSI, and microelectronics specializations.

Mechanical Department

Name of Academic Unit: Mechanical Engineering
Level: B. Tech.
Programme: B.Tech.

i	**Title of the course**	**ME 421 Turbomachines**
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
v	**Whether Full or Half Semester Course**	Full
vi	**Pre-requisite(s), if any – specify course number(s)**	Fluid Mechanics; Thermodynamics
vii	Course Content	**Introduction**: (2) Classifications of Turbomachines, Advantages of Rotary over Reciprocating, Applications **Basic Fluid Mechanics, Thermodynamics**: (3) Conservation of Mass, Momentum and Energy, Work and Energy Equations in a Rotating Frame with Constant Angular Velocity, Static and Stagnation Properties, Compressible gas flow relations, Mechanical Efficiency and Internal Efficiency, Internal Energy & Entropy **Dynamic Similitude**: (4) Definition, Dimensionless Parameter Groups with a Constant Density Fluids, Buckingham PI Theorem and its Significance, Characteristic Numbers of Turbomachines, Specific Speed and Specific Diameter, Power Specific Speed, Imperfect Similitude, **Hydraulic Pumps**: (6) Components, Priming of Pumps, Head Developed by pump, NPSHA and NPSHR, Cavitation, Characteristics of pumps, Types of vanes, Specific speed, Special Pumps e.g. Borehole Pumps, Slurry Pumps, Vertical Submerged Pumps. **Hydraulic Turbines**: (6) Hydraulic Energy, Types, Pelton Turbines: Impulse Turbines: Performance Characteristics, Velocity triangles, Specific Speed, Francis and Kaplan Turbines: Reaction Turbines: Velocity Triangles, Degree of Reaction and Speed Ratio, Cavitation, Draft Tubes, Conditions for maximum efficiency **Steam Turbines**: (6) Types of Turbines: Impulse and Reaction, Velocity triangles, Efficiencies, Condition for maximumefficiencies, Compounding of turbines - Velocity and Pressure, Degree of reaction, Reaction Turbines **CD Nozzles**: (6) Relation between area and velocity, Mach Number and Mach Cone, 1D steady isentropic flow, Chokingin isentropic flow, Nozzle efficiency, CD Nozzle and characteristics. **Gas Turbines:** (6) Turbine and compressor cascade, Elementary cascade theory, Cascade nomenclature, Lift and drag, Turbine cascade correlation, Optimum space-chord ratio of turbine blades (Zweifel), Axial flow turbines:Two-dimensional Theory, Stage losses and efficiency **Compressors:** (4) Axial Flow Compressors, Principle of operation, Work done, power input factor, efficiency, Passage Vortex and Trailing Vortices, Loss Assessment, Diffuser, Losses in centrifugal compressors, Axial velocity distribution along blade height, Degree of Reaction, performance characteristics, Radial compressors
viii	Texts / Ref.	1. Fluid Mechanics and Thermodynamics of Turbomachinery – SL Dixon, Elsevier; 7th edition, BH 2. Gas Turbine Theory, Cohen, Rogers and Saravanamuttoo, Pearson India 3. Turbines, compressors and Fans, SM Yahya, McGraw Hill Education, 2017. 4. Hydraulic Machines, VP Vasandani, Khanna Publishers 5. An Introduction to Energy Conversion: Turbomachinery - Vol. III, Kadambi & Prasad, NAIP, 2011.
ix	**Name(s) of Instructor(s)**	DVP, SS
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/ areequivalent to this course? If so, please give details.**	NA

xii	**Justification/ Needfor introducing the course**	Turbomachines are essential fluid machinery which is present in a day-today practical usage. The working principles, design principles are essential for a B.Tech. (Mech.). As thisis an application of the core Mechanical courses, the course is listed as an elective.

i.	Title of the Course	**Energy and Environment Lab**
ii.	Credit Structure	L T P C 0 0 3 3
iii.	Prerequisite, if any	
iv.	Course Content (separate sheet may be used, if necessary)	**Fuel cells** • Determine characteristics of a fuel cell • Determine performance of fuel cell with AC and DC loads **Thermal energy storage using phase change materials (PCM)** • Evaluation of heat transfer, system thermal efficiency during charging and discharging of PCM • Evaluation of two PCM systems in cascade **Wind turbine** • Determine the wind turbine coefficient of performance, and characteristics of a wind turbine • Determine the charge controller efficiency, power curve and conduct power analysis for different loads **Solar thermal energy** • Evaluation of performance in thermosyphonic mode of flow • Evaluation of performance in forced mode of flow **Solar concentrator system** • Evaluation of performance in thermosyphonic mode of flow • Evaluation of performance in forced mode of flow
v.	Texts/References (separate sheet may be used, if necessary)	Lab manuals
vi.	Instructor (s)	Sudheer Siddapureddy, Keerthi M. C.
vii.	Name of departments to whom the course is relevant	Electrical Engineering and Mechanical Engineering
viii	Justification	This lab course offers a practical exposure to the subsystems and systems involved in energy conversion processes.

Name of Academic Unit: Mechanical, Materials and Aerospace Engineering
Level: **PG**
Programme: M.Tech./MS/PhD

i	**Title of the course**	**Advanced Solid Mechanics**
ii	**Credit Structure (L-T-P-C)**	3-0-0-6
iii	**Type of Course**	M.Tech. (Mechanical) Core
iv	**Semester in which normally to be offered**	Odd
v	**Whether Full or Half Semester Course**	Full
vi	**Pre-requisite(s), if any – specify course number(s)**	-

vii	Course Content	**Module 1: Analysis of Stress:** Concept of traction, Cauchy Stress formula: Traction on arbitrary planes, Equality of cross-shears, Principal stresses and Principal Planes, Stress invariants, State of Stress Referred to Principal Axes – Octahedral stresses, Mohr's Circles for 3D State of Stress, Equations of equilibrium – Cartesian and Cylindrical coordinate systems. **Module 2: Analysis of Strain:** Displacement field, Deformation gradient, Change in length of a linear element and its linearization and physical interpretation, State of Strain at a point, Change in thedirection of a linear element, cubical dilatation, change in the angle between two linear elements – shear strain, Principal axes of strain and Principal strains, Strains in cylindrical coordinate systems, compatibility of linear strains. **Module 3: Stress-strain Relations – Linear Elastic Solids:** Generalized Hooke's Law, Material Symmetry Planes – Monoclinic, Orthotropic and Isotropic, Lames's constants, Bounds on moduli. **Module 4: Formulations, General theorems and Solution Strategies:** Stress formulation – Beltrami-Michell Compatibility relations, Navier-Lame Equations of equilibrium, Strain Energy Concept, Saint Venants principle, Principle of Superposition, Uniqueness theorem; General Solution strategies. **Module 5: Plane elasticity:** Plane stress, Pane strain, 2D stress formulation in Cartesian and Polar Coordinates: Airy stress function. **Module 6: 2D Problems:** Cartesian coordinate Problems: Using Polynomials and Fourier series , Polar coordinate Problems: Axisymmetric problems - Lame, Rotating Disk, curved beams under pure moments, Infinite/Semi-infinite body subjected to concentrated loads – Kelvin and Flamant problems, Stress concentration in an infinite plate with a small hole – Kirsch problem. **Module 7: Extension, Flexure and Torsion of Prismatic bars:** Extension formulation; Torsion formulation: Saint Venants semi-inverse approach, Prandtl's stress function approach, Membrane analogy, Solution using Fourier series, Torsion of thin-walled tubes – Bredt-Batho formula; Flexure formulation without twist.
viii	Texts/ References	**Text-books: 1.** M.H.Sadd,"Elasticity: Theory, Applications and Numerics",Academic Press, 2013. **2.** J. R. Barber, Elasticty, Springer, 2010. **3.** L.S.Srinath,"Advanced Mechanics of Solids" Tata McGraw Hill, 2007. **References: 1.** S.P. Timoshenko and J.N. Goodier, "Theory of Elasticity," McGraw-Hill, Third Ed., New York, 1970. 2. Allan F. Bower, Applied mechanics of Solids.. CRC press, 2009. 3. Adel S. Saada , Elasticity: Theory and Applications, Second Edition, Revised & Updated.. J. Ross Publishing, ,2009. 4. Robert William Soutas-Little, Elasticity, Courier Corporation, 2012.

