PG-Curriculum
(Structure and Course Contents)
Mechanical Engineering

With effect from July 2018

EXPLORE INNOVATE EXCEL

Mechanical Engineering
Punjab Engineering College

(Deemed to be University)

Chandigarh

Index

PG Curriculum Structure
(Semester I)

S. No.	Course Stream	Code	Course Name	Fractal systems (each section of 0.5 credits and 7 contact hours)						Credits
				1	2	3	4	5	6	
1.	Soft Computing		Internet of Things							1.5
			Machine Learning & Python							1.5
2.	Design of Experiments and Research Methodology		Design of Experiments and Research Methodology (DE)							3.0
3.	PC-I		CAD & FEA							3.0
4.	PC –II		Advance Manufacturing & Precision Engineering							3.0
5.	PC-III		Advanced Design of Thermal Systems							3.0
6.	EM		Differential Equation							1
			Numerical Methods							1
			Optimization Techniques -II							1
	Total									18

(Semester II)

S. No.	Course Stream	Code	Course Name	Fractal systems (each section of 0.5 credits and 7 contact hours)						Credits
				1	2	3	4	5	6	
1.	Soft skills & Management		Communication Skill							1.5
			Management, Entrepreneurship & IPR							1
			Professional Ethics							0.5
2.	Program Core-IV		Advance Mechanisms & Vibration Control							3.0
3.	Program Elective-I		Any two from the Program Elective from Stream Specific Basket							3.0
4.	Program Elective-II									3.0
5.	Open Elective		Any One from the Open Elective Basket (to be offered by other branches to MED)							3.0
6.	Mini Project/ Pre Dissertation									3.0
Total										**18**

Summer Term

After examination of 2nd semester in the first week of summer vacation Industry visit can be undertaken.

S. No.	Course Code	Course Name	Credits
1.		Industrial visit (3 days to one week of visit, submission and presentation of visit report)	Satisfactory/ Not-satisfactory

3rd Semester

S. No.	Course Code	Course Name	LTP	Credits
1.		Dissertation-I	0-0-28	14
Total				14

4th Semester

S. No.	Course Code	Course Name	LTP	Credits
1.		Dissertation-II	0-0-36	18
Total				18

Total Credits-68

- ***20% courses/ semester can be offered in blended mode MOOC's/Industry.***
- ***MOOC's/Industry offered course is having fractional credits. Industry offering course content will be designed by industry will be as per expert availability. Industry person will deliver and evaluate this subject. As per the duration of MOOC's/industry offered course, credits of this course can be decided (fractional credits).***

List of Programme Electives (Any two from a specific stream)

S. No	Course Code	Course Name	L-T-P	Credits
(Design Stream)				
1		Fracture Mechanics of Composites and Polymers	2-1-0	3
2		Advance Mechatronics and Robotics	2-1-0	3
3		MEMS Design and Industrial Automation	2-1-0	3
(Thermal Stream)				
1		Computational Fluid Dynamics	2-0-2	3
2		Advanced and Non Conventional Energy Systems	2-1/2-2*1/2	3
3		Advance Heat Transfer and Heat Recovery Systems	2-1-0	3
(Manufacturing Stream)				
1		Advance Forming and Surface Engineering	2-1/2-2*1/2	3
2		Fabrications and Processing of Advance Material	2-1/2-2*1/2	3
3		Manufacturing Management and Logistic Systems	2-1/2-2*1/2	3
4		Advance Metal Cutting: Measurement & Analysis	2-1/2-2*1/2	3

List of Open Elective (Select any one from Sr. No. the following- For other branches)

S. No	Course Code	Course Name	L-T-P	Credits
1		MEMS and Micro System Design	2-1/2-2*1/2	3
2		Maintenance & Reliability Engineering	2-1-0	3
3		Fabrication Techniques of Advance & Smart Materials	2-1/2-2*1/2	3
4		Advanced Internal Combustion Engine Technology	2-1/2-2*1/2	3

SOFT COMPUTING

Course Name	**:**	**Internet of Things**
Course Code	**:**	
Credits	**:**	**1.5**
L T P	**:**	**2 0 2**
Segment	**:**	**1-3**

Total no. of lectures: 14
Total no. of Lab hrs : 14

Course Objectives:

The main objectives of this course are:	
1.	Understand core technology, applications, sensors used and IOT architecture along with the industry perspective.
2.	Principles and operations of different types of sensors commonly used on mobile platform will be taught in a manner that by the end of the course the students will be able to design and implement real time solutions using IOT.

Course Contents:

S.No.	Course Contents	No. of Lectures
1	**Introduction to IoT** What is IoT, how does it work? Difference between Embedded device and IoT device, Properties of IoT device, IoT Ecosystem, IoT Decision Framework, IoT Solution Architecture Models, Major IoT Boards in Market	2
2	**Setting Up Raspberry/Arduino to Create Solutions** Explore Raspberry Pi, Setting up Raspberry Pi, Showing working of Raspberry Pi using SSH Client and Team Viewer, Understand Sensing actions, Understand Actuators and MEMS	3
3	**Communication Protocols used in IoT** Types of wireless communication, MajorwirelessShort-rangecommunicationdevices,properties,comparisonofthesedevices Bluetooth, WIFI, ZigBee, 6LoWPAN), Major wireless Long-range communication devices, properties, comparison of these devices (Cellular IoT,LPWAN)	3
4	**IoT Applications** Industrial Internet 4.0, Applications such as: Smart home, wearables, smart city, smart grid, , connected car, connected health(digital health, telehealth, telemedicine), smart retail	3
5	**Sensors:** Applications of various sensors: Google Maps, Waze, Whats App, Ola Positioning sensors: encoders and accelerometers, Image sensors: cameras, Global positioning sensors: GPS, GLONASS, IRNSS, Galileo and indoor localization systems, Motion & Orientation Sensors: Accelerometer, Magnetometer, Proximity Sensor, Gyroscope Calibration, noise modeling and characterization and-noise filtering and sensor data processing. Privacy &Security	3

Lab Work:

Sr. No.	Lab contents	No. of Hours
1.	Design and build systems that will use sensors, communication protocol and actuators.	14

Course Outcomes:

At the completion of this course, students will be able to:	
1.	Understand concept of IOT and ability to implement in real time scenarios
2.	Design solutions based on IOT architecture and applications in various fields
3.	Critically analyze security and privacy issues in IOT
4.	Apply knowledge to Design and develop variousapplicationsofsensorsinIndustrial,healthcare,commercial,andbuildingautomation

Bibliography:

S.No.	Book Detail	Year of Publishing
1	Vijay Madisetti and ArshdeepBahga, Internet of Things (AHands-on Approach), 1st Edition, VPT	2014
2	Francis daCosta, Rethinking the Internet of Things: A ScalableApproach to Connecting Everything, 1stEdition, Apress Publications	2013
3	CunoPfister, Getting Started with the Internet of Things, OReillyMedia	2011
4	Kyung, C.-M., Yasuura, H., Liu, Y., Lin, Y.-L., Smart Sensorsand Systems, Springer International Publishing	2015

MOOCs on this course are available at:

1) Introduction to Internet of Things - https://www.edx.org/course/introduction-to-the-internet-of-things-iot
2) IoT Programming and Big Data -https://www.edx.org/course/iot-programming-big-data-curtinx-iot4x

Course Name	**:**	**Machine Learning & Python**
Course Code	**:**	
Credits	**:**	**1.5**
L T P	**:**	**2 0 2**
Segment	**:**	**4-6**

Total no. of lectures: 14

Total no. of lab hrs: 14

Course Objectives:

	The main objectives of this course are:
1.	To formulate machine learning problems corresponding to different applications.
2.	To understand a range of machine learning algorithms along with their strengths and weaknesses.
3.	To develop reasoning behind Model selection, model complexity, etc.

