ELECTRICAL ENGINEERING (2017 BATCH) SEMESTER VII					
Course Code	**Course Name**	**Course Structure**			
		L	**T**	**P**	**C**
	Elective II	3	0	0	6
	Elective III	3	0	0	6
	Elective IV / Project				6
				Total Credits	

List of the departmental electives for EE-VII Sem			
Sl.No.	**Course Name**	**Instructor**	**Exposure to**
1	**Power system dynamics and controls**	**Prof. Pratyasa Bhui**	**Power System, Electrical Machines**
2	**Advanced Power Electronics and drives**	**Prof. Satish Naik**	**Circuits, semiconductor devices and Electric Machines &power electronics**
4	**VLSI Design**	**Prof. Naveen K**	**Electronic Devices, Analog Electronics**

Outside department courses for Electrical Engineering branch would be as follows

Sl.No.	Course Name	Instructor	Exposure to
1	Quantum field theory	Prof. B.L. Tembe	Quantum Physics and Applications
2	Astrophysics for Engineers	Prof. D. Narasimha	Electricity & Magnetism, Calculus, Linear Algebra and Differential Equation
3	*Introduction to Literature (HSS elective)	Prof. Ridhima Tewari	Nil
4	*Philosophy (HSS elective)	Prof. Jolly Thomas	Nil
5	Stochastic processes	Prof. Tejas Bodas	Basic Calculus
6	Intellectual property management (HSS elective)	Prof. R. R. Hirwani	Nil
7	Pattern recognition and machine learning **	Prof. Mahadeva Prasanna	Calculus
8	Mathematics for data science	Prof. Bharath B.N	Basic concepts in calculus and linear algebra
9	Biomedical Imaging and instrumentation	Prof. Sudhanshu Shukla, Prof. Surya Pratap Singh, Prof. Neelkamal Mahanta	Biology
10	Numerical linear Algebra	Prof. Amlan Barua	Calculus and linear algebra
11	Introduction to number theory	Prof. N.S. Narasimha Sastry	Nil
12	Software engineering	Prof. Nikhil Hegde	Data structures and algorithms, Programming in C,C++ and Java.
13	Distributed Systems	Prof. Kedar K	Operating Systems, Data Structures and Algorithms, Programming in C++
14	Logic of computer science	Prof. Ramchandra Phawade	Discrete mathematics, theory of computation
15	Advanced topics in embedded computing	Prof. Gayathri	Computer architecture and operating systems
16	Advanced computer networks	Prof. Siba Narayan	Computer networks, reasonably good programming background
17	Finite Element Analysis	Prof. P. Seshu	Engineering Mechanics, Mechanics of Materials
18	Vibrations of Linear Systems	Prof. Shrikanth V	Mechanics of Materials
19	Additive Manufacturing	Prof. Somashekara M. A	Manufacturing process, Engineering Mechanics
20	Solar Energy Collector Systems	Prof. Dhiraj V Patil	Fluid mechanics, thermodynamics and heat transfer
21	Fluid flow and heat transfer in porous media	Prof. S.V.Prabhu	Fluid mechanics, thermodynamics and heat transfer

***this course should not have been taken earlier .**

****- Pattern Recognition and Machine learning is a 9 credit course (6 credits for theory and 3 credits for laboratory).**

Syllabus for all department & outside department electives for EE VII Sem

Name of Academic Unit : Chemistry

Level : B.Tech

Programme : B.Tech.

i	**Title** of the course	**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 Departments/ Academic Units to whom** the course is **relevant**	B.Tech. students of all departments
xi	Is/Are there any course(s) in the same/ other academic unit(s) which is/ are **equivalent** to this course? If so, please give details.	No
xii	**Justification/ Need** for introducing the course	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.

Name of Academic Unit : Physics

Level : B.Tech

Programme : B.Tech.

i	**Title of the course**	**Astrophysics for Engineers**
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**	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, (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 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 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**	1. The New Cosmos (A. Unsold, B. Baschek) 2. An Introduction to Modern Astrophysics (B.W. Carroll, D.A. Ostlie) 3. Elements of Cosmology (J.V. Narlikar)
ix	**Name(s) of Instructor(s)**	DN
x	**Name(s) of other Departments/ Academic Units to whom the course is relevant**	All
xi	**Is/Are there any course(s) in the same/ other academic unit(s) which is/ are equivalent to this course? If so, please give details.**	Nil
xii	**Justification/ Need for introducing the course**	Astrophysics and Cosmology have a few fundamental unsolved problems. This course is an attempt to convey to the students that there are upcoming powerful astronomical facilities capable of solving some of them. But both at hardware and software level, it is Technology that drives what observations are feasible. India is one of the main contributors for development of some of the technologies.

Name of Academic Unit: HSS

Level: B.Tech.