ix	**Name(s) of Instructor(s)**	MMAE Faculty
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.**	Nil

xii	Justification / Need for introducing the course	Analysis of deformable solids beyond bars, shafts and beams under small displacements and Hooke's law, necessitates a more general and rigorous theory. This course generalizes the concepts of stress, strain and Hooke's law exposed in Mechanics of Materials course to set a platform for analysis of solids under small displacements and Hooke's law. Mechanics of Materials problems and other problems of engineering importance are formulated using the above principles as BVP to evaluate stresses, strains and displacements.

Name of Academic Unit: Mechanical, Materials and Aerospace Engineering
Level: **PG**
Programme: M.Tech./MS/PhD

i	**Title of the course**	**Advanced Mechanisms and Dynamics of Mechanical Systems**
ii	**Credit Structure (L-T-P-C)**	3-0-0-6
iii	**Type of Course**	M.Tech (Mechanical) Core
iv	**Semester in which normally to be offered**	Odd
v	**Whether Full or Half Semester Course**	Full
vi	**Pre-requisite(s), if any – specify course number(s)**	

vii	**Course Content**	• Review of Grashof criterion and its derivation
		• Synthesis of Mechanisms - Four bar linkage and Slider crank mechanisms
		  o Two position Double rocker design
		  o Two position motion generation
		  o Three position motion generation
		  o Function Generation
		  o Synthesis of crank-rocker for a specified rocker amplitude
		• Path synthesis -- practical Approaches
		  o Roberts Cognate Theorem
		• Review of Special Mechanisms
		  o Straight Line generating mechanisms
		  o Ackermann Steering Mechanism
		  o Pantograph Mechanism and its derivation
		• Brief introduction to spatial linkages
		  o Serial Chain
		  o Closed loop linkages
		• Review of Dynamics of particles
		  o Newton's laws, Impulse Momentum
		  o Moment of a force and Angular Momentum, Work and Energy
		  o System of particles
		• Fundamentals of Analytical Mechanics
		  o Degrees of freedom and generalized coordinates
		  o Systems with constraints
		  o The stationary value of a function and a definite integral
		  o The principle of virtual work
		  o D' Alembert's principle
		  o Hamilton's principle
		  o Lagrange's equation of motion
		  o Lagrange's equations for impulsive forces
		  o Conservation laws
		  o Routh's method for ignoration of coordinates
		  o Rayleigh's dissipation Function
		  o Hamilton's equations

viii	Texts/ References	TEXTBOOKS 1. "Kinematics Dynamics and Design of Machinery", Kenneth Waldron and Gary L. KInzel,Second Edition, John Wiley and Sons. 2. "Analytical Dynamics", Leonard Meirovitch, First Edition, McGraw Hill.
ix	**Name(s) of Instructor(s)**	MMAE Faculty

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/ areequivalent to this course? If so, please give details.**		Nil
xii	**Justification/ Need for introducing the course**	This is a fundamental course which is essential for appreciating equations of motion in mechanicalsystems	

Name of Academic Unit: Mechanical, Materials and Aerospace Engineering
Level: PG
Programme: M.Tech./MS/PhD

i	**Title of the course**	**Advanced Fluid Mechanics and Heat Transfer**
ii	**Credit Structure (L-T-P-C)**	3-0-0-6
iii	**Type of Course**	M.Tech (Mechanical) Core
iv	**Semester in which normally to be offered**	Odd
v	**Whether Full or Half Semester Course**	Full
vi	**Pre-requisite(s), if any – specify course number(s)**	
vii	**Course Content**	Boundary layer theory: fundamentals, derivation of N-S equations, exact solutions of N-S equations,Boundary-layer equations in plane flow, coupling of thermal boundary layers and velocity field of the temperature field, internal flows Potential flow and flow past immersed bodies Turbulence: high Re flows, energy-transfer concepts, turbulent boundary layers, free-shear flows like jets, wakes, and mixing layers, turbulence modelling Compressible flows: energy equation, assumptions, compressible flows, stagnation properties, speed of sound, isentropic and non-isentropic flows, potential and rotational flows, effect of area change, shaft work, heat addition, mass addition and friction on flow states in a compressible (channel) flow. Pool Boiling: Nukiyama curve, boiling regimes, correlations, enhancement of boiling heat transfer Two phase flow and heat transfer: liquid-vapor interface, contact angle hysteresis, bubble formation,flow regimes, flow models, condensation. Radiation: Intensity, radiosity, irradiance, view factor geometry and algebra, radiative heat transfer equation, extinction and scattering properties of gases and aerosols, overview of solution methods and applications. Radiation in Enclosures – Gas Radiation – Diffusion and Convective Mass Transfer – Combined Heat and Mass Transfer
viii	Texts/ References	**Texts:** 1. Hermann Schlichting, and Klaus Gersten. Boundary layer theory. 9th edition. Springer, 2017. 2. Tennekes, Hendrik, and John L. Lumley. A first course in turbulence. MIT press, 2018. 3. Anderson, John D. Modern compressible flow. Tata McGraw-Hill Education, 2003. 4. Carey, Van P. Liquid-vapor phase-change phenomena: an introduction to the thermophysics ofvaporization and condensation processes in heat transfer equipment. CRC Press, 2018. 5. Incropera, Frank P., et al. Fundamentals of heat and mass transfer. Wiley, 2007. 6. Modest, Michael F. Radiative heat transfer. Academic press, 2013. **References:** 7. Davidson, Peter Alan. Turbulence: an introduction for scientists and engineers. Oxford universitypress, 2015. 8. Pope, Stephen B. "Turbulent flows." (2001): 2020. 9. Bejan, Adrian. Convection heat transfer. John wiley & sons, 2013. 10. Kays, William Morrow. Convective heat and mass transfer. Tata McGraw-Hill Education,2011.
ix	**Name(s) of Instructor(s)**	MMAE Faculty
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.**	Nil
xii	**Justification/ Need for introducing the course**	This course introduces advanced concepts in the fluid mechanics and heat transfer graduating fromthe basic fluid mechanics course.