Course Contents:

S.No.	Course Contents	No. of Lectures
1	**BASICS OF MACHINE LEARNING:** Applications of Machine Learning, processes involved in Machine Learning, Introduction to Machine Learning Techniques: Supervised Learning, Unsupervised Learning and Reinforcement Learning, Real life examples of Machine Learning.	3
2	**SUPERVISED LEARNING:** Classification and Regression: K-Nearest Neighbour, Linear Regression, Logistic Regression, Support Vector Machine (SVM), Evaluation Measures: SSE, MME, R2,confusionmatrix,precision,recall,F-Score,ROC-Curve.	6
3	**UNSUPERVISED LEARNING:** Introduction to clustering, Types of Clustering: Hierarchical-Agglomerative Clustering and Divisive clustering; Partitioned Clustering - K-means clustering, Principal Component Analysis, ICA.	5

Lab Work:

S.No.	Lab Contents	No. of hours
1	Python Introduction: Loops and Conditions and other preliminary stuff, Functions, Classes and Modules, Exceptions, Database access, Mathematical computing with Python packages like: numpy, Mat- plot Lib, pandas Tensor Flow, Keras	8
2	Application Oriented Project Work	6

Course Outcomes:

At the completion of this course, students will be able to:	
1.	Design and implement machine learning solutions to classification, regression and clustering problems
2.	Evaluate and interpret the results of the different ML techniques
3.	Design and implement various machine learning algorithms in a range of Real-world applications.
4.	Use Python for various applications.

Bibliography:

S.No.	Book Detail	Year of Publishing
1.	Tom Mitchell, Machine Learning, McGraw Hill,	2017
2.	Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer,	2011
3.	T. Hastie, R. Tibshirani, J. Friedman. The Elements of Statistical Learning, 2e,	2008
4.	Yuxi (Hayden) Liu, "Python Machine Learning By Example", Packet Publishing Limited	2017

MOOCs on this course are available at:

1) Data Science: Machine Learning -https://www.edx.org/course/data-science-machine-learning
2) Machine Learning - https://www.coursera.org/learn/machine-learning

DESIGN OF EXPERIMENTS
&
RESEARCH METHODOLOGY

Course Name	**:**	**Design of Experiments and Research Methodology**
Course Code	**:**	
Credits	**:**	**3**
L T P	**:**	**2-0-2**
Segment	**:**	**1-6**

Total No. of Lectures: 28
Total No. of Lab Hrs : 28

Course Objectives:

	The main objectives of this course are:
1.	To introduce objective of research for various types of research
2.	To enhance competence analysing experimental results
3.	To enhance competence in understanding mathematical relation between process variables and results
4.	To introduce contribution of Taguchi in designing, analysing and interpreting experiments.

Course Contents:

Sr. No.	**Course contents**	**No. of lectures**
1.	Overview of Scientific research& Engineering Research: Nature and objective of research, Research topic, Literature review, steps in conducting literature review Formulation of problem, research questions and hypothesis, types of hypothesis, evaluation of hypothesis Research design, Sampling design, Measurement and scaling technique, Methods of Data collection, Statistical and sensitive analysis of data, Interpretation of result	4
2.	Analyzing results of from experiment: Various Tests of significance based on type of input and output data, Steps involved in testing for significance, concept of p value, testing for means, Testing for variance, chi-square test-Goodness of fit, test of independence	3
3.	Regression & Correlation, linear and non linear regression, multi variable liner regression	3
4.	Classification of experimental designs, Analysis of variance (ANOVA), ANOVA for detecting sources of variation – Statistical procedure for one-way ANOVA, Procedure for two-way ANOVA	3
5.	Engineering Research: Planning & management of experiments; Conventional method for experiment: One factor at a time (OFAT) experiment, Concept of design of experiments: Common terms, Designed experiment, Full factorial experiments: Orthogonality of experiments, Y = F (x) for DoE, main effect analysis, interaction analysis and results	4
6.	Fractional factorial experiments, Resolution of design, screening DoE, practicing with excel and statistical software, Optimizing using Response Surface Methodology (RSM)	4

7.	Taguchi Methods: Difference between conventional DoE and Taguchi methods, Orthogonal arrays, Taguchi's Robust parameter design, Noise factors, S/N ratio, Selection of right orthogonal array	5
8.	Procedure for writing a research report and manuscript: steps of writing a report, layout of report, layout of research paper, ethical issues related to publishing, Plagiarism and Self-Plagiarism.	2

Lab Work

Performing following analysis using statistical software	
1. Hypothesis tests (Z-test, t-test, 2t test, paired t-test, Chi s square and test of equal variance etc)	5
2. Correlation analysis between independent events, Regression analysis for dependent variables (having cause & effect) and developing Y = F (x)	5
3. One-way ANOVA, Two-way ANOVA, General Linear Model	5
4. Creating and analysing 2^kExperiments (Full & Fractional Factorial) and General Full Factorial Design	5
5. Development of model using Response Surface Methodology	4
6. Creating and analysing Taguchi design	4

Course Outcomes:

After successful completion of the course, students will be able to	
1.	Plan a research activity including sample design, scaling, data collection and analysis
2.	Perform a required statistical analysis for the a research/ experiment
3.	Understand the relationship between process variables and output as Y = f(x) + □
4.	Select the appropriate orthogonal array for a Taguchi design

Bibliography:

Sr. No.	**Book Detail**	**Year of Publication**
1.	Design and Analysis of Experiment, Douglas C Montgomery, John Wiley & Sons	2016
2.	Taguchi Techniques for Quality Engineering Phillip, J. Ross; The Tata McGraw-Hill	2017
3.	Research Methodology - Methods and Techniques, C. K. Kothari, New Age International, 2nd Edition	2004

PROGRAM CORE

Course Name	**:**	**CAD & FEA**
Course Code	**:**	
Credits	**:**	**3.0**
L T P	**:**	**2 0 2**
Segment	**:**	**1-6**

Total No. Lectures:-28
Total No. Lab hours:-28

Course Objectives:

The objective of this course are:

1. To understand the role of CAD for modelling & analysis of mechanical component & system design.
2. To give an insight of the basic mathematical fundamentals to CAD software.
3. To provide fundamental and practical notions in FEA like discretization, global stiffness matrix, load vector, iso-parametric representation etc.
4. To provide a practical approach for the modelling and exposure to use FEA software for one and two dimensional problems in various engineering fields.

Course Contents:

Sr.No	Course Contents	No. of Lectures
1.	Introduction; Computer graphics system; Primitives	2
2.	2D and 3D geometric transformations	2
3.	Projections, Curves	4
4.	Surfaces, NURBS	4
5.	Solids, Features & 3D graphics	2
6.	Review of solid mechanics and matrix algebra;	3
7.	Difference between finite element analysis (FEA), finite difference method (FDM), Mesh-free FEM, extended FEM and analytical solutions;	2
8.	Various methods to derive the element property,	2
9.	Steps in FEA; Types and implementation of boundary conditions in FEA; Numerical integration,	3
10.	1D and 2D problem modelling, analysis and its solution; Limitations of the FEA	4

Lab Work

Sr.No	Lab. Contents	No. of Hours
1.	Project work that shall be utilizing the drafting/sketching of CAD software, assembly using top down or bottom up approaches and part modelling	14
2.	Project work that shall be utilizing FEA software package (ANSYS etc.) to model and solve one and two dimensional engineering problem (truss, structural mechanics and heat transfer etc.)	14

Course Outcomes

At the end of the course, students will have:	
1	Understand the role of computers in the different phases of product design, development cycle and its analysis in a systematic manner.
2	Acquire the entry level skills in the domain of Computer aided design & drafting

3	Develop skills to use software to create 2D and 3D models of engineering components
4	Be in a position to use solid modeling concepts and techniques in design and analysis aspects
5	Be able to formulate and model a physical system
6	Be able to discretize and solve governing equation of a physical system using FEA
7	Be in a position to use as well as validate one and two dimensional problems using software with confidence
8	Be able to use commercial FEA software to solve industrial and practical problems

Bibliography:

Sr. No	Book Detail	Year of Publication
1.	Mastering CAD/CAM: Ibrahim Zeid, TMH	2012
2.	Computer Aided Design: (A Basic and Mathematical Approach) Sunil Kumar Srivastava, I K International,	2012
3.	Mathematical Elements for Computer Graphics: DF Rogers, Tata-McGraw-Hill International	2002
4.	Computer Aided Engineering Design: Anupam Saxena and Birendra Sahay, Anamya and Springer Publications.	2006
5.	Introduction to Finite Elements in Engineering: Chandrupatala & Belegundu, PHI, 3rd Ed	2010
6.	Concept & Application of Finite Element Analysis: Cook et al, John Wiley, 4th Ed, 2002	2002
7.	The Finite Element Method for Engineers: Huebner et al, John Wiley, 4th Ed.	2008
8.	Text Book of Finite Element Analysis: P Seshu, PHI	2009

Classical Books:

Sr. No	Book Detail	Year of Publication
1.	Geometric Modeling: Mortenson M. E., John Wiley and Sons, New York., 2nd Ed.	1997
2.	Finite Element Analysis (Theory & Programming): C S Krisnamoorthy, TMH, 2nd Ed.	1994