Programme: B.Tech.

i	**Title of the course**	**HS 303 Introduction to Literature**
ii	**Credit Structure (L-T-P-C)**	(3-1-0-6)
iii	**Type of Course**	Core course
iv	**Semester in which normally to be offered**	Autumn
v	**Whether Full or Half Semester Course**	Full
vi	**Pre-requisite(s), if any (For the students)** **– *specify course number(s)***	--
vii	**Course Content**	What is Literature, Genres of Literature, Literary Texts and Co Major Themes in Literature
viii	**Texts/ References**	*Glossary of Literary Terms* by MH Abrams, *The Norton Antho of Poetry* edited by Margaret Ferguson, *Animal Farm* by Geor Orwell, *The Penguin Book of Modern Indian Short Stories*- Stephen Alter, *Oxford Book of English Short Stories Reissue* Edition (English, Paperback, A. S. BYATT), *Three Theban Pl Antigone; Oedipus the King; Oedipus at Colonus* (English, Paperback, Sophocles)
ix	**Name(s) of Instructor(s)**	Prof. Ridhima Tewari
xii	**Justification/ Need for introducing the course**	The course is aimed at introducing students to literature- its rea appreciation, and its relation to contemporary world, knowledge systems and contexts.

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**	1. What is Philosophy? (Philosophy in India and West) 2. Main Branches of Philosophy 3. Three Laws of Thought 4. Epistemology and Logic (Indian and Western) 5. Metaphysics (Universal and Particular, Substance and Attributes, Causality, Space, Time, Soul, God, Freedom) 6. Three Great Greek Philosophers: Socrates, Plato and Aristotle 7. Modern Philosophy: Rationalism and Empiricism (Descartes, Locke, Berkeley and Hume) 8. Ethics (Utilitarianism, Categorical Imperative of Kant, Ethical Relativism, Bio-Medical Ethics, Ethical Issues) 9. Indian Philosophy Component (Nishkama-karma of Gita, Virtue Ethics of Buddhism, Advaita Vedanta). 10. Meaning of Life.
viii	**Texts/References**	1. Ganeri, Jonardon, *Philosophy in Classical India: An Introduction and Analysis* (London: Routledge, 2001). 2. Maritain, Jacques, *An Introduction of Philosophy* (New York and Oxford: Rowman & Littlefield, 2005). 3. Mohanty, J. N. *Classical Indian Philosophy: An Introductory Text* (New York and Oxford: Rowman & Littlefield, 2000). 4. Nagel, Thomas, *What Does It All Mean? A Short Introduction to Philosophy* (Oxford: Oxford University Press, 2004). 5. Russel, Bertrand, *The Problems of Philosophy* (Oxford: Oxford University Press, Reprint by Kalpaz Publication, 2017). 6. Sharma, Chandradhar, *A Critical Survey of Indian Philosophy* (Delhi: Motilal Banarsidass, 2016).

		7. Thilly, Frank, *A History of Philosophy* (New Delhi: SBW Publishers, 2018). 8. 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 course is relevant**	All
xi	**Is/Are there any course(s) in the same/ other academic unit(s) which is/ are equivalent to this course? If so, please give details.**	No
xii	**Justification/ Need for introducing the course**	HS 301 is a unique course that aims to provide the BTech 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 and act ethically in their profession with relation to the societal expectations of their fellow humans in India.

Academic Unit: Electrical
Engineering Level: UG

Programme: B.Tech.

i	**Title** of the course	**Stochastic Process**
ii	Credit Structure (**L-T-P-C**)	**(3 0 0 6)**
iii	**Type** of Course	Elective
iv	Semester in which normally to be offered	Fifth
v	Whether **Full or Half Semester** Course	Full
vi	**Pre-requisite(s)**, if any (For the students) – *specify course number(s)*	Basic calculus
vii	Course **Content***	**Background**: Review of probability theory, random variables, limit theorems, and basics of random processes. **Application problems**: Statistical signal processing, random graphs and percolation, hypothesis testing. **Poisson Processes:** Definition and properties of Poisson process, Combining and splitting of Poisson Process, and non-homogenous Poisson Process, Introduction to Poisson Point Process. **Gaussian Process:** Gaussian random vectors and its properties, Conditional PDFs for Gaussian random vectors, Stationarity, Orthonormal expansion, Filtering, and introduction to Circular symmetric Gaussian random variables. **Markov Chain:** Communication classes and its properties, stationary distribution and its existence, Poisson processes, Example applications of Markov decision process. **Advanced Random Process:** KL expansion, introduction to special random process such as Martingale and Brownian motion.

Viii	Texts/References	*1.* **Robert B. Ash**, ``Basic Probability Theory," *Reprint of the John Wiley & Sons, Inc., New York, 1970 edition.* *2.* ***Sheldon Ross***, *``A first course in probability," Pearson Education India, 2002.* *3.* ***Bruce Hayek***, *``An Exploration of Random Processes for Engineers,"* Lecture notes *4.* **Robert G. Gallager**, "Stochastic Processes: Theory For Applications," Cambridge university Press 2013.
ix	Name(s) of **Instructor(s)** ***	Prof.Tejas Bodas
x	Name(s) of **other Departments/ Academic Units to whom** the course is **relevant**	Computer science, physics and mathematics.
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 builds on an elementary course titled "Introduction to Probability." The course deals with analysis and applications of stochastic process. This course caters to several applications such as statistical signal processing, communications, and machine learning.