Name of Academic Unit: Mechanical, Materials and Aerospace Engineering
Level: **PG**
Programme: M.Tech./MS/PhD

i	**Title of the course**	**Additive and Forming Manufacturing Processes**
ii	**Credit Structure (L-T-P-C)**	3-0-0-6
iii	**Type of Course**	M.Tech (Mechanical) Core
iv	**Semester in which normally to be offered**	Odd
v	**Whether Full or Half Semester Course**	Full
vi	**Pre-requisite(s), if any – specify course number(s)**	
vii	**Course Content**	**Module 1:** Introduction to Smart manufacturing, various Smart Manufacturing Technologies, Smart foundry, Reverse engineering, Traditional manufacturing, Rapid Tooling, Rapid Manufacturing; Indirect Processes - Indirect Prototyping, Indirect Tooling, Indirect Manufacturing. Introduction to Additive Manufacturing (AM): Overview of Additive Manufacturing (AM), Introduction to flexible manufacturing processes **Module 2:** AM technologies, classification of AM processes: Sheet Lamination, Material Extrusion, Photo-polymerization, Powder Bed Fusion, Binder Jetting, and Direct Energy Deposition, Popular AM processes. Additive manufacturing of different materials **Module 3:** Advance in welding techniques, Robotic welding, characterization, Non-traditional Manufacturing processes, **Module 4:** Introduction: CAD/CAM, NC/CNC, CNC machines, Industrial applications of CNC, economic benefits of CNC. CNC Machine Tools, CNC tooling: Qualified and pre-set tooling, tooling systems, tool setting, automatic tool changers, work holding and setting. Programming: Part programming language, programming procedures, proving part programmes, computer aided part programming **Module 5:** Metal forming: Bulk and sheet metal forming processes, Fundamentals of plasticity, yield and flow, anisotropy, instability, yield criterion for isotropic materials, plastic stress strain relations for isotropic materials. Force equilibrium method and its application to metal forming processes. Introduction to incremental sheet and bulk metal forming **Module 6:** Industry 4.0 cases studies of manufacturing
viii	Texts/ References	1. Gibson, D. W. Rosen, and B. Stucker, Additive Manufacturing Technologies: Rapid Prototypingto Direct Digital Manufacturing. Springer, 2014. 2. C. K. Chua and K. F. Leong, Rapid Prototyping: Principles and Applications in Manufacturing.World Scientific, 2003. 3. Theory of Plasticity by J. Chakrabarty, McGrawHill Book Co., InternationalEdition, 19874. 4. Messler, R. W. (2008). Principles of Welding: Processes, Physics, Chemistry, and Metallurgy.Germany: Wiley. 5. Ibrahim Zaid, R. Sivasubramanian, CAD/CAM: Theory and Practice. McGraw Hill Education,2nd edition, 2009. 6. M. P. Groover, E. W. Zimmers, CAD/CAM: Computer-aided design and manufacturing.Pearson, 2013.
ix	**Name(s) of Instructor(s)**	MMAE Faculty
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
xii	**Justification/ Need for introducing the course**	Aim of this course is to introduce the fundamentals of advanced manufacturing. A broad range of advanced manufacturing technologies and the fundamentals of plastic deformation in metal forming processes are introduced. Basics of computer aided manufacturing, smart manufacturing, additive manufacturing and industry 4.0 lays the foundations to futuristic manufacturing.

Chemistry Department

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

i	**Title of the course**	**CH 405 Our Health and Medicine**
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 Semester
vi	**Pre-requisite(s), if any (for the students) – specify course number(s)**	None
vii	**Course content**	Health and nutrition**,** role of different nutrients (carbohydrates, proteins, fats, vitamins, and minerals), diet and metabolism, basic introduction to human physiology, communicable diseases (common bacterial and fungal infections, antibiotics and resistance, common viral infections, corona virus (SARS, MERS, SARS-COV-2), vaccine and antivirals, non-communicable diseases (diabetes, cancer), basic medicinal chemistry, preventative and community medicine, health policies, healthcare system, health awareness and best practices
viii	**Texts/References**	1. Oxford textbook of medicine: Infection ed. by David Warrell and Timothy Cox, 1st edition, OUP, 2012. 2. Textbook of community medicine ed. by Rajvir Bhalwar, 2nd edition, Wolters Kluwer, 2017. 3. Koneman's textbook of diagnostic microbiology, 7th edition, Wolters Kluwer, 2017. 4. Principles of therapeutic nutrition and dietetics, by Avantina Sharma, 1st edition, CBS, 2017. 5. Textbook of medical biochemistry by Rajinder Chawla, E.H. El-Metwally and Suchanda Sahu, 2nd edition, Wolters Kluwer, 2017. 6. An introduction to medicinal chemistry by Graham L. Patrick, 3rd edition, OUP, 2005.
ix	**Name (s) of the instructor (s)**	Nilkamal Mahanta
x	**Name (s) of other departments / Academic Units to whom the course is relevant**	All departments with B. Tech/MS and PhD courses are encouraged

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 course is designed to spread awareness among students on the best practices to maintain a good health and to emphasize on the role of diet and nutrition. It will also encompass common diseases that we encounter often and various ways to prevent and mitigate them with the basic understanding of human physiology and medicinal chemistry. In the wake of this global COVID-19 pandemic, fundamental information on good health and community medicine as well as healthcare system/policies has become indispensable. This course will provide the necessary foundation on the mechanism of various commonly used drugs, preventative medicine, and suitable family health practices which will facilitate one in making informed decisions on prevention, diagnosis, treatment, care, and support when required.