MOOCS Links

Sr. No	Link
1.	http://nptel.ac.in/courses/112104031/ CAD Course by Prof. Anupam Saxena IIT Kanpur
2.	http://nptel.ac.in/courses/105105041/ FEM Course by Prof. S.K. Bhattacharyya Dr. D. Maity ,IIT Kharagpur

Course Name	**:**	**Advanced Manufacturing & Precision Engineering**
Course Code	**:**	
Credits	**:**	**3**
L T P	**:**	**2 1/2 2*1/2**
Segment	**:**	**1-6**

Total No. Lectures:-28
Total No. Tutorial hours:-07
Total No. Lab hours:-14

Course Objectives:

The objectives of the course are:

1. To understand the various rapid prototyping techniques used in fabrication of products in industry,
2. To study and analyze the advanced machining techniques for machining of difficult to machine materials.
3. To provide broad idea and knowledge about the special manufacturing processes for manufacturing of advanced inserts by various coating on cutting tool.
4. To understand about the high-precision, ultra-precision processes and nanotechnology used in fabrication of precision products,
5. To study and analyze the precision and accuracy of machining in micro domain.
6. To provide idea and knowledge about the micro-electro-mechanical systems, non-conventional precision manufacturing processes and close tolerance manufacturing

Course Contents:

Sr.No	Course Contents	No. of Lectures
1.	Review on product development cycle and conventional manufacturing techniques.	2
2.	Rapid Prototyping: Importance and Types, Principles and advantages, Stereolithography, FDM, SLS, factors effects the responses of RP, Accuracy and Economic considerations.	3
3.	Advanced Machining Processes: AJM, UM, AFF, AWJC; LBM, EBM, PAM; ECG, ESD and STEM: tool design, analysis of material removal rate, effect of parameters, analysis and modeling for process performance with practical examples.	5
4.	Special Manufacturing Processes: PVD, CVD, Electroless coating and thermal metal spraying, Micro joining and Micro casting: effect of process parameters and analysis for process performance.	4
5.	Precision Engineering, High-precision, Ultra-precision Processes and Nanotechnology, Precision Machining, Ultra-Precision Machine Elements: Guide-ways, Drive Systems, Tool Materials for Precision Machining, MQL, Achievable Machining Accuracy and Economics of Machining.	5
6.	Micro-electro-Mechanical Systems: Characteristics and Principles, Materials and Design, application of MEMS, Fabrication of wafers and Micro-manufacturing processes of micro-electronic circuits,	4
7.	Non-conventional Precision Manufacturing Processes: Principle, types, merits, demerits and applications. Hybrid and micro forming processes: rotary swaging, electro, magneto and laser assisted bending and deep drawing. Film, Hybrid precision and micro machining: LAEJM, TWECSM.	5

Lab Work

Sr. No	Lab. Contents	No. of Hours
1.	Project work on design and fabrication of advance machining setup	07
2.	Experimental Investigation on ECDM, Laser assisted ECM on conducting and non-conducting materials respectively.	07

Course Outcomes

At the end of the course, students will have:	
1.	Theoretical understanding of different rapid prototyping techniques and their applications in industry.
2.	Critical investigation/thinking, design and analysis of advanced machining method and their hybridization.
3.	Design and development of manufacturing method for precision manufacturing.
4.	Theoretical understanding about the precision engineering, high and ultra-precision processes and their applications in industry.
5.	Critical investigation and thinking about design and analysis of ultra-precision machine elements, application of micro-electro-mechanical systems in industry
6.	Design and development of manufacturing method and their hybridization for precision manufacturing

Bibliography:

Sr.No	Book Detail	Year of Publication
1.	Advanced Machining Processes, V.K.Jain, Allied Publshing Pvt.Ltd, New Delhi	2007
2.	Non-conventional Machining Processes, P.K. Mishra, Narosa Publication.	2014
3.	Precision Engineering, V.C.Venktesh, Tata Mc.Graw Hill, New Delhi 2007	2007
4.	Manufacturing Engineering and Technology. Kalpakjian S., 3rd Ed. Addision-Wesley Publishing Co.,New York, 2001.	2001
5.	Introduction to Micromachining, V.K.Jain, Norosa Publishing House, New Delhi	2018

Classical Books:

Sr.No	Book Detail	Year of Publication
1.	Advanced Manufacturing Processes, G.F. Benedict, Marcel Dekker.	1987
2.	Manufacturing Processes B.H. Amsteal, Philip F. Ostwald & Myron L. Bengeman , John Wiley & Sons, eighth edition	1987
3.	Principles of Precision Engineering, Nakzavawa H, Oxford University Press, 1994.	1994

MOOCS Links

Sr. No	Link
1.	http://nptel.ac.in/courses/112107077/ Advanced Manufacturing Processes by Pardeep Gupta and A K Sharma IIT Roorkee
2.	http://nptel.ac.in/courses/112107078/ Advanced Manufacturing Processes by A K Sharma IIT Roorkee

Course Name	**:**	**Advance Design of Thermal System**
Course Code	**:**	
Credits	**:**	**3**
L T P	**:**	**2 1/2 2*1/2**
Segment	**:**	**1-6**

Total No. Lectures:-28
Total No. Tutorial hours:-07
Total No. Lab hours:-14

Course Objectives:

7. To provide the knowledge of various mathematical techniques in solution of variety of complex problems related to design and optimization of Thermal Systems.
8. To understand the significance of modelling and simulation of different engineering problems using various techniques
9. To give an insight of analysis software for modelling, simulation and optimization of engineering systems problems

Course Contents:

1.	Design and Mathematical Modeling of Thermal Systems, Approach to Robust Design. Applications of numerical methods for analysis of thermal and energy systems, Closed form solutions of 1D and 2D problems related to heat transfer, solution of Non Linear Equations; Interpolation, Regression, and Solution of ODE's. Roots of Polynomials	05
2.	Design and Analysis of Industrial Equipment, Design Consideration for Engineering Material Selection.	04
3.	Case Studies: Thermal System Analysis and Simulation Using ANSYS. Hydraulic Circuit Design and Analysis, Finite Difference Formulations and Finite Volume Formulations; Application of TDMA Method	05
4.	Design and Analysis of Mechanical and Electronic Equipments	04
5.	Problem Formulation and Optimization, Different Methods, Optimization of Mechanical System, Practical Aspects in Optimal Design, Case Studies Related to Optimization of Mechanical Systems	05
6.	Optimization for Constrained and Unconstrained Problems, Thermo-economic Analysis and Optimization of Thermal Systems.	05

Course Outcomes

At the end of the course, students will have:	
1	Inculcate an ability to solve engineering problems using knowledge of various disciplines.
2	Inculcate an ability to identify, formulates, and solves engineering problems.
3	Inculcate an ability to use the mathematical tools for optimization of engineering problems.
4	Inculcate the use of latest software's for solution of problems related to engineering disciplines.

Bibliography:

Sr.No	Book Detail	Year of Publication
1	Design and Optimization of Thermal System by Y Jaluria. (2nd Edition)	2014
2	Handbook for Product Design and Manufacture by G Bralla. (4th Edition)	2016
3	Thermal Design and Optimization by A Bejan, G Satsoranis and M Moran.(2nd Edition)	2012
4	NPTEL Lectures of Hydraulic and Pneumatic Systems.	
5	Computational Fluid Dynamics by Versteeg and Malalasekhera.(3rd Edition)	2013

Practicals

Sr.No	Practical Name	Lab Hours
1	Project on Analysis of advance IC Engine, Combustion Chamber, Heat Generation and Simulation	04
2	Project on Design and Simulation of Refrigeration and Air Condition	04
3	Project of Thermal Analysis of Food Processing Plant	03
4	Project on Thermal Analysis of Effluent Treatment Plant	03

MOOCS Links

Sr. No	Link
1.	http://nptel.ac.in/courses/112106064/ Design and Optimization of Energy System by C Balaji IITM.

ENGINEERING MATHEMATICS

Course Name	**:**	**Differential Equations**
Course Code	**:**	
Credits	**:**	**01**
L T P	**:**	**2-1-0**
Segments	**:**	**1-2**

Total No. of Lectures – 10,
Total No. of Lab Hrs -5

Course Objectives:

1. To learn the methods to formulate and solve linear differential equations.
2. To apply differential equations in the applications of engineering problems.