Name of Academic Unit: Humanities and Social Sciences
Level: UG

Programme: B. Tech.

i	**Title of the course**	**HS 305 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 Industrialised 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 fertilisation of ideas, generation of alternate solutions, technology monitoring, and competitive intelligence. It is felt necessary to sensitise the students to current IP regime and prepare them for the career in technology ventures.

Academic Unit: Electrical
Engineering Level: UG

Programme: BTech

i	**Title of the course**	**Machine Learning and Pattern Recognition**
ii	**Credit Structure (L-T-P-C)**	3 0 0 6 (Theory) 0 0 3 3 (Laboratory)
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 Calculus or equivalent.
vii	**Course Content**	**Recap** (a) Probability Theory, Linear Algebra, Convex Optimization **Introduction to statistical decision theory** (a) Hypothesis testing (b) Regression, Classification, Bias Variance trade-off **Regression and PCA** (a) Linear Regression, Multivariate Regression, (b) Subset Selection, Shrinkage Methods, (c) Principal Component Regression, Partial Least squares (d) Linear Classification, Logistic Regression, Linear Discriminant Analysis **Neural Networks** (a) Models of Neural Networks, Learning laws, Perceptron (b) Neural Networks - Introduction, Early Models, Perceptron Learning, activation and synaptic dynamics, feed- forward neural network etc. (c) Backpropagation, Initialization, Training and Validation, Parameter Estimation - MLE, MAP, Bayesian Estimation **Graphical Models**

		(a) Undirected Graphical Models, HMM, Variable Elimination, Belief Propagation (b) Bootstrapping and Cross Validation, Class Evaluation Measures, ROC curve, MDL (c) Gaussian Mixture Models, Expectation Maximization **Clustering** (a) Partitional Clustering, Hierarchical Clustering, Birch Algorithm CURE Algorithm, Density-based Clustering
viii	**Texts/References**	1. Trevor Hastie, Robert Tibshirani, Jerome H. Friedman "The Elements of Statistical Learning," Springer text in statistics. 2. C. Bishop, "Pattern Recognition and Machine Learning," Springer text in information science and statistics. 3. B. Yegnanarayana, "Artificial Neural Networks," Prentice Hall Publications, 2005.
ix	**Name(s) of Instructor(s)**	S. R. M. Prasanna **(Flip mode)**
x	**Name(s) of other Departments/ Academic Units to whom the course is relevant**	EE, CSE, 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

Academic Unit: Electrical Engineering
Level: UG
Programme: BTech

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

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

i	**Title of the course**	**Biomedical Imaging and Instrumentation**
ii	**Credit Structure (L-T-P-C)**	3-0-0-6
iii	**Type of Course**	Elective
iv	**Semester in which normally to be offered**	Fall
v	**Whether Full or Half Semester Course**	Full
vi	**Pre-requisite(s), if any (For the students) – *specify course number(s)***	BB102, EE102
vii	**Course Content**	Module 1: Human Physiology Module 2: Medical Imaging and Instrumentation(ECG, CT etc) Module 3: Basics of microscopy Module 4: Nuclear Magnetic Resonance spectroscopy (NMR) and magnetic resonance imaging (MRI) Module 5: Mass Spectrometry and applications Module 6: Fluorescence spectroscopyand applications Module 7: Infrared spectroscopyand applications Module 8: Raman spectroscopyand applications
viii	**Texts/References**	1. Laser fundamentals, William. T Silfvast, 2004 2. Photonics, Volume 4: Biomedical spectroscopy, photonics and microscopy, David L Andrews,2015 3. Biophotonics: vibrational spectroscopic diagnostics, Mathew baker, Caryn Hughes, Katherine A Hollywood,2016 4.Fundamentals of Medical imaging, Suetens P, 2017 5.D. Pavia "Introduction to spectroscopy" Cengage Learning India Private Ltd., 5th Ed., 2015. 6.R. Silverstein, F. Webster, D. Kiemle, and D. Bryce "Spectrometric identification of organic compounds", 8th Ed., Wiley, 2015. 7.C. Banwell and E. McCash "Fundamentals of molecular spectroscopy" 4th Ed., McGraw Hill Education, 2017. 8.J. Keeler "Understanding NMR spectroscopy" 2nd Ed., Wiley, 2011 9.J.K. Hall: Guyton and Hall Medical Physiology. Second South Asia Edition 2019, Elsevier
ix	**Name(s) of Instructor(s)**	Surya Pratap Singh, Nilkamal Mahanta, Sudhanshu Shukla
x	**Name(s) of other Departments/ Academic Units to whom the course is relevant**	Chemistry, Physics, Electrical Engineering
xi	**Is/Are there any course(s) in the same/ other academic unit(s) which is/ are equivalent to this course? If so, please give details.**	No
xii	**Justification/ Need for introducing the course**	The primary aim of this course is to introduce the field of medical imaging and instrumentation to the participants. The basic theory, instrumentation and working principles of routinely employed techniques in biomedical and chemistry research will be discussed. Participants will be introduced initially to human physiology followed by a detailed orientation todifferent imaging approaches with a special focus on disease diagnosis and monitoring and instrumentation engineering applications.