Name of Academic Unit: Chemistry/EE/ME
Level: UG/PG
Programme: B.Tech./MS/M.Tech.

i	**Title of the course**	Introduction to Sophisticated characterization Techniques
ii	**Credit Structure (L-T-P-C)**	2-0-2-6
iii	**Type of Course**	Elective
iv	**Semester in which normally to be offered**	Autumn
v	**Whether full or half semester course**	Full Semester
vi	**Pre-requisite(s), if any (for the students) – specify course number(s)**	None
vii	**Course content**	**Module 1**: **Nuclear Magnetic Resonance spectroscopy** - Introduction to NMR • instrumentation • working principle • Basic principles of analysis • characterization of different samples **Module 2**: **Spectrophotometer and Spectrofluorimeter** - Fundamental concepts • Instrumentation • Basic principles of analysis • characterization and analysis of samples **Module 3: Atomic Force Microscope** – Instrumentation • Physics and working principle • Different modes of operation • Different imaging techniques • Analysis of the data • Niche applications. **Module 4: Field Emission Scanning Electron Microscope** – Introduction to electron microscopy • Different signals generated • Vacuum systems • Instrumentation • working principle • Imaging methods and different parameters associated to them **Module 5: Universal Test machines –** Overview of Mechanical properties under static and dynamic loads • Introduction to UTMs • Introduction to UTM accessories • Introduction to Static tests • Introduction to Fatigue tests • Introduction to Fracture Mechanics tests
viii	**Texts/References**	1. G. E. Dieter, Mechanical Metallurgy, 3rd Edition, McGraw Hill Education India, 1986 2. J. R. Davis, Tensile Testing, 2nd Edition, ASM International, 2004. 3. J. R. Lakowicz, Principles of fluorescence spectroscopy, 3rd Edition,2006 4. H. Gunther, NMR Spectroscopy: Basic Principles, Concepts and Applications in Chemistry, 3rd Edition, 2013. 5. Banwell Colin, Fundamentals for Molecular Spectroscopy 4th Edition.
ix	**Name (s) of the instructor (s)**	RRM, TPG, RG

x	**Name (s) of other departments / Academic Units to whom the course is relevant**	Chemistry, Physics, Electrical Engineering, Mechanical Engineering, Biological Sciences and Bioengineering
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 hands-on experience of various sophisticated instruments is vital and will enable students to understand the concepts learnt in the class. It will also motivate the students to pursue research in many areas of modern science and technology. This course provide the necessary skills required to handle and operate sophisticated instruments.

Name of Academic Unit: Chemistry
Level: B.Tech.
Programme: B.Tech.

i	**Title** of the course	**CH 402 Quantum field theory**
ii	Credit Structure (**L-T-P-C**)	2-1-0-6
iii	**Type** of Course	Elective 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)*	Exposure to Physics, Chemistry and Mathematics
vii	Course **Content***	Introduction: Review of Classical Field Theories and the need for Quantum Field Theory Bosonic Fields: Second quantization of bosons; non-relativistic quantum fields and the Landau Ginzburg theory; relativistic free particles and the KleinGordon field; causality and the Klein-Gordon propagator; quantum electromagnetic fields and photons. Fermionic Fields: Second quantization of fermions; particle-hole formalism; Dirac equation and its nonrelativistic limit; quantum Dirac field; spinstatistics theorem; Dirac matrix techniques; Lorentz and discrete symmetries. Interacting Fields and Feynman Rules: Perturbation theory; correlation functions; Feynman diagrams; S-matrix and crosssections; Feynman rules for fermions; Feynman rules for QED. Functional Methods: Path integrals in quantum mechanics; "path" integrals for classical fields and functional quantization; functional quantization of QED; QFT and statistical mechanics; symmetries and conservation laws. Quantum Electrodynamics: Some elementary processes; radiative corrections; infrared and ultraviolet divergencies; renormalization of fields and of the electric charge; Ward identity. Renormalization Theory: Systematics of renormalization; `integration out' and the Wilsonian renormalization; `running' of the coupling constants and the renormalization group. Non-Abelian Gauge Theories: Non-abelian gauge symmetries; Yang-Mills theory; interactions of gauge bosons and Feynman rules; Fadde'ev-Popov ghosts and BRST; renormalization of the YM theories and the asymptotic freedom; the Standard Model.
Viii	Texts/References	1. “An Introduction to Quantum Field Theory”, Michael Peskin and Daniel Schroeder (Addison Wesley) 2. “Introduction to Quantum Field Theory”, A. Zee 3. “Quantum Field Theory”, Lewis H. Ryder 4. “Quantum Field Theory and Critical Phenomena”, by Jean Zinn-Justin. 5. “Quantum field Theory for the Gifted Amateur”, T. Lancaster and Stephen J. Blundell 6. NPTEL lectures in Quantum Field Theory (https://nptel.ac.in/courses/115106065/)

ix	Name(s) of **Instructor(s)** ***	Prof. B. L. Tembe
x	Name(s) of **other**	B.Tech. students of all departments
	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?	No
xii	**Justification/ Need** for introducing the course	Quantum Field Theory is one of the basic theories in physics which has met with great success in explaining a large number of natural phenomena. This could be of interest to most students with a desire to learn physics and mathematics and who have a basic background in science in engineering of up to the third year of IIT B.Tech courses.

HSS Department

Name of Academic Unit: HSS
Level: B. Tech.
Programme: B.Tech.

i	**Title of the course**	**HS 301: Philosophy**
ii	**Credit Structure (L-T-P-C)**	3-0-0-6
iii	**Type of Course**	Core – Humanities
iv	**Semester in which normally to be offered**	1
v	**Whether Full or Half Semester Course**	Full
vi	**Pre-requisite(s), if any (For the students) – specify course number(s)**	None
vii	**Course Content**	What is Philosophy? (Philosophy in India andWest) 2. Main Branches of Philosophy 3. Three Laws of Thought 4. Epistemology and Logic (Indian and Western) Metaphysics (Universal and Particular, Substance and Attributes, Causality, Space, Time,Soul, God, Freedom) Three Great Greek Philosophers: Socrates,Plato and Aristotle Modern Philosophy: Rationalism andEmpiricism(Descartes, Locke, Berkeley and Hume) Ethics (Utilitarianism, Categorical Imperative of Kant, Ethical Relativism, Bio-Medical Ethics, Ethical Issues) Indian Philosophy Component (Nishkama-karmaof Gita, Virtue Ethics of Buddhism, Advaita Vedanta). 10. Meaning of Life.

viii	**Texts/References**	Ganeri, Jonardon, *Philosophy in Classical India: AnIntroduction and Analysis* (London: Routledge, 2001). *2*. Maritain, Jacques, *An Introduction of Philosophy* (New York and Oxford: Rowman & Littlefield, 2005). Mohanty, J. N. *Classical Indian Philosophy: AnIntroductory Text* (New York and Oxford: Rowman &Littlefield, 2000). Nagel, Thomas, *What Does It All Mean? A Short Introduction to Philosophy* (Oxford: Oxford UniversityPress, 2004). Russel, Bertrand, *The Problems of Philosophy* (Oxford: Oxford University Press, Reprint by Kalpaz Publication, 2017). Sharma, Chandradhar, *A Critical Survey of Indian Philosophy* (Delhi: Motilal Banarsidass, 2016).
		Thilly, Frank, *A History of Philosophy* (New Delhi:SBW Publishers, 2018). Williams, Bernard, *Morality: An Introduction to Ethics* (Cambridge: Cambridge University Press, 2012).
ix	**Name(s) of Instructor(s)**	Prof. Jolly Thomas.
x	**Name(s) of other Departments/ Academic Units to whom the courseis relevant**	All
xi	**Is/Are there any course(s) in the same/ other academic unit(s) whichis/ are equivalent to this course? If so, please give details.**	No

xii	**Justification/ Need for introducingthe course**	HS 301 is a unique course that aims to provide the B.Tech. students an understanding of philosophy and history of ideas. Through this course they are expected to develop philosophical analysis and critical thinking which will enhance their engineering imagination as a skill and profession with the training in epistemology, logic, philosophical speculation and creativity. The ethics-module of the course will help them to think andact ethically in their profession with relation to the societal expectations of their fellow humans in India.