Course contents:

Sr.No	Course Contents	No. of Lectures
1	Order and degree of differential equations, Solutions of differential equations, First order equations, second order linear homogeneous differential equations with constant coefficients. Applications to Engineering problems.	**04**
2	Wronskian, Non-homogeneous equations of order two, Homogeneous equations of n^{th} order, Initial value problem, Applications to Engineering problems.	**04**
3	Use of Mathematica / MATLAB to solve differential equations numerically	**02**

Course Outcomes:

By the end of this course the students will be able to	
1	learn the methods to formulate and solve linear differential equations.
2	apply differential equations in the applications of engineering problems.
3	use Mathematica / MATLAB to solve differential equations numerically

Bibliography:

Sr.No.	Name of Book / Authors / Publishers	Year of Publication/ Edition
1	"An introduction to ordinary differential equations", E A Coddington.	1972
2	"Advanced Engineering Mathematics", E. Kreyszig. 9th Edition, Wiley.	2006
3	"Elementary Differential Equations and Boundary Value Problems", Boyce, W.E. and Diprima, , John Wiley and Sons, USA	2001

Course Name	**:**	**Numerical Methods**
Course Code	**:**	
Credits	**:**	**1**
L T P	**:**	**2-0-2**
Segments	**:**	**3-4**

Total No. Lectures:-10
Total No. of Lab Hours – 10

Course Objectives:

1. To understand the basics of numerical methods.
2. To solve problems on system of linear equations and Interpolation by numerical methods.

Course Contents:

Sr.No	Course Contents	No. of Lectures
1	**Error Analysis:** Definition and sources of errors, Propagation of errors, Floating-point arithmetic and rounding errors.	02
2	**Interpolation:** Interpolation using Finite differences, Numerical Differentiation and Numerical integration, Trapezoidal and Simpson's rules.	04
3	**Numerical Solution of Differential Equations:** Picard's method, Taylor series method, Euler and modified Euler methods, Runge-Kutta methods, Predictor-Corrector method.	04

Lab Work:

Sr.No	Lab contents	No. of Hours
1.	Solving Interpolation, Numerical Differentiation and Numerical integration problems using Mathematica.	04
2.	Solving Differential equations numerically using Mathematica.	06

Course Outcomes:

At the end of the course, students will have:	
1.	Problems on Interpolation.
2.	Problems on Differentiation, Integration.
3.	Solve differential equations

Bibliograhy:

Sr.No	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	"Introduction to Numerical Analysis",Atkinson K. E., John Wiley.	1989
2	"Applied Numerical Analysis", Gerald C. F. and Wheatley P. O., Pearson	2004
3	"Numerical Methods for Scientific and Engineering Computation", Jain M. K., Iyengar S.R.K. and Jain R. K., New Age International Publisher.	2004
4	"Elements of Numerical Analysis", Gupta R.S., Macmillan India Ltd .	2008

Course Name	**:**	**Optimization Techniques-II**
Course Code	**:**	
Credits	**:**	**1**
L T P	**:**	**2-0-2**
Segment	**:**	**5-6**

Total No. Lectures:-10
Total No. of Lab hours – 10

Course Objectives:

1. To understand the need of Optimization Techniques and develop the ability to form mathematical model of optimization problems.
2. To identify and solve various optimization problems using Genetic Algorithms.

Course Contents:

Sr.No	Course Contents	No. of Lectures
1	Introduction to optimization problem, local and global optimum, conversion of a constrained problem to unconstrained problem.	**04**
2	Genetic Algorithms, Binary and Real coded Genetic Algorithms, Coding and decoding of variables, Key steps in a GA, starting population, fitness evaluation, reproduction, crossover, mutation, evaluation.	**06**

Lab Work:

Sr.No	Lab contents	No. of Hours
1.	Using Genetic Algorithms in various optimization Problems	**10**

Course Outcomes:

At the end of the course, students will have:	
1	The students are able to form mathematical model of optimization problems .
2	The students are able to distinguish between linear and nonlinear models .
3	The students are able to solve simple problems using Mathematica/MATLAB

Bibliography:

Sr.No	Name of Book/ Authors/ Publisher	Year of Publication/Reprint
1	"Practical Genetic Algorithms", Haupt, R. L. and Haupt, S.E., John Wiley &Sons	**1998**
2	"Genetic Algorithm in Search, Optimization and Machine Learning" , Goldberg, D.E., Addison Wesley.	**1989**
3	"Engineering Optimization", Ranjan, Ganguli,University Press.	**2011**

SOFT SKILLS & MANAGEMENT

Course Name	**:**	**Communication Skills**
Course Code	**:**	
Credits	**:**	**1.5**
L T P	**:**	**1-0-4**
Segment	**:**	**1-3**

Total No. Tutorials-7
Total No. of Lab hours – 28

Course Objectives:

	The main objectives of this course are:
3.	To enhance competence in communication skills: verbal and nonverbal.
4.	To provide orientation in technical communication skills: spoken and written.
5.	To sensitize students to attitude formation and behavioural skills.

Course Contents:

Sr.No	Course contents	No. of Tutorials
1.	**Introduction to Communication Skills, Soft Skills and Interpersonal Communication**	**1**
2.	**Speech:** Structure, Elements, Content, Organization and Delivery, J-a-M	**1**
3.	**Writing Skills:** Letters, Minutes of Meeting	**1**
4.	**Technical Report Writing:** Concept and Structure	**1**
5.	**Research Writing:** Concept and Structural Framework	**1**
6.	**Power Point Presentation:** Project Presentation	**1**
7.	**Interviews**	**1**

Lab Work:

Sr.No	Lab contents	No. of Hours
1.	Self- Introduction	**2**
2.	Negotiation Skills & Role Play	**2**
3.	J-a-M Session	**2**
4.	Building Word Power through Reading	**2**
5.	Group Discussion and Case Study	**4**
6.	Writing Skills: Letters, Minutes of Meeting	**2**
7.	Technical Report Writing: Concept & Structure	**4**
8.	Research Writing: Concept and Structural Framework	**4**
9.	Power Point Presentation: Project Presentation	**4**
10.	Interviews	**2**

Course Outcomes:

At the completion of this course, students will be able to:	
1.	Show enhanced competence in communication skills and technical communication.
2.	Develop awareness of attitude formation and behavioural appropriateness
3.	Gain self-confidence and perform better in their academic and professional life.

Bibliography:

Sr.No	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1.	"Technical Communication", Raman Meenakshi and Sharma Sangeeta, Oxford University Press.	**2015**
2.	"English for Research Paper Writing", Wallwork Adrian, Springer, London.	**2011**
3.	"English Vocabulary In Use: Advanced+ CD", Michael McCarthy, CUP, Cambridge.	**2004**
4.	"Advanced English Grammar", Hewings Martin, CUP, Cambridge.	**2003**
5.	"Study Listening", Tony Lynch, CUP, Cambridge.	**2004**
6.	"Study Speaking", Kenneth Anderson, CUP, Cambridge.	**2010**
7.	"Study Reading", Glendenning H. Eric, CUP, Cambridge.	**2004**
8.	"Study Writing", Hamp Lyons Liz & Heasley Ben, CUP, Cambridge.	**2004**
9.	"Study Skills in English", Wallace Michael J., CUP, Cambridge.	**2004**

MOOCs on this course are available at:

1) "Take Your English Communication Skills to the Next Level". Available at Coursera (Offered by Georgia Institute of Technology), 4 weeks, Starts on September 10, 2018.
https://www.coursera.org/learn/english-communication-capstone

2) "Effective Communication in Globalised Workplace- The Capstone". Available at Coursera (Offered by National University of Singapore), 3 weeks, Starts on August 06, 2018.
https://www.coursera.org/specializations/effective-communication

Course Name	**:**	**Management Entrepreneurship and IPR**
Course Code	**:**	
Credits	**:**	**1**
L T P	**:**	**0-2-0**
Segment	**:**	**4-5**

Total No. Tutorials – 14

Course Objectives:

The main objectives of this course are:	
1.	To make students familiar with the concepts of Management, Entrepreneurship and Intellectual Property Rights (IPRs).
2.	To make students understand how to initiate a new Start-up and manage it effectively.
3.	To enable students to convert their innovative ideas into different forms of IPRs.