Academic Unit: Mathematics
Level: UG
Programme: BTech

i	**Title of the course**	**Numerical Linear Algebra**
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 Calculus, Linear Algebra
vii	**Course Content**	Vector and Matrix Norms, Gram Schmidt Orthogonalization, Singular Value Decomposition, QR factorization, Householder Triangularization. Floating point number system, Condition number and Stability, Stability of Back substitution, Gauss Elimination and Householder methods Numerical techniques for finding eigenvalues, Rayleigh Quotient, QR methods, Divide and Conquer strategies Krylov subspace techniques, GMRES and Conjugate Gradient (c) Backpropagation, Initialization, Training and Validation, Parameter Estimation - MLE, MAP
viii	**Texts/References**	1. Lloyd N. Trefethen and David Bau, Numerical Linear Algebra, SIAM, US, 1997 2. Gene Golub and Charles Van Loan, Matrix Computations, 4th Edition, John Hopkins University Press, US, 2013 3. Iterative Methods for Sparse Linear Systems, Yousef Saad, 2Tl d Edition, SIAM, US, 2003
ix	**Name(s) of Instructor(s)**	Amlan K. Barua
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 course will enable a student to gain advanced knowledge on the numerical perspectives of linear algebra. The potential applications can be in large scale computations in engineering

Name of Academic
Unit: Mathematics
Level: UG

Programme : B.Tech.

i	**Title of the course**	**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 be offered**	
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: 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 the Academic Unit: Computer Science & Engineering
Level: B.Tech.
Programme: B.Tech

i	**Title of the course**	**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.

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

i	**Title of the course**	**CS 4xx Logic for Computer Science**
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**	Autumn
v	**Whether Full or Half Semester Course**	Full
vi	**Pre-requisite(s), if any (For the students) – *specify course number(s)***	Discrete Mathematics, Theory of computation.
vii	**Course Content***	Module 1 :Propositional Logic: Syntax, Semantics, Normal Forms, Boolean Functions. Module 2: Computational complexity of Satisfiability P vs NP, SAT: hardest among NP. Module 3: Syntactic SAT solvers : Resolution, Tableaux. Module 4:proof Systems: Semantic entailment, Compactness, Soundess Completeness, Natural Deduction, Gentzen Sequent Calculus, Hilbert System. Module 5: Predicate Logic. Randomized SAT solvers. Programming assignments: using SAT/SMT solver z3.
Viii	**Texts/References**	(1) Logic in Computer Science, Michael Huth and Mark Ryan, Cambridge University Press. (2) SAT/SMT by example, Dennis Yurichev.
ix	**Name(s) of Instructor(s) *** **	Ramchandra Phawade
x	**Name(s) of other Departments/ Academic Unitsto whom the course is relevant**	Nil
xi	**Is/Are there any course(s) in the same/ other academic unit(s) which is/ are equivalent to this course? If so, please give details.**	No
xii	**Justification/ Need for introducing the course**	This course introduces notions and methods of formal logic from a computer science standpoint, covering propositional logic, predicate logic and foundations of SAT solvers. It presents applications and themes of computer science research such as resolution and automated deduction.

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

i	**Title of the course**	**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 (including Real Time), Memory Management, Optimizations (Data level and Memory level), Embedded Systems Security, Introduction to Embedded GPUs and Accelerators, Embedded Heterogenous Programming with Open CL Application Case Study on Embedded Platforms – eg. Neural Network inferencing on Embedded Platforms, Advanced Driver Assistance Systems
viii	**Texts/References**	1. Building Embedded Linux Systems, 2nd Edition by Gilad Ben-Yossef, Jon Masters, Karim Yaghmour, Philippe Gerum, O'Reilly Media, Inc. 2008 2. Linux Device Drivers, Third Edition By Jonathan Corbet, Alessandro Rubini, Greg Kroah-Hartman, O'Reilly Media, Inc. 2005 3. Embedded Systems: ARM Programming and Optimization by Jason D Bakos, Elsevier, 2015 4. Learning Computer Architecture with Raspberry Pi by Eben Upton, Jeff Duntemann, Ralph Roberts, Tim Mamtora, Ben Everard, Wiley Publications, 2016 5. Real Time Systems by Jane S. Liu, 1 edition, Prentice Hall; 2000 6. 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

xii	**Justification/ Need for introducing the course**	The use of embedded computing systems has prolifereated in our lives starting from consumer devices, such as smartphones and game consoles, to less visible electronic devices that control, for instance, different aspects of a car's operation. Typical embedded applications are targeted to run in heavily constrained environements. The aim of this course is to develop interdisciplinary skills such that the students can understand the limitations of the underlying hardware and accompanying runtime support and also teach them how to develop solutions able to meet stringent nonfunctional requirements, such as performance in current and emerging embedded computing systems.