Name of Academic Unit: HSS
Level: UG
Programme: B. Tech.

i	**Title of the course**	**Energy Economics & Policy**
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**	• **General Orientation**: Energy Flow Diagram, Understanding the Energy Crisis - OPEC and Oil price shocks in the 1970s, Energy Value Chain, Global Trends in Energy Use, Resources & Reserves Growth Rates in Consumption, Estimates of Duration of Fossil Fuels, Primary and Secondary Source of Energy. • **Energy Economics**: Energy Demand and Supply, Simple Payback Period, Criteria for Assessing Energy Projects – (Net Present Value (NPV), Benefit/Cost Ratio (B/C), Inflation, Internal Rate of Return (IRR), Pricing in Energy Markets: Functioning of Power Exchange and Commodity Exchanges (Energy), Financing Energy – Debt/ Equity- Sources of funds, innovative financing models, Cost of Energy. Private Investment in Energy Sectors, International Carbon Markets and Carbon Finance. • **Energy Policy**: Energy and Quality of Life, Energy Security, National and International Perspective, Energy Inequality, Indicators of energy poverty, Affordability, Climate Change, UNFCCC, Kyoto Protocol, National Action Plan on Climate Change, Renewable Energy, Cross Border Energy Cooperation, Energy and Environment, Power Policy, Regulation of Indian Energy Sectors Electricity, Oil & Gas and Coal Sectors.
viii	**Texts/ References**	1. Stevens, P. (2000). An Introduction to Energy Economics. In Stevens, P. (ed.) The Economics of Energy, Vol. 1, Edward Elgar, Cheltenham, UK. 2. Bhattacharyya, Subhes. C. (2011). Energy Economics: Concepts, Issues, Markets and Governance. Springer. London, UK. 3. Hartwick, J. M, and Olewiler, N. D. (1986). The Economics of Natural Resource Use. Harper and Row Publishers, New York, USA. 4. GEA, 2012: Global Energy Assessment - Toward a Sustainable Future, Cambridge University Press, Cambridge, UK and New York, NY, USA and the International Institute for Applied Systems Analysis, Laxenburg, Austria 5. Hiren Sarkar and Gopal K. Kadekodi, Energy pricing in India: perspectives, issues and options, 1988. 6. Tietenberg, T., and L. Lewis. "The Allocation of Depletable and Renewable Resources: An Overview." In *Environmental & Natural Resource Economics*. 8th ed. Addison-Wesley, 2008, pp. 134–55. ISBN: 9780321485717. 7. Tiwari, G. N., & Mishra, R. K. Advanced Renewable Energy Sources. Royal Society of Chemistry. 2011.

		8. Laurance R. Geri, David E. McNabb. Energy Policy in the U.S.: Politics, Challenges, and Prospects for Change. CRC Press. 2011. 9. Wilson, J. Q., ed. "The Politics of Regulation." In *The Politics of Regulation*. Basic Books, 1982, pp. 357–94. ISBN: 9780465059683.	
ix	**Name(s) of Instructor(s)**	Gopal Sharan Parashari	
x	**Name(s) of other Departments/ Academic Units to whom the course is relevant**	All Departments; minor in Energy and Environment	
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 course provides introductory knowledge about economic concepts and policies about energy and related domains. It gives a general idea of economics, policy and regulatory frameworks in energy sector to a general student irrespective of her major.	

Name of Academic Unit: Humanities and Social Sciences
Level: UG
Programme: B. Tech.

i	**Title of the course**	HS 304 Intellectual Property Management
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)**	Nil
vii	**Course Content**	Historical Development of Intellectual Property in Industrialized Society, Patent Basics, Patent Systems around the world, Application of patents in different technology areas including Software and Business Methods, How to read a Patent, Introduction to Patent Databases and Analysis Tools, Patent Searching and Analysis, Use of Patent Information for Research and Business Planning, Introduction to TRIZ , Evaluation of Patents, IPR Beyond Patents (Copyright, Trade Marks, Designs and other forms of IP rights), IP Management including IP Strategy for Start-ups and Corporates , IP Licensing, IP Acquisition and Enforcement, Case studies and Tutorial.
viii	**Texts/References**	Reading material will be provided
ix	**Name(s) of Instructor(s)**	Prof. R. R. Hirwani
x	**Name(s) of other Departments/ Academic Units to whom the course is relevant**	All the 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.**	Nil
x	**Justification/ Need for introducing the course**	Intellectual Property plays an important role in technological innovations, creation and growth of technology start-ups. The existing patent databases are repositories of global technical knowledge and can be used for problem identification, cross fertilization of ideas, generation of alternate solutions, technology monitoring, and competitive intelligence. It is felt necessary to sensitize the students to current IP regime and prepare them for the career in technology ventures.

Name of Academic Unit: HSS

Programme: B.Tech. / M.Tech. / Ph.D.: (Institutional Course)

i	**Title** of the course	Innovation and Social Entrepreneurship (Guided Study)
ii	Credit Structure (**L-T-P-C**)	**(2 0 0 4)**
iii	**Type** of Course	Elective course (Guided Study)
iv	Semester in which normally to be offered	Spring
v	Whether **Full or Half Semester** Course	Half (This is pilot course and later on based on experience gained, it will be expanded to full semester course with inclusion of Proof of Concept)
vi	**Prerequisite(s)**, if any (For the students) – *specify course number(s)*	NIL
vii	Course **Content***	The objective of this course is to apply advanced knowledge in science and technology to problems that are socially and economically relevant and to create and nurture social entrepreneurs. Students are expected to undertake a 6-8 weeks' project concerned with societal/ rural issues. The main focus will be to enhance income and to improve the quality of lifeof the population at the bottom of the pyramid. Some illustrative examples are as follows: ➢ Value added Agriculture ➢ Waste to Wealth ➢ Low cost housing ➢ Affordable health care ➢ Potable Water supply ➢ Sustainable energy and energy efficiency ➢ Environment protection and Sustainability Any other projects that address societal problems. • Students shall select a topic of social relevance and align with above objectives and study the problem in detail. • Students shall try to find out and evaluate solutions which are techno-commercially viable and have the potential to be scaled up to reach out to uplift the life of millions. • Develop a business model that will make it a sustainable social enterprise. ➢ The course will involve self-study under guidance of instructor,

		few guest lectures by practitioners and/or visit to a social enterprise. ➢ The students shall select the project in consultation with course instructor. ➢ After carrying out the project, the student will submit a report and give a presentation highlighting the observations/results of the project and proposed business plan. This will be reviewed and graded.
Viii	Texts/References	*Social Innovation and Social Entrepreneurship: Fundamentals, concepts and Tools* *Luis Portales* Palgrave Macmillan This will be supplemented by Indian case studies
x	Name(s) of **Instructor(s)** ***	Prof. R. R. Hirwani
x	Name(s) of **other Departments/ Academic Units towhom** the course is **relevant**	This course will be an open Institute course and can be taken by students from all disciplines.
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	There is a need to *address social complex challenges* by providing innovative solutions at local and global levels, to modernize public local services, general interest services and community services often by involving users in the design, implementation and evaluation of these services and to *respond* in a more tailored, effective way to *people's needs with a view to* produce social change. New solutions to social challenges have to produce positive social impact and externalities (wellbeing of the users) and at the same time solutions have to be economically sustainable and involve entrepreneurial approach.