Course Contents:

Sr.No	Course contents	No. of Tutorials
1.	**Introduction to Management:** Concepts and Principles of Management	**1**
2.	**Functions of Management:** Planning Process - Hypothetical Planning of an Event/Activity, Form of Organization Structure - Case Study, Human Resource Planning and Process, Elements of Directing and Effective Control Mechanism, Activity: Role Playing/Management Game	**4**
3.	**Introduction to Entrepreneurship:** Concepts of Entrepreneurship and Characteristics of Entrepreneurs	**1**
4.	**Development Phases of Entrepreneurship:** Innovation and Idea Generation, Project Formulation and Validation (Feasibility Analysis), Business plan	**2**
5.	**Ecosystem for Entrepreneurship Development:** Government Schemes and Initiatives, Financial and Non-Financial Institutional Support, Legal Framework, Role of Incubator, Venture Capitalist, Angel Investor, Crowd Funding Accelerator etc.	**2**
6.	**Intellectual Property Rights (IPRs):** Concept and Relevance of IPRs, Process for filing IPR	**2**
7.	**Different Forms of IPRs:** Patents, Copyright, Trademarks, Industrial Designs and Geographic Indicator	**2**

Course Outcomes:

At the completion of this course, students will be able to:	
1.	Develop and manage new project/Start-up.
2.	Apply managerial skills for success of entrepreneurial/business venture.
3.	Make effective use of IPR practices in their ventures.

Bibliography:

Sr.No	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1.	"Management Principles and Practice", Srinivasan R. and Chunawalla S.A., Himalaya Publishing House.	**2017**
2.	"Introduction to Management", Schermerhorn John R. Jr. And Bachrach Daniel G., 13th Edition, Wiley Publications	**2016**
3.	"Principles & Practice of Management", Prasad L.M., 8th Edition, Sultan Chand & Sons.	**2015**
4.	"The New Era of Management", Daft R.L., 11th Edition, Pubs: Cengage Learning.	**2014**
5.	"Case Studies in Management", Pandey Chandra Akhilesh, 2nd Edition, I.K. International Publishing House Pvt. Ltd.	**2015**
6.	"Harvard Business Review: Manager's Handbook", Harvard Business School Press.	**2018**
7.	"Entrepreneurship", Trehan Alpana, Dreamtech Press.	**2016**
8.	"Entrepreneurship and Small Business" Schaper Michael, Volery Thierry, Weber Paull and Lewis Kate, 3rd Asia-Pacific Edition, Wiley Publications	**2018**
9.	"Harvard Business Review: Entrepreneur's Handbook", 1st Edition, Harvard Business Review Press	**2018**
10.	"Take Me Home", Bansal Rashmi, 1st Edition, Westland.	**2014**
11.	"Intellectual Property Law", Narayanan P., 3rd Edition, Eastern Law House	**2017**
12.	"Intellectual Property Rights", Pandey Neeraj and Dharni Khushdeep, PHI Learning	**2014**
13.	"Intellectual Property Rights", Rosedar S.R.A., LexisNexis (Quick Reference Guide – Q&A Series)	**2016**
14.	MSME Annual Publications (www.msme.gov.in)	**Annual**
15.	WIPO Annual Publications (www.wipo.int)	**Annual**

MOOCs on this course are available at:

1) "Entrepreneurship: Do Your Venture", Available at edx (Offered by IIM Bangalore), Self-Paced (6 weeks).
   https://www.edx.org/course/entrepreneurship-do-your-venture
2) "Becoming an Entrepreneur", Available at edx (Offered by MIT), Self-Paced (6 weeks).
   https://www.edx.org/course/becoming-entrepreneur-mitx-launch-x-4
3) "How to Build a Start-up", Available at Udacity, Self-Paced (One Month).
   https://in.udacity.com/course/how-to-build-a-startup--ep245
4) "Intellectual Property Rights: A Management Perspective, Available at edx (Offered by IIM Bangalore), Starts on 1 August 2018 (6 weeks).
   https://www.edx.org/intellectual-property-rights-a-management-perspective

Course Name	**:**	**Professional Ethics**
Course Code	**:**	
Credits	**:**	**0.5**
L T P	**:**	**0-1-0**
Segment	**:**	**6**

Total No. Tutorials -7

Course Objectives:

	The main objectives of this course are:
6.	To imbibe ethical values and understanding.
7.	To develop moral thinking that will help students to recognize their potential.
8.	To engage and motivate the students to perform ethically in their professional life.

Course Contents:

Sr.No	Course contents	No. of Tutorials
1.	**Introduction to Ethics:** Concept of Ethics – Nature, Scope, Sources, Types, Functions and Factors influencing Ethics, Ethics in Engineering	**2**
2.	**Ethics in Profession:** Concepts of Honesty, Integrity, Reliability, Risk, Safety and Liability, Responsibilities and Rights of Professionals, Professional accountability.	**2**
3.	**Ethics and Business:** Concept of Business Ethics – Nature and Objectives, Ethical dilemmas in business ethics.	**1**
4.	**Self-Development:** Concept of Self-Assessment – SWOT Analysis, Self-Concepts, Self-Confidence, Self-Esteem, Managing Time and Stress, Human values.	**2**

Course Outcomes:

At the completion of this course, students will be able to:	
1.	Demonstrate knowledge and better understanding of self and to manage time and stress effectively.
2.	Have subjective well-being.
3.	Have ethical decision making ability in their personal and professional life.

Bibliography:

Sr.No	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1.	"Professional Ethics", Subramaniam R., 2nd Edition, Oxford University Press.	**2017**
2.	"Introduction to Psychology", Kalat James W., 11th Edition, Cengage Learning.	**2017**
3.	"Business Ethics – Text and Cases", Murthy C.S.V., 1st Edition, Himalaya Publishing House.	**2014**
4.	"A Foundation Course in Human Values and Professional Ethics", Gaur R.R., Sangal R. and Bagaria G.P., Excel Books.	**2010**
5.	"Issues and Ethics in the Helping Professions", Corey G., Corey M.S. and Callanan P., 8th Edition, Brooks/Cole, Cengage	**2010**

	Learning.	
6.	"The Curse of Self: Self-awareness, Egotism and the Quality of Human Life", Leary M.R., 1st Edition, Oxford University Press.	**2007**
7.	"Business Ethics", Hartman L.P. and Chatterjee A., 3rd Edition, Tata McGraw Hill.	**2006**
8.	"Business Ethics and Professional Values", Rao A.B., Excel Books.	**2006**
9.	"Business Ethics – Concepts and Cases", Velasquez M.G., 5th Edition, Prentice Hall.	**2001**
10.	"Theories of Personality", Hall C.S., Lindzey D. and Cambell J.B., 4th Edition, Hamilton Printing Company.	**1997**

MOOCs on this course are available at:

1) "Ethics in Engineering Practice". Available at SWAYAM(Offered by IIT Kharagpur), 8 weeks, Starts on August 27, 2018. https://swayam.gov.in/courses/4799-july-2018-ethics-in-engineering-practice
2) "Ethics, Technology and Engineering". Available at Coursera (Offered by EindhovenUniversity of Technology), 8 weeks, Starts on July 16, 2018. https://www.coursera.org/learn/ethics-technology-engineering

PROGRAM
CORE- IV

Course Name	**:**	**Advanced Mechanisms & Vibration Control**
Course Code	**:**	
Credits	**:**	**3**
L T P	**:**	**2 1 0**
Segments	**:**	**1-6**

Total No. Lectures:-21
Total No. Tutorials:-14

Course Objectives:

1. To develop understanding of the theoretical background for advanced kinematics, synthesis of mechanisms to achieve desired motion.
2. To develop understanding on advanced computer-based tools for the analysis & synthesis of the mechanisms.
3. To understand the unwanted effect of vibration which includes the loss of quality, malfunctioning, resonance or fatigue failure, excessive wear, generation of noise and other harmful effects on the human operators.
4. To inculcate the understanding of the principle of vibration controls in mechanical system.
5. To introduce the various vibration control strategies in mechanical system design

C**ourse Contents:**

Sr.No	Course Contents	No. of Lectures
1.	Review of basics concepts of the mechanism, Advanced kinematic synthesis and analysis of linkages	4
2.	Graphical and analytical methods for the synthesis of planar and spatial linkages, Techniques for velocity and acceleration analysis of simple mechanisms	4
3.	Techniques for the synthesis and analysis of spatial mechanisms	4
4.	Free and forced vibrations with and without damping; Reduction of vibration at source; Active and semi-active control system	4
5.	Vibration isolation; Vibration generation mechanisms;	3
6.	Source classification; Self-excited and flow induced vibration;	3
7.	Design consideration in the material selection; Design of absorber; Absorber with ideal spring; Shock absorber;	3
8.	Isolators with stiffness and damping; Piezoelectric materials; Electro and magneto rheological fluids; Magneto and electro strictive materials in vibration control	3