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

i	**Title** of the course	**Advanced Computer Networks**
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	Autumn
v	Whether **Full or Half Semester** Course	Full
vi	**Prerequisite(s)**, if any (For the students) – *specify course number(s)*	Undergraduate Computer Networks course, Good Programming Background.
vii	Course **Content***	1. Circuit, Packet and Virtual Circuit Switching, MPLS 2. Switch Architectures, Buffering Strategies, Input and Output Queuing, IP Buffer Sizing 3. Quality of Service and Scheduling Algorithms 4. IP Address Lookup and IP Packet Classification algorithms 5. Software Defined Networking 6. Next Generation Network Architectures, Network Provisioning and Design, and "Green" (Energy-Efficient) Networking 7. Data Driven Networking
Viii	Texts/References	*Textbook:* *(1) Computer Networks: A Systems Approach, Larry Peterson and Bruce Davie, 2011.* *(2) Performance Evaluation of Computer Systems, by Raj Jain, Wiley, 1991.* *(3) Computer Networking, Kurose and Ross, Addison-Wesley, 2012.*

		Reference: *(1) An Engineering Approach to Computer Networking by S. Keshav, 1997, Addison-Wesley Professional Series.* *(2) Network Routing, by Deepankar Medhi and Karthikeyan Ramasamy, Morgan Kaufmann, 2007.* *(3) SDN: Software Defined Networks, by Thomas D. Nadeau, Ken Gray, O'Reilly Media, 2013.* *(4) High Performance Switches and Routers, By H.Jonathan Chao and Bin Liu, Wiley, 2007.* *(5) Network Algorithmics, by George Varghese, Morgan Kaufmann, 2005.*
x	Name(s) of **Instructor(s)** ***	Siba Narayan Swain
x	Name(s) of **other Departments/ Academic Units to whom** the course is **relevant**	Nil
xi	Is/Are there any course(s) in the same/ other academic unit(s) which is/ are **equivalent** to this course? If so, please give details.	No
xii	**Justification/ Need** for introducing the course	The objective of this course is to cover theoretical topics in the areas of advanced networking protocols and related mechanisms/algorithms. In particular, we will study the internal components and mechanisms of a network router/switch. Further, we will also look into several advanced topics in networks pertaining to Software Defined Networking (SDN), Network Function Virtualization (NFV), and Data Driven Networking. The course also requires students to implement programming assignments related to the above topics.

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
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

Name of Academic: : Electrical Engineering

Programme: B.Tech.

Level: / MS(R) / PhD

i	**Title of the course**	**Advanced Power Electronics**
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)**	Circuits, semiconductor devices and Electric Machines &power electronics
vii	**Course Content**	Basics of semiconductor devices, gate drives for BJT, MOSFET and IGBT, heat sink selection, snubber circuits, non-isolated converters like buck, boost and buck-boost converters, isolated converters like forward, push pull, half bridge, full bridge and fly back, design of magnetics for inductors and transformers, inverters, PWM generation - SPWM, space vector PWM, dq axis theory for 2 and 3 phase applications. Introduction to electric drives, and speed control of electric machines. Design examples like, EV Battery chargers, and grid connected PV inverter.
viii	**Texts/References**	1. L. Umanand, Power electronics and applications, Wiley India Pvt. Limited, 2009. 2. Chryssis, G.C., High frequency switching power supplies, Second Edn, McGraw Hill, 1989. 3. R. W. Erickson, Dragan Maksimovic, Fundamentals of Power Electronics, Springer, 2001. 4. N.Mohan, Power Electronics: Converter, Applications & Design, John Wiley & Sons, 1989. 5. Ranganathan V T, Electric Drives, Course Notes, IISc, 2005-06. 6. Leonhard W., Control of Electrical Drives, 3rd Edition, Springer.
ix	**Name(s) of Instructor(s)**	Prof. Abhijith
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.**	None
xii	**Justification/ Need for introducing the course**	This is an elective course for Power Systems Spine

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

i	Title of the course	**VLSI Design**
ii	Credit Structure (L-T-P-C)	(3 0 0 6)
iii	Type of Course	Elective
iv	Semester in which normally to be offered	Autumn
v	Whether Full or Half Semester Course	Full
vi	Pre-requisite(s), if any (For the students) – *specify course number(s)*	Digital systems
vii	Course Content*	Review of MOS transistor models, Technology scaling, CMOS logic families including static, dynamic and dual rail logic. Integrated circuit layout; design rules, parasitics. low power design, high performance design, logical effort, Interconnect aware design, clocking techniques. VLSI design: data and control path design, floor planning, Design Technology: introduction to hardware description languages(VHDL), logic, circuit and layout verification.
Viii	Texts/References	1. *N. Weste and D. M. Harris, "CMOS VLSI Design, A circuits and systems perspective" Pearson, 2010* 2. *S. Kang and Y. Leblebici, "CMOS Digital Integrated circuits", Tata McGraw Hill edition, 2003* 3. *Jan M. Rabaey, A. Chandrakasan and B. Nikolic, "Digital Integrated circuits" Pearson , 2016*
ix	Name(s) of Instructor(s) ***	NK
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	Digital integrated circuits have revolutionized computers and the way we control and design electronic systems. This is a advanced course on CMOS digital integrated circuits, which gives exposure to high performance VLSI design in CMOS technologies.