		At IIT, Dharwad we wish to develop and deploy technological solutions to socially relevant problems of local and regional nature and promote social entrepreneurship amongst students who have to learn to think out of the box and to walk off the beaten track and be able to mobilize different human, organizational and financial resources and to work in partnership with other stakeholders and develop new governance models.
xiii	**Other notes**	It shall not be a mandatory requirement to live and work in the targeted areas, however, it will involve some field work to gather data and pilot work. Students can undertake above Social Innovation project either at IIT, Dharwad or any other Institute or Organization. In case the student wants to do the project in organization other than IIT, Dharwad, the permission of Dean, Academic Programme will be taken through the Course Instructor. The Institute / Organization where the project is to be undertaken shall provide all necessary infrastructural facilities and extend all possible helpand cooperation to facilitate the student to complete the project

Name of Academic Unit: HSS
Level: UG
Programme: B.Tech./M.S./M. Tech/Ph.D.

<table>
<tr><td>i</td><td>Title of the Course</td><td colspan="5">HS 403 Happiness and Well-Being</td></tr>
<tr><td>ii</td><td>Credit Structure</td><td>L</td><td>T</td><td>P</td><td>C</td><td></td></tr>
<tr><td></td><td></td><td>2</td><td>1</td><td>0</td><td>6</td><td></td></tr>
<tr><td>iii</td><td>Type of Course</td><td colspan="5">Elective</td></tr>
<tr><td>iv</td><td>Semester in whichnormally to be offered</td><td colspan="5">Autumn/Spring</td></tr>
<tr><td>v</td><td>Whether Full or Half Semester Course</td><td colspan="5">Full</td></tr>
<tr><td>vi</td><td>Prerequisite(s), if any(For the students) – specify course number(s)</td><td colspan="5">None</td></tr>
<tr><td>vii</td><td>Course Content</td><td colspan="5" rowspan="2">In this course, we will explore the concept and different definitions ofhappiness and well-being, and the connection between happiness, positive attitude, relationships and the purpose and meaning of life. Techniques to achieve happiness in life will be studied. The course will be primarily participatory in nature with class discussions, presentations and journal assignments. The course material will be taken from a variety of sources. The causes that disturb the harmony inlife will be analysed and practices to address these satisfactorily will beinvestigated. The methods of yoga, pranayama different meditation paths and healing techniques will be evaluated so that each student can adopt a suitable combination to suit her needs. Assignments will be aimed at a better understanding of oneself and the society and the environment that we live in.
Learning Objectives.
After studying this course, the students will be able to:
● Identify key psychological, social, cultural and biological factors inhappiness and well being
● Understand the relationship between happiness, human connections,and qualities such as compassion, altruism, and gratitude
● Describe the principles behind the specific activities that boosthappiness
● Apply lessons from positive & social psychology to their personaland professional lives, enhancing their self-understanding
● Practice research-tested techniques for enhancing happiness
● Analyse human nature in terms of the three gunas and thepanchakosha model of beings.
● Adopt methods of yoga and meditation for self-improvement andsocial well-being</td></tr>
<tr><td></td><td></td></tr>
</table>

		Course Contents Happiness and wellbeing: definitions and measurement. The Hedonictradition. Role of social connections in fostering happiness. Kindness and compassion, altruism and happiness, Success, money and happiness. Cooperation, reconciliation and happiness. Mindfulness, attention and focus. Mental habits of happiness: self-compassion, flow, and optimism. The Pursuit of Happiness: Does Being Good or Bad Produce More Happiness? Understanding the Causes of "Suffering." Cultivating Right" Attention and "Right" Desire. Meaningful Relationships. The strong links between gratitude and happiness. Curiosity, Play, and Creativity.The art of letting go. Finding Your Happiness Fit and the New Frontiers. Happiness and Meaning in Life Yoga, Panchakoshas and Gunas: Guna concept: satwa, rajas and tamasand balancing the gunas. Ashtanga Yoga: Yama, Niyama, Aasana and Pranayama Pratyahar, Dharana and Dhyana. Vipassana Meditation and Reiki
		Kindness and compassion, altruism and happiness, Success, moneyand happiness. Cooperation, reconciliation and happiness. Mindfulness, attention and focus. Mental habits of happiness: self-compassion, flow, and optimism. The Pursuit of Happiness: Does Being Good or BadProduce More Happiness? Understanding the Causes of "Suffering." Cultivating Right"Attention and "Right" Desire. Meaningful Relationships. The strong links between gratitude and happiness. Curiosity, Play, and Creativity.The art of letting go. Finding Your Happiness Fit and the New Frontiers. Happiness and Meaning in Life Yoga, Panchakoshas and Gunas: Guna concept: satwa, rajas and tamasand balancing the gunas. Ashtanga Yoga: Yama, Niyama, Aasana and Pranayama Pratyahar,Dharana and Dhyana. Vipassana Meditation and Reiki

Mathematics Department

Name of Academic Unit: Mathematics
Level: UG
Programme: B.Tech.

i	**Title of the course**	**MA 403 Introduction to Number theory**
ii	**Credit Structure (L-T-P-C)**	(3-0-0-6)
iii	**Type of Course**	UG Elective
iv	**Semester in which normally to beoffered**	
v	**Whether Full or Half Semester Course**	Full
vi	**Pre-requisite(s), if any (For the students) – specify course number(s)**	None
vii	**Course Content**	Primes and Factorization; Fundamental theorem of Arithmetic; Congruences, Euclidean Algorithm, Chinese Reminder theorem; Algebraic and transcendental numbers; algebraic integers, Euler's phi-function; primitive elements; Wilson's theorem; Introduction to public-key encryption systems; Mobius inversion formula; quadratic law of reciprocity;
Viii	**Texts/References**	1. I. N. Niven, H. S. Zuckermann,and H. L. Montgomery, An introduction to theory of numbers, Sixth edition (Student edition), US, Wiley, 2018. 2.T. M. Apostol, Introduction to Analytic number theory, Springer international student edition, Narosa publishing house, New Delhi, 2013. 3.H. Davenport, The Higher Arithmetic,
ix	**Name(s) of Instructor(s)**	N. S. N. Sastry
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
xii	**Justification/ Need for introducing the course**	This is an introductory course on number theory, which will allow undergraduate students to learn certain aspects of Number Theory. The prerequisites are kept to minimum.