Course Outcomes

At the end of the course, students will have:	
1	Gain theoretical background in kinematics analysis and synthesis of a given mechanisms.
2	Become familiar with advanced tools for the analysis and design of linkages.
3	Be able to apply theory and use of engineering tools in a substantial mechanism design project.
4	To understand various types of vibration control strategies
5	To design the devices to bring down the undesirable effects of vibration to an acceptable level for a mechanical system

Bibliography:

Sr.No	Book Detail	Year of Publication
1	Theory of Machines and Mechanisms: JJ Uicker, GR Pennock and JE Shigley, 4th Ed., Oxford University Press.	2009
2	Design of Machinery: An Introduction to the Synthesis and Analysis of Mechanism and Machine: RL Norton, 3rd Ed., Tata McGraw Hill.	2005
3	Advanced Mechanism Design, (Vol.1 & 2): NG Sandor and GA Erdman, Prentice Hall.	2004
4	Vibration Control of Active Structures: A Premont, Springer Publication, 4th Ed.	2018
5	Principles of Passive and Active Vibration Control: AK Mallik and S Chatterjee Affiliated East-West Press	2014

Classical Books

Sr.No	Book Detail	Year of Publication
1	Kinematic Analysis and Synthesis of Mechanisms: AK Mallik, A Ghosh, G Dittrich, CRC	1994
2	Theory of Mechanism and Machines: A Ghosh and AK Mallik, 3rd Ed., EWLP, Delhi.	1999
3	Principles of Vibration Control: AK Mallik, Affiliated East-West Press, India	1990
4	Passive Vibration Control: DJ Mead, Wiley Publication, 1st Ed.	1999

MOOCS Links

Sr. No	Link
1.	http://nptel.ac.in/courses/112105236/ Mechanism and Robot Kinematics by IIT Kharagpur AnirvanDasGupta ,IIT Kharagpur
2.	http://nptel.ac.in/courses/112104211/ Principles of Vibration Control by IIT Kanpur Prof. Bishakh Bhattacharya ,IIT Kanpur

PROGRAM ELECTIVE

Course Name	**:**	**Fracture Mechanics of Composites and Polymers**
Course Code	**:**	
Credits	**:**	**3**
L T P	**:**	**2 1 0**
Segments	**:**	**1-6**

Total No. Lectures:-28
Total No. Lectures:-14

Course Objectives:

1. To gain knowledge about the theories of fracture mechanics and its principles
2. To develop an understanding of the linear elastic analysis of composite materials.
3. To give understanding of the concepts such as anisotropic material behaviour etc.
4. To enrich the student's understanding for the analysis of laminated plates and other composite structures

Course Contents:

Sr.No	Course Contents	No. of Lectures
1.	Background of fracture mechanics and various modes of fracture failure;	2
2.	Dilemma of Griffith; Surface energy; Energy release rate (ERR); Anelastic deformation at crack tip; Crack resistance; Stable and unstable crack growth; Critical ERR;	4
3.	Linear elastic fracture mechanics (LEFM); Stress and displacement fields in an isotropic elastic material; Stress intensity factor (SIF) and its mathematical background; Approach of Westergaard for different modes of the fracture and its analysis;	6
4.	J-integral; Path independence and stress & strain relations; Engineering approach to J integral.	2
1.	Hooke's law for anisotropic, monoclinic, orthotropic, transversely isotropic and isotropic materials;	2
2.	Unidirectional and angle ply lamina; Strength theories of lamina; Volume and mass fraction;	2
3.	Density and void content; Evaluation of elastic module;	2
4.	Ultimate strength of the unidirectional lamina; Laminate code; Stress-strain relations;	2
5.	In-plane and flexural modulus; Hygrothermal effects;	2
6.	Symmetric, cross, angle ply and anti-symmetric laminates; Failure criteria and failure modes of composite materials	4

Course Outcomes

At the end of the course, students will have:	
1	An understanding of fundamental principles of the fracture mechanics
2	Be able to use fracture mechanics concepts for the analysis and evaluation of structure having low factor of safety
3	Ability to identify the properties of fibre and matrix composite materials
4	Ability to predict the elastic properties of both long and short fibre composites
5	Ability to rotate stress, strain and stiffness tensors using ideas from matrix algebra.
6	Ability to analyse laminated plate in bending, including finding its properties from the lamina properties and also to find residual stresses from curing and moisture
7	Ability to predict the failure strength of a laminated composite structures

Bibliography:

Sr.No	Book Detail	Year of Publication
1	Elements of Fracture Mechanics: P Kumar, Tata McGraw-Hill Education	2016
2	Fracture Mechanics: An Introduction: EE Gdoutos, Springer,	2005
4	Mechanics of Composite Materials: AK Kaw, CRC Press, 2nd Ed.,	2005
7	Engineering Mechanics of Composite Materials: IM Daniel and O Ishai, 2nd Ed., Oxford University Press.	2005
8	Mechanics of Laminated Composite Plates and Shells-Theory and Analysis: JN Reddy, 2nd Ed., CRC Press,	2003

Classical Books

Sr.No	Book Detail	Year of Publication
3	Elementary Fracture Mechanics: SA Meguid, Elesvier Applied Science, London,	1989
5	Mechanics of Composite Materials: RM Jones, CRC Press,	1998
6	Analysis and Performance of Fibre Composites: BD Agarwal and JD Broutman, New York, John Willey & Sons.	1990

MOOCS Links

Sr. No	Link
1.	http://nptel.ac.in/courses/112106065/ Engineering Fracture Mechanics by K Ramesh ,IIT Madras
2.	http://nptel.ac.in/courses/112104161/ Mechanics of Laminated composite structure by Prof. Nachiketa Tiwari ,IIT Kanpur

Course Name	**:**	**Advanced Mechatronics & Robotics**
Course Code	**:**	
Credits	**:**	**3**
L T P	**:**	**2-1-0**
Segments	**:**	**1-6**

Total No. Lectures – 28
Total No. Tutorials - 14

Course Objectives:

1. To impart knowledge and information about design, development and control of intelligent systems.
2. To provide overview of the principles of robotics and to enhance their knowledge towards the automation practices.
3. To provide the understanding of the basic functioning, principles, classification and uses of robots in the industrial applications.

Course Contents:

Sr.No	Course Contents	No. of Lectures
1.	**Understanding Mechatronics :**Basic Components of Mechatronics and Advanced Mechatronics Examples : Manufacturing, CNC Robotics, Transportation equipment, Medical equipment, Defence equipment, Space exploration, Sports, Smart homes ,Smart Grid ,Smart City	03
2.	**Hardware concept of Mechatronics** : **(i)Transducers and Sensors**: Ultrasonic transducer, Laser ultrasonic, Hall Effect sensor, Variable reluctance sensor, Pressure sensor, and Accelerometer, **(ii)Signal condition devices** : Analog and Digital Circuits and Devices **(iii)Controllers** : Microprocessor based system, Microcontroller based system, Programmable Logic Controller based System **(iv)Actuators:** Mechanical, Electrical Piezoelectric, Hydraulic and Pneumatic, Electromechanical.	04
3.	**Software concept of Mechatronics**: Programming Languages, Assembly, C,C++ ,Matlab ,Ladder, Simulink etc. Real time system	03
4.	**Advance Mechatronics Approach** : Systems Modeling and Simulation, transfer function, system response, Linear /non-linear system analysis, system stability, Digital control Applications, , On- Off Control, Supervisory Controller , Direct Digital Controller ,P-I-D Controller	04
5.	System Fault Finding, Trouble Shooting, **Mechatronics system hands on training and project design & development**: Sensor/transducer system, Signal conditioning, Controller, Actuator, Advanced design and development approach.	04
6.	Robotics systems; Matrix representation; Forward & inverse kinematics of robots; Homogeneous transformations; Robot arm dynamics; D-H representation of robots; Dynamics of manipulators; Formulation of equations of motion; Recursive dynamics; Planning and control of Trajectory; Position & force control; Modelling and control of flexible manipulators, wheeled mobile robots, bipeds etc	10