Academic Unit: Mechanical Engineering

Level: UG
Programme: B. Tech

i	**Title of the course**	**Finite Element Analysis**
ii	**Credit Structure (L-T-P-C)**	(3-0-0-6)
iii	**Type of course**	Elective
iv	**Semester in which normally to be offered**	Odd/Even
v	**Whether Full or Half Semester Course**	Full
vi	**Pre-requisite(s), if any (For the students) – specify course number(s)**	Mechanics of Materials
vii	**Course content**	• Approximate solution of differential equations -- Weighted residual techniques. Collocation, Least Squares and Galerkin methods. Piecewise approximations. Basis of Finite Element Method. Formulation of the matrix method -- "stiffness matrix"; transformation and assembly concepts. Example problems in one dimensional structural analysis, heat transfer and fluid flow. Elements of Variational calculus. Minimisation of a functional. Principle of minimum total potential. Piecewise Rayleigh - Ritz method and FEM. Comparison with weighted residual method. • Two dimensional finite element formulation. Isoparametry and numerical integration. Algorithms for solution of equations. Convergence criteria, patch test and errors in finite element analysis. • Finite element formulation of dynamics. Applications to free vibration problems. Lumped • and consistent mass matrices. Algorithms for solution of eigenvalue problems
viii	**Texts/References**	1. Bathe, K. J., Finite element procedures in Engineering Analysis, Prentice Hall of India, 1990. 2. Cook, R.D., D. S. Malkus and M. E. Plesha, Concepts and Applications ofFinite element analysis, John Wiley, 1989. 3. Reddy, J. N., An Introduction to the Finite Element Method, 2nd ed., McGraw Hill, 1993. 4. Seshu, P. Finite Element Method, Prentice Hall of India, New Delhi, 2003. 5. Zienkiewicz, O. C., and K. Morgan, Finite elements and approximation, John Wiley, 1983. 6. Zienkiewicz, O. C., and R. L. Taylor, The finite element method, vol.1&2, Tata McGraw Hill
ix	**Name(s) of the Instructor(s)**	Prof. Amar Gaonkar
x	**Name(s) of other Departments/ Academic**	NA

	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**	FEM is a numerical method to solve PDEs. The course introduces the basic concepts and principles involved in FE formulation of PDEs. Applications to domains spanning structural mechanics , fluid mechanics and heat transfer are taken to illustrate the concepts

Academic Unit: Mechanical Engineering
Level: UG
Programme: B. Tech

i	**Title of the course**	**Vibrations of Linear 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)**	--
vii	**Course content**	• **Concepts of Vibrations:** Harmonic motion and definitions and terminology, Harmonic analysis, Fourier series expansion, Importance of vibration, Basic concepts of vibration, Classification of Vibration, Vibration analysis procedure. • Characteristics of Discrete System Components, Equivalent Springs, Dampers and Masses, Modeling of Mechanical Systems, System Differential Equations of Motion, Nature of Excitations, System and Response Characteristics – Superposition Principle, Vibration about Equilibrium Point. • **One DOF systems:** Free Vibrations – Undamped and damped vibrations, Harmonic Oscillator, Types of damping, Viscously Damped Single DOF Systems, Measurement of Damping, Coulomb Damping – Dry Friction. • Forced Vibrations – Response of Single DOF System to Harmonic Excitations, Frequency Response Plots, Systems with Rotating Unbalanced Masses, Whirling of Rotating Shafts, Harmonic Motion of the Base, Vibration Isolation, Vibration Measuring Instruments – Accelerometers, Seismometers, Energy Dissipation, Structural Damping, Response to Periodic Excitations, Fourier Series. • Response of Single DOF systems to Nonperiodic Excitations, The Unit Impulse - Impulse Response, The Unit Step Function - Step Response, The Unit Ramp Function - Ramp Response, Response to Arbitrary Excitations - The Convolution Integral, Shock Spectrum, System Response by the Laplace Transformation Method -Transfer Function, General System Response. • **Two DOF Systems:** System Configuration, Equations of Motion-2 DOF Systems, Free Vibration of Undamped Systems, Natural Modes, Response to Initial Excitations, Coordinate Transformations – Coupling, Orthogonality of 3 Modes - Natural Coordinates, Beat Phenomenon, Response of Two-Degree-of-Freedom Systems to Harmonic Excitations, Undamped Vibration Absorbers.