Name of Academic Unit: Mathematics
Level: UG/PG
Programme: UG/PG

i	**Title of the course**	**MA 501 Measure Theory**
ii	**Credit Structure (L-T-P-C)**	3-1-0-8 (8 credit full semester course)
iii	**Type of Course**	PhD course work
iv	**Semester in which normally to be offered**	
v	**Whether Full or Half Semester Course**	Full
vi	**Pre-requisite(s), if any (For the students) – specify course number(s)**	Real analysis
vii	**Course Content**	Construction of Lebesgue measure on Real line, Introduction to abstract measure theory, Measurable functions, Caratheodory's Extension Theorem, MCT, Fatou's Lemma, DCT, Product space, Product measure, Fubini's Theorem, Definition of signed measures, Positive and negative sets. Hahn-Jordan Decomposition. Absolute continuity of two σ-finite measures. Radon-Nikodyme Theorem and Lebesgue Decomposition.
viii	**Texts/References**	H. L. Royden; Real analysis. Third edition. Macmillan Publishing Company, New York, 1988. W. Rudin; Real and complex analysis. Third edition. McGraw-Hill Book Co., New York, 1987. S. Athreya and V.S. sunder; Measure & probability. CRC Press, Boca Raton, FL, 2018. K.R. Parthasarathy; Introduction to probability and measure, Hindustan Book Agency, 2005.
	Name(s) of Instructor(s)	Dhriti Ranjan Dolai
x	**Name(s) of other Departments/ Academic Units to whom the course is relevant**	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.**	No
xii	**Justification/ Need for introducing the course**	This course will be beneficial for PhD students who wants to work in the area of analysis (like functional analysis, Harmonic analysis, PDE).

Name of Academic Unit: Mathematics
Level: Ph.D.
Programme: Ph.D.

i	**Title of the course**	**Functional Analysis**
ii	**Credit Structure (L-T-P-C)**	3-0-0-6
iii	**Type of Course**	PhD course work
iv	**Semester in which normally to be offered**	
v	**Whether Full or Half Semester Course**	Full
vi	**Pre-requisite(s), if any (For the students) – specify course number(s)**	Basic topological concepts, Metric spaces, Measure theory
vii	**Course Content**	Stone-Weierstrass theorem, L^p spaces, Banach spaces, Bounded linear functionals and dual spaces, Hahn-Banach theorem. Bounded linear operators, open-mapping theorem, closed graph theorem, uniform boundedness principle. Hilbert spaces, Riesz representation theorem. Bounded operators on a Hilbert space. The spectral theorem for compact, self- adjoint, normal (including unbounded) operators.
viii	**Texts/References**	J. B. Conway: A course in functional analysis, Springer-Verlag, New York, 1990 B.V.Limaye: Functional Analysis, New Age InternationalLimited,Publishers, New Delhi, 1996 Michael Reed, Barry Simon: Methods of modern mathematical physics. I. Functional analysis. Second edition.Academic Press, Inc, New York, 1980 E. Kreyszig: Introductory Functional Analysis withApplications, John Wiley & Sons, New York, 2001
	Name(s) of Instructor(s)	Dhriti Ranjan Dolai
x	**Name(s) of other Departments/ Academic Unitsto whom the course is relevant**	Physics
xi	**Is/Are there any course(s) in the same/ other academic unit(s) which is/ are equivalent to thiscourse? If so, please give details.**	No
xii	**Justification/ Need for introducing the course**	The course will start from basic functional analysis, then it will cover the spectral theorem for normal operators. This course will be helpful to those phd students who wants to work in Schrodinger operator, Harmonic analysis, PDE, Branch space theory, and Operator theory.

Physics Department

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

<table>
<tr><td>i</td><td>Title of the Course</td><td colspan="5">PHXXX: Electrodynamics</td></tr>
<tr><td>ii</td><td>Credit Structure</td><td>L</td><td>T</td><td>P</td><td>C</td><td></td></tr>
<tr><td></td><td></td><td>2</td><td>1</td><td>0</td><td>6</td><td></td></tr>
<tr><td>iii</td><td>Type of Course</td><td colspan="5">Core course</td></tr>
<tr><td>iv</td><td>Semester in which normally to be offered</td><td colspan="5">Autumn/Spring</td></tr>
<tr><td>v</td><td>Whether Full or Half Semester Course</td><td colspan="5">Full</td></tr>
<tr><td>vi</td><td>Pre-requisite(s), if any (For the students) – specify course number(s)</td><td colspan="5">Successful completion of PH102</td></tr>
<tr><td>vii</td><td>Course Content</td><td colspan="5">Review of electrostatics and magnetostatics.

Electrodynamics: Differential and integral forms of Maxwell’s equations, Scalar and vector potentials, gauge transformations, Coulomb and Lorentz Gauge; Maxwell’s equations in terms of potentials. Energy and momentumin electrodynamics.

Electromagnetic waves: Electromagnetic waves in non-conducting media: Monochromatic plane waves in vacuum, propagation through linear media; Boundary conditions; Reflection and transmission at interfaces. Fresnel’s laws; Electromagnetic waves in conductors: Modified wave equation, monochromatic plane waves in conducting media, Dispersion: Dispersion in non-conductors, free electrons in conductors and plasmas. Guided waves.

Retarded potentials, Electric dipole radiation, magnetic dipole radiation. Radiation from a point charge: Lienard-Wiechart potentials, fields of a point charge in motion, power radiated by a point charge.

Electrodynamics and Relativity: Review of special theory of relativity, Lorentz transformations, Minkowski four vectors, energy-momentum four vector, covariant formulation of mechanics; Transformation of electric and magnetic fields under Lorentz transformations, field tensor, invariants of electromagnetic field, Covariant formulation of electrodynamics, Lorentzforce on a relativistic charged particle.
Waveguides, Resonant Cavities and Optical Fibers, Basics of Antennas.</td></tr>
</table>

viii	**Texts/References (separate sheet may be used, if necessary)**	(1) D. J. Griffith: Introduction to Electrodynamics, 4th edition, Pearson, 2015. (2) J.D. Jackson: Classical Electrodynamics, Wiley student edition, 3rd edition, 2007. (3) Modern Electrodynamics, Andrew Zangwill, Cambridge University Press, 2012. (4) Foundations of Electromagnetic Theory, J. R. Reitz, F. J. Milford, and R. W. Christy, Addison-Wesley, 4th edition, 2008. (5) W K H Panofsky and M Philips: Classical Electricity and Magnetism Addison Wesley, 2nd edition, 1962. (6) W Greiner: Classical Electrodynamics, Springer, 1998. (7) Hayt, William H., Jr., and John A. Buck, "Engineering Electromagnetics", 7th ed. McGraw-Hill, 2006. (8) M.A. Heald and J.B. Marion, Classical Electromagnetic Radiation, Saunders, 1983.
ix	**Name(s) of Instructor(s)**	Faculty, Department of Physics
x	**Name(s) of other Departments/ Academic Units to whom the course is relevant**	Physics and 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
viii	**Justification/ Need for introducing the course**	This is a core course for Engineering Physics Program. It deals with many aspects of electromagnetic properties, behavior of electromagnetic wave in space and materials. The formalism developed here could help in better understanding of several technologies, like, communication, antennas, GPS, etc.