Course Outcomes:	
1.	To be able to understand the process involved in design, development and control of intelligent systems.
1	To be able to explain the basic principles of robotic technology, configurations, control and its programming
2	To be to describe the concept of robot kinematics and dynamics, its latest algorithms & analytical approaches
3	To be to design an industrial robot which can meet given kinematic and dynamic constraints

Bibliography:

Sr.No	Name of Book/ Authors/ Publisher	Year of Publication
1.	Tilak Thakur Mechatronics ,Oxford University Press ,2016	2016
2.	C. De Silva. Mechatronics: An Integrated Approach. CRC Press, 2005	2005
3.	W. Bolton. Mechatronics: A Multidisciplinary Approach. 4th Edition, Pearson, 2008	2008
4.	Robotics Engineering- An Integrated Approach: RD Klafter, Thomas. A, Chri Elewski, Michael Negin, PHI Learning.	2009
5.	Introduction to Robotics: SK Saha, Tata McGraw-Hill Publishing Company Ltd.	2008
6.	Introduction to Robotics-Analysis Systems, Applications: SB Niku, Pearson Education	2001
7.	Robotics: Fundamental Concepts and Analysis: A Ghosal, Oxford University Press	2008

MOOCS Links

Sr. No	Link
1.	http://nptel.ac.in/courses/112106224/ Mechatronics by Dr. Shrikrishna N. Joshi ,IIT Guwahati
2.	http://nptel.ac.in/courses/112103174/ Mechatronics and Manufacturing Automation by Prof. Manivannan.P.V , IIT Madras

Course Name	**:**	**MEMS Design and Industrial Automation**
Course Code	**:**	
Credits	**:**	**3**
L T P	**:**	**2 1 0**
Segments	**:**	**1-6**

Total No. Lectures:-28
Total No. Tutorials:-14

Course Objectives:

1. To explore the world of micro-electro-mechanical devices and systems by looking into their material properties, fabrication technologies, basic structural mechanics, calibration, and testing.
2. To enrich the student's knowledge towards design & development of industrial automation systems and the concepts of automated machines and equipment.

Course Contents:

Sr.No	Course Contents	No. of Lectures
1.	Micro-Electro-Mechanical-Systems (MEMS) and micro-system products; Multidisciplinary nature of micro-systems; Scaling laws in miniaturization;	2
2.	Application of micro-system in the industries; Intrinsic characteristics of MEMS; Sensors; Micro-actuation through thermal forces; SMA-Piezo electric crystals and electrostatic forces;	4
3.	Magnetic actuation; Micro-grippers; Micro-motors; Micro-valves; Micro pumps; Micro accelerometers; Materials;	4
4.	Mechanics and design of micro-systems; Piezo-resisitors; Micro-fabrication and micro-etching.	4
5.	Various automation devices and controls; Design and analysis of automated flow lines; Automatic transfer mechanisms; Assembly systems and their types;	3
6.	Automated assembly lines & their types; Analysis of line balancing; Automatic assembly transfer systems; Automatic feeding and orienting devices;	4
7.	Performance and economics of assembly systems; Feasibility study for assembly automation;	4
8.	Programmable AGV analysis and its control; Numerical and adaptive control & its programming; Introduction to industry 4.0.	3

Course Outcomes

At the end of the course, students will have:	
1	Be able to familiar with the important concepts applicable to MEMS
2	Be able to identify the basic devices to be used in any MEMS systems
3	Be able to design, analyze and test the MEMS
4	Be able to apply the MEMS for different industrial applications
5	To identify potential areas for automation and justify need for automation
6	To select suitable control components required to automate a process or an activity
7	To translate and simulate a real time activity using modern tools and discuss the benefits of automation.
8	To identify suitable automation hardware for the given application.

Bibliography:

Sr.No	Book Detail	Year of Publication
1	MEMS and Micro system Design and Manufacturing: TR Hsu, Tata McGraw Hill	2017
2	Foundation of MEMS: C Liu, Pearson Education	2017
3	Micro sensors, MEMS and Smart devices: JW Gardner, VK Varadhan, John Wiley & Sons	2001
4	Nano structure and Nano materials, synthesis, properties and applications: G Cao, Ying, World Scientific Publishing Co.	2011
5	Nano Scale Science and Technology: Robert K, Ian WH, Mark Geoghegan	2005
6	Automation, Production systems and Computer Integrated Manufacturing: MP Groover, Prentice-Hall Inc. Englewood Cliffs	2016
7	Product Design for Manufacture and Assembly: G Boothroyd, P Dewhurst and W Knight, 2nd Ed., Marcel Dekker, New York	2002

MOOCS Links

Sr. No	Link
1.	http://nptel.ac.in/courses/108105062/ Industrial Automation and Control by S Mukhopadhaya , IIT Kharagpur
2.	http://nptel.ac.in/courses/117105082/ MEMS by Prof. Santiram Kal ,IIT Kharagpur

Course Name	**:**	**Computational Fluid Dynamics (CFD)**
Course Code	**:**	
Credits	**:**	**3**
L T P	**:**	**2 0 2**
Segments	**:**	**1-6**

Total No. Lectures:-28
Total No. Labs:-28

Course Objectives:

1. To equip students with the knowledge base essential for application of computational fluid dynamics to engineering fluid flow and heat transfer problems.
2. To provides the essential numerical background for solving the partial differential equations governing the fluid flow and heat transfer.

Course Contents:

Sr.No	Course Contents	No. of Lectures
1.	Review of governing equations of Fluid Flow;	2
2.	Discretization by derivatives by FDM/FVM, error, time-stepping, Numerical stability and consistency;	4
3.	Steady and unsteady conduction, explicit and implicit method, direct and iterative methods of solution;	4
4.	Finite Volume Method for Diffusion, Convection – Diffusion Problems;	4
5.	Algorithms for steady and unsteady flows, Solution of discretized equations;	4
6.	Implementation of boundary conditions, Errors and uncertainty in CFD Modelling	3

List of Lab Works

Sr.No	Lab. Contents	No. of Hours
1.	Ansys Simulation of heat transfer and fluid flow through pipe	05
2.	Ansys Simulation of flow past regular and irregular bodies.	05
3.	Ansys Simulation of Conduction, Convection and Radiation	06
4.	Ansys Simulation of flow through porous media.	06
5.	Ansys Simulation of Phase Change Materials	06

Course Outcomes

At the end of the course, students will have:	
1	Improve the student's understanding of the basic principles of fluid mechanics and heat transfer
2	Improve the student's research and communication skills using a self-directed, detailed study of a complex fluid-flow problem and to communicate the results in written form.

Bibliography:

Sr.No	Book Detail	Year of Publication
1	H. Versteeg and W. Malalasekra, An Introduction to Computational Fluid Dynamics: The Finite Volume Method, 2007.	2007

Classical Books

Sr.No	Book Detail	Year of Publication
1	J.D. Anderson, Jr., Computational Fluid Dynamics: The Basic with Applications, McGraw Hill, Inc., 1995.	1995
2	Suhas V. Patankar, Numerical Heat Transfer and Fluid Flow, Taylor & Francis,1980.	1980

MOOCS Links

Sr. No	Link
1.	http://nptel.ac.in/courses/101106045/ Introduction to CFD by Prof. M. Ramakrishna ,IIT Madras

Course Name	**:**	**Advanced & Non Conventional Energy Systems**
Course Code	**:**	
Credits	**:**	**3**
L T P	**:**	**2 1/2 2*1/2**
Segments	**:**	**1-6**

Total No. Lectures: -21
Total No. Tutorials: -07
Total No. Tutorials: -14

Course Objectives:

1. To make the students to understand the energy scenario and the environmental issues related to the power plants.
2. To put emphasis on creating awareness to the students on the various utilities in the power plants and the avenues for optimizing them.
3. To learn and study the radiation principles with respective solar energy estimation and to understand about PV technology principles and techniques.
4. To learn economic and environmental merits of solar energy for variety of applications.