		• **Vibrations of Continuous Systems:** Vibrating String, Longitudinal vibrations of Bar, Torsional vibrations of Rod. Lateral vibrations of Beam.
viii	**Texts/References**	TEXTBOOKS 1. S S Rao, Mechanical Vibrations, Pearson Education, 5th Edition, 2004. REFERENCES 1. W T Thomson, M D Dahleh and C Padmanabha, Theory of Vibration with applications, Pearson Education, 2008. 2. Leonard Meirovitch, Fundamentals of Vibrations, 3. McGraw-Hill, 2000. 4. Den Hartog, Mechanical Vibrations, Dover Publications.
ix	**Name(s) of the Instructor(s)**	Shrikanth V.
x	**Name(s) of other Departments/ Academic Units to whom the course is relevant**	Electrical Engineering
xi	**Is/Are there any course(s) in the same/ other academic unit(s) which is/ are equivalent to this course? If so, please give details.**	No
xii	**Justification/ Need for introducing the course**	This course deals with the study of vibration in mechanical systems which is concerned with the oscillatory motions of bodies and the forces associated with them. This course aims to provide you with an understanding of the nature and behaviour of dynamic engineering systems and the capability of applying the knowledge of mathematics, science, and engineering to solve engineering vibration problems.

Academic Unit: Mechanical Engineering
Level: UG
Programme: B. Tech

i	**Title of the course**	**Additive Manufacturing**
ii	**Credit Structure (L-T-P-C)**	(3-0-0-6)
iii	**Type of course**	Elective
iv	**Semester in which normally to be offered**	Odd
v	**Whether Full or Half Semester Course**	Full
vi	**Pre-requisite(s), if any (For the students) – specify course number(s)**	--
vii	**Course content**	**Module 1:** General overview, Introduction to 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) (5 hr) **Module 2:** Software & Methods, Solid moduling, Designing for Additive Manufacturing (DfAM), • Software Tools vs. Requirements, Pre- & Post-processing 3D Scanning & the Scanning Process, • Sculpting & Repairing Data, AM File Formats, STEP File Format, More Detail on NURBS Model • Validation, Working with DICOM Files for 3D Printing Medical Imagery, Data formats, conversion, • checking, repairing and transmission. Synergic integration technologies Part slicing and Build • Orientation, Area-filling strategies, applications and limitations of AM. (7 hr) **Module 3:** 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 (7 hr). **Module 4:** Materials science for AM, discussion on different materials used in AM, use of multiple • materials, multifunctional and graded materials in AM, role of solidification rate, Biomaterials, • Heirarchical Materials & Biomimetics, Ceramics & Bio-ceramics, Shape-Memory Materials, 4D • Printing & Bio-active materials (7 hr). **Module 5:** Key Related Processes, Process selection, decision methods planning, control for AM,

		• Monitoring and control of defects, and selection of Additive Manufacturing processes, tooling and • manufacturing systems based on product requirements (7 hr). **Module 6:** Applications of AM, Direct Digital Manufacturing, Distributed Manufacturing, Mass • Customization Biomedical Applications, Aerospace & Automotive Applications, Architectural • Engineering Food & Consumer Applications, Personalized Surgery Art, Fashion, Jewelry, Toys & • Other Applications (7 hr)
viii	**Texts/References**	1. Gibson, D. W. Rosen, and B. Stucker, Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing. Evener, 2014 2. C. K. Chua and K. F. Leong, Rapid Prototyping: Principles and Applications in Manufacturing. World Scientific, 2003. 3. Lu, L., Fuh, J., Wong, YS., 2001, Laser Induced Materials and Processes for Rapid Prototyping, Kluwer. 4. Pique, A., Chrisey, DB., 2002, Direct Write Technologies for Rapid Prototyping Applications: Sensors, Electronics and Integrated Power Sources, Academic Press. 5. Venuvinod, PK., Ma, W., 2004, Rapid Prototyping - Laser Based and Other Technologies, Kluwer
ix	**Name(s) of the Instructor(s)**	Somashekara M A
x	**Name(s) of other Departments/ Academic Units to whom the course is relevant**	--
xi	**Is/Are there any course(s) in the same/ other academic unit(s) which is/ are equivalent to this course? If so, please give details.**	NA
xii	**Justification/ Need for introducing the course**	Additive Manufacturing (AM) processes has shown extreme flexibility in design, optimization and fabrications. Usage of AM