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

<table>
<tr><td>i</td><td>Title of the Course</td><td colspan="5">PHXXX: Astrophysics</td></tr>
<tr><td>ii</td><td>Credit Structure</td><td>L</td><td>T</td><td>P</td><td>C</td><td></td></tr>
<tr><td></td><td></td><td>2</td><td>1</td><td>0</td><td>6</td><td></td></tr>
<tr><td>iii</td><td>Type of Course</td><td colspan="5">Elective course</td></tr>
<tr><td>iv</td><td>Semester in which normally to be offered</td><td colspan="5">Autumn/Spring</td></tr>
<tr><td>v</td><td>Whether Full or Half Semester Course</td><td colspan="5">Full</td></tr>
<tr><td>vi</td><td>Pre-requisite(s), if any (For the students) – specify course number(s)</td><td colspan="5">Successfully finishing first 3 semesters</td></tr>
<tr><td>vii</td><td>Course Content</td><td colspan="5">1. a. An inventory of the Universe,
b. Celestial sphere, Coordinates
c. Units, sizes, masses and distance scale

2. Electromagnetic spectrum

a. Radio, Microwave, Infrared, Optical, X-ray and Gamma Ray
b. Telescopes and Detectors

3. Stars

A. General

a. Sun, Planets, (Mother Earth)
b. Mass, Radius, Luminosity, Temperature, Chemistry, Age and Types of stars
c. Hertzsprung-Russell Diagram
d. Birth and Evolution of stars
c. Limits on Mass - Quantum mechanism at large scale: Brown Dwarf

B: Structure of a star:
a. Virial Theorem (qualitative)
b. Nuclear Energy, Pressure, Interaction with radiation.
c. Basic Equations of Stellar Structure
d. Thermal Equilibrium, Radiation and Convection - Schwarzchild Criterion

e. Helioseismology

4. Galactic and Extragalactic Astronomy

a. The Milky Way and Andromeda
b. Rotation Curve - Dark Matter
c. Structures within 500 mega light years
d. Clusters of Galaxies, Superclusters, Filaments and Voids</td></tr>
</table>

		5. Special Topics: a. White Dwarf - Quantum Mechanics and Gravitation: Chandrasekhar limit b. Supernova, Neutron Stars, (Pulsar astronomy), c. Black Holes, Gravitational Wave Astronomy d. Gamma Ray Burst e. Quasars and Active Galactic Nuclei 6. Topics in Cosmology (This will be decided afterdiscussing certain issues with Department members) a. Hubble Expansion - Cosmic Distance Scale - Age of the Universe b. Standard Model of Cosmology c. Cosmic Microwave Background d. Supernova Cosmology Project and Dark Energy e. Gravitational Lens 7. Major Astronomical facilities where India is involved: GMRT, SKA, Thirty Metre Telescope, LIGO, ASTROSAT 8. Open questions in Astrophysics and Cosmology
viii	**Texts/References (separate sheet may be used, if necessary)**	1. The New Cosmos: An introduction to Astronomy and Astrophysics, A.Unsold and B. Baschek, Springer, 5th edition, 2010. 2. An Introduction to Modern Astrophysics, B.W. Carroll and D.A. Ostlie,Cambridge University Press, 2nd edition, 2017. 3. Elements of Cosmology, J.V. Narlikar, University Press, 1996.
ix	**Name(s) of Instructor(s)**	Faculty, Department of Physics
x	**Name(s) of other Departments/ Academic Unitsto whom the course is relevant**	Physic and all 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
viii	**Justification/ Needfor introducing thecourse**	Astrophysics and Cosmology have a few fundamental unsolved problems. Thiscourse is an attempt to convey to the students that there are upcoming powerfulastronomical facilities capable of solving some of them. But both at hardware and software level, it is Technology that drives what observations arefeasible. India is one of the main contributors for development of some of the technologies.

Name of Academic Unit: Department of Physics
Level: UG/PG
Programme: B.Tech./Ph.D.

i	**Title of the Course**	**PHXXX: Introduction to Quantum Information and Computation**				
ii	**Credit Structure**	**L**	**T**	**P**	**C**	
		2	1	0	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 – Quantum Physics and Application MA102 - Linear Algebra				
vii	**Course Content**	Framework of Quantum Mechanics: Quantum States, Dirac notation and Hilbert Space, Operators, Spectral Theorem, Functions of operators, Tensor Products, Schmidt Decomposition theorem; Time-evolution of a closed system; composite systems, measurement, pure and mixed states and general quantum operations. Quantum systems: Qubits, qudits, bipartite and multipartite systems, Continuous variable states. Quantum Entanglement: Definition, detection, quantification in various quantum systems Quantum Communication: no-go theorems, quantum teleportation, quantum dense coding, and other quantum communication protocols without security. Quantum Cryptography: essentials of classical cryptography, quantum protocols with security like, BB84, B92, Ekert, etc. Quantum Computation: Quantum gates, quantum algorithms, D-wave quantum computer. Status update for experimental realization on some of these protocols.				
viii	**Texts/References (separate sheet may be used, if necessary)**	1. Quantum Computation and Quantum Information, M. A. Nielsen & I. L. Chuang, 10th Edition, Cambridge University Press, NY, USA (2011). 2. Quantum Information Theory, M. M. Wilde, Cambridge University Press, 2nd edition, 2017. 3. An introduction to Quantum Computing, P. Kaye, R. Laflamme and M. Mosca, Oxford University Press, (2010). 4. Preskill's lecture notes on Quantum Informationand Quantum Computation, http://www.theory.caltech.edu/people/preskill/ph229/ 5. Principles of Quantum Computation and Information (Vol.-1), G. Benenti, G. Casati, and G. Strini, World Scientific, 2004. 6. Classical and Quantum Computation, A. Yu. Kitaev, A. H. Shen, and M. N.				

		Vyalyi, Americal Mathematical Society, 2002 7. Quantum Computation and Quantum Communication-Theory and Experiments, M. Pavicic, Springer, 2006. 8. Quantum Computer Science, N. D. Mermin, Cambridge, 2007. 9. Lectures on Quantum Information, Edited by D. Bruss and G. Leuchs, Wiley-VCH Verlag, 2007.
ix	**Name(s) of Instructor(s)**	Dr. R. Prabhu, Department of Physics
x	**Name(s) of other Departments/ Academic Units to whom the course is relevant**	Elective for all engineering branches.
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.
viii	**Justification/ Need for introducing the course**	The course introduces to the important topics which has intrigued the scientists and engineers working in quantum domain. It deals with introduction to most commonly heard topics like qubits, quantum entanglement, quantum communication, quantum algorithms, etc, which are essential for understand cutting edge research activities involved in free space communications with security or quantum computers, where quantum systems play a pivotal role.