Academic Unit: Mechanical Engineering
Level: UG
Programme: B. Tech

i	**Title of the course**	**Solar Energy Collector 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**	Odd/Even
v	**Whether Full or Half Semester Course**	Full
vi	**Pre-requisite(s), if any (For the students) – specify course number(s)**	--
vii	**Course content**	**Recap of solar energy:** Solar angles, Declination of Sun, Solar Tracking, Sun path diagram, Solar radition (4 hrs) **Solar thermal-energy collectors:** Basic construction and design aspects of flat-plate collector, stationary compound parabolic collector, evacuated tube collector, Sun-tracking concentrating collectors: Parabolic trough collector, Linear Fresnel reflector, Parabolic dish reflector, Heliostat field collector: Solar thermal-electric power. (6 hrs) **Thermal analysis of solar collectors:** Thermal analysis of flat-plate collectors including air- collectors, Thermal analysis of compound parabolic collectors, Thermal analysis of parabolic trough collectors, Collector thermal efficiency, Collector incidence angle modifier, acceptance angle of concentrating collectors, Uncertainty quantification in solar collector testing. (8 hrs) **Solar water-heating (SWH) systems:** Passive systems as thermosiphon, integrated collector storage, Active systems as direct circulation, indirect water-heating, air-water-heating, and Pool heating, Heat storage as sensible or latent hear, Solar ponds, Applications of SWHs, Module and array design of SWH systems. (8 hrs) **Solar air-heating (SAH) systems:** Active, hybrid or passive, With or without storage, With or without fins, Single/double pass, performance enhancement techniques for SAHs, intergartion of thermal-storage unit with SAHs, Applications of SAHs, Solar sterling engine. (8 hrs) **Photovoltaic (PV) systems:** Photovoltaic effect, PV cell characteristics, Module and array design of PV systems, PV technology and materials, PV module equipment, Applications of PVs, Design and sizing of PVs, Hybrid PV/T systems. (8 hrs)
viii	**Texts/References**	**Textbooks:** 1. S.A. Kalogirou, Solar Energy Engineering: Processes and Systems, Elsevier; 2nd Ed., 2014. 2. S.P. Sukhatme, J.K. Nayak, Solar Energy: Principles of Thermal Collection and Storage, Tata McGraw-Hill Education, 3rd Ed.,1996. **References:** 1. V. Sivaram, Taming the Sun – Innovations to Harness Solar Energy and Power the

		Planet, 1st Ed., MIT Press, 2018. 2. JA. Duffie, WA. Beckman, Solar Engineering of Thermal Processes, Wiley, 4th Edition, 2013.
ix	**Name(s) of the Instructor(s)**	Dhiraj V Patil
x	**Name(s) of other Departments/ Academic Units to whom the course is relevant**	Electrical Engineering
xi	**Is/Are there any course(s) in the same/ other academic unit(s) which is/ are equivalent to this course? If so, please give details.**	No
xii	**Justification/ Need for introducing the course**	The origin and continuation of humankind is based on solar energy. This course introduces basics of solar energy harvesting, thermal-analysis of various collectors. Next, the course introduces the design and performance aspects of solar water-heating, air-heating systems and photovoltaic modules. The course is essential for the current technologist foreseeing the future use of green, renewable and sustainable energy.

Academic Unit: Mechanical Engineering
Level: UG
Programme: B. Tech

i	**Title of the course**	**Fluid Flow and Heat Transfer in Porous Media**
ii	**Credit Structure (L-T-P-C)**	(3-0-0-6)
iii	**Type of course**	Elective
iv	**Semester in which normally to be offered**	Odd/Even
v	**Whether Full or Half Semester Course**	Full
vi	**Pre-requisite(s), if any (For the students) – specify course number(s)**	Exposure to fluid mechanics and heat transfer
vii	**Course content**	**Module 1:** Mechanics of Fluid flow through Porous Medium: porosity, volume averaging procedure, Equation of continuity, momentum equation (Darcy's Law, Forchheimer equation, Brinkman equation), Turbulence in porous media. (10 hr) **Module 2:** Heat Conduction in Porous Medium: Local thermal equilibrium, effective stagnant thermal conductivity, thermal dispersion, local thermal non-equilibrium, interfacial heat transfer coefficient (8 hr) **Module 3:** Forced Convection through Porous Medium: external flow, internal flows and jet impinging flows (9 hr) **Module 4:** Natural Convection through Porous Medium: external flows (9 hr) **Module 5:** Radiation heat transfer through Porous Medium: Radiation transport equation, energy equation with radiation (6 hr)
viii	**Texts/References**	1. Donald A Nield and Adrian Bejan, Convection in Porous Medium, Springer publications, Newyork, 2017, Fifth Edition. 2. M. Kaviany, Principles of Heat Transfer in Porous Media, Springer publications, Newyork, 1999, Second Edition 3. Arunn Narasimhan, Essentials of Heat and Fluid Flow in Porous Media, Ane Books Private Limited, New Delhi, 2016, First Edition. 4.Faruk Civan, Porous Media Transport Phenomena, John Wiley and Sons, Singapore, 2011, First Edition. 5. F.A. L. Dullien, Porous Media: Fluid Transport and Pore Structure, Academic Press, London, 1992, Second Edition 6. Kambiz Vafai, Handbook of Porous Media, Taylor and Francis, Florida, 2005, Second Edition
ix	**Name(s) of the Instructor(s)**	SVP
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**	Knowledge of heat and fluid flow through porous media finds extensive applications in several engineering devices covering branches, mechanical, civil and chemical engineering. Recent ramifications include bioengineering and bio-technology.