Course Contents:

Sr. No	Course Contents	No. of Lectures
1.	E.C cycles– Gas turbine & Sterling-Gas turbine cycles–thermodynamic analysis– cycle improvements- Intercoolers, Re heaters, regenerators. Cogeneration systems–topping & bottoming Cycles-Performance indices of cogeneration systems– Heat to power Ratio-Thermodynamic performance of steam turbine cogeneration systems–gas turbine cogeneration systems.	06
2.	Modern Combustion Technologies, Advance ultra-super critical technology, zero emission coal power plant, denitrification and desulphurization, ESP Technologies, Supercritical power plants, Heat transfer and Fluid Flow in Nuclear Power Plants. PWR and BWR.	04
3.	Solar Radiation and Collector Systems: Solar angles–Sun path diagrams–Radiation-extraterrestrial characteristics-measurement and estimation on horizontal and tilted surfaces-flat plate collector thermal analysis-testing methods-evacuated tubular collectors-concentrator collectors–classification-design and performance parameters-tracking systems-compound parabolic concentrators-parabolic trough concentrators-concentrators with point Focus-Heliostats– performance of the collectors. Solar Power Plants Solar	06
4.	Thermal Technologies: Principle of working, types, design and operation of-Solar heating and cooling Systems-Thermal Energy storage systems–Solar Desalination– Solar cooker: domestic, community– Solar pond–Solar drying	06
5.	Solar PV Technologies: Semiconductor–properties-energy levels-basic equations of semiconductor devices physics. Solar cells-p-n junction: homo and hetro junctions-metal-semiconductor interface- dark and illumination characteristics-figure of merits of solar cell-efficiency limits-variation of efficiency with band-gap and temperature-efficiency measurements-high efficiency cells–Solar thermo- photovoltaic.	06

Sr. No	Lab contents	No. of Hours: 14
1	Evaluation of UL, FR and η in Thermosyphonic mode of flow with fixed input parameters	2
2	Determine the Performance (UL, FR, η) of the Parabolic Trough collector with fixed parameters with (i) Water and (ii) Oil as working fluid.	4
4	Charging period analysis of system containing any PCM	2
5	Mini Project: Solar Resource Forecasting using AI Techniques	6

Course Outcomes

At the end of the course, students will have:	
1	Understanding of possible mitigation of anthropogenic emissions by optimizing the power plant cycles/utilities.
2	Knowledge of working principle and design strategies of power plant system components.
3	Expertise in the design of solar photovoltaic based power systems for both domestic and industrial applications.

Bibliography:

Sr.No	Book Detail	Year of Publication
1.	Goswami, D.Y., Kreider, J. F. and & Francis., Principles of Solar Engineering, Taylor and Francis,2000	2000
2.	Chetan Singh Solanki, Solar Photovoltaic's–Fundamentals, Technologies and Applications, PHI Learning Private limited, 2011	2011
3.	Sukhatme S P, J K Nayak, Solar Energy–Principle of Thermal Storage and collection, Tata McGraw Hill, 2008.	2008
4.	Solar Energy International, Photovoltaic–Design and Installation Manual–New Society Publishers, 2006	2006
5.	Roger Messenger and Jerry Vnetre, Photovoltaic Systems Engineering, CRC Press, 2010	2010

Classical Books:

Sr.No	Book Detail	Year of Publication
1.	Wood, A.J., Wollenberg, B.F., Power Generation, operation and control, John Wiley, New York,1984.	1984
2.	Gill, A.B., Power Plant Performance, Butterworth's, 1984.	1984
3.	Lamarsh, J.R., Introduction to Nuclear Engg.2nd edition, Addison-Wesley, 1983	1983

MOOCS Links

Sr. No	Link
1.	http://nptel.ac.in/courses/112105050/ Solar Energy Technology by Prof. V.V. Satyamurty ,IIT Kharagpur
2.	http://nptel.ac.in/courses/108105058/ MEMS by Prof. Santiram Kal ,IIT Kharagpur Prof. S. Banerjee ,IIT Kharagpur

Course Name	**:**	**Advance Heat Transfer and Heat Recovery Systems**
Course Code	**:**	
Credits	**:**	**3**
L T P	**:**	**2 1 0**
Segments	**:**	**1-6**

Total No. Lectures: -28
Total No. Tutorials: -14

Course Objectives:

1. To analyze the basic energy generation cycles along with a detailed idea about the concept of cogeneration, its types and probable areas of applications.
2. To give an overview about various methods of Waste Heat Recovery in industry to harness the available energy potential.
3. To be able to design and analysis heat transfer and heat recovery system.

Course Contents:

Sr.No	Course Contents	No. of Lectures
1.	Overview of Cogeneration technologies: Configuration and thermodynamic performance, conventional and advanced cogeneration systems, fuel cell technology.	06
2.	Design and estimation of heat transfer of complex energy systems, Heat integration and methods of recovery, Case studies related to heat transfer analysis of various equipments used in utility and process industries.	06
3.	Waste heat recovery systems: Selection criteria for waste heat recovery technologies, recuperators, Regenerators, economizers, plate heat exchangers.	05
4.	Waste heat boilers, classification, location, service conditions, design Considerations, fluidized bed heat exchangers, heat pipe exchangers.	05
5.	Economic analysis: Investment cost, economic concepts, measures of economic Performance, procedure for economic analysis, examples procedure for optimized system selection and design, load curves sensitivity analysis.	06

Course Outcomes

At the end of the course, students will have:	
1	Analyze the performance of co-generation cycles.
2	Compare the performance of various cogeneration systems.
3	Illustrate the applications of cogeneration technologies.
4	Analyze the economic aspects of cogeneration system
5	Understand the importance of waste heat recovery system for harnessing of energy potential associated with waste heat.
6	To innovate in the area of estimation and exploitation of waste heat recovery associated with different energy systems.

Bibliography:

Sr. No	Book Detail	Year of Publication
1.	Charles H. Butler, Cogeneration, 3rd Edition, 2014	2014
2.	J.H. Horlock Cogeneration - Heat and Power, Thermodynamics and Economics, 2nd Edition 2016	2016
3.	Sengupta Subrata, Lee SS EDS, Waste Heat Utilization and Management, 3rd Edition, 2013	2013

Classical Books:

Sr. No	Book Detail	Year of Publication
1.	EDUCOGEN – The European Educational tool for cogeneration.	1999
2.	Institute of Fuel, London, Waste Heat Recovery, Chapman & Hall Publishers, 5th Edition, 1963	1963

MOOCS Links

Sr. No	Link
1.	http://nptel.ac.in/courses/103105052/ Advance Heat and Mass Transfer by Dr. Saikat Chakraborty ,IIT Kharagpur

Course Name	**:**	**Advance Forming and Surface Engineering**
Course Code	**:**	
Credits	**:**	**3**
L T P	**:**	**2 1/2 2*1/2**
Segments	**:**	**1-6**

Total No. Lectures:-28
Total No. Tutorial hours:-07
Total No. Lab hours:-14

Course Objectives:

1. To get familiar with the bulk plastic deformation of materials
2. To develop basic understanding about advance forming techniques used in miniaturization of products
3. To provide understanding of surface texture of different materials after deformation
4. To provides the understanding of surface modifications of the materials and their applications

Course Contents:

Sr. No	Course Contents	No. of Lectures
1.	Review of forming processes, theory of slip line, upper and lower bound theory, analysis of compression with coulomb friction, sticking friction, compression of circular disc with slipping friction, analysis of compression stresses of polygonal disc between two flat dies.	07
2.	Ekulund's formulation for rolling load, calculation and analysis of load in specific rolling in hot strips rolling, design of motor through calculation of motor torque for strip rolling processes. Analysis of load and stress for strip drawing and wire extrusion through curved dies.	07
3.	Approaches and classifications of surface engineering techniques, conventional Surface engineering Methods Applicable to analysis formation of advance ductile and brittle materials. Analysis of surface texture of electrically non conductive materials.	05
4.	Emerging surface engineering techniques, fabrication using top down and bottom up approaches, chemical and electro-chemical routes, Etching, deposition techniques of silicon nitride and titanium carbide etc by advance techniques.	05
5.	Surface engineering through advance micro machining, Economics of surface engineering processes	04

Lab Work

Sr. No	Lab. Contents	No. of Hours
1.	Project on micro-fabrication of miniature components and measurement of surface texture.	07
2.	Project on to develop set up for characterize the deformed / formed surfaces.	07

Course Outcomes

At the end of the course, students will have:	
1	To understand about the calculation and analysis of loads and stresses for different advance forming processes applied to ductile and brittle materials.
2	To be capable in measurement and analysis of deformed surface texture.
3	To be able to gather the knowledge about the fabrication of coating by different micro-fabrication techniques.

Bibliography:

Sr. No	**Book Detail**	**Year of Publication**
1	Fundamental of micro-fabrication and nano technology Vol.3 Marc. J Madon, CRC Press	2011
2	Micro advance fabrication by V K Jain	2014
3	Advance Metal Forming Processes by B. Avitzur McGraw Hill Book Company (UK)	2012

Classical Books:

Sr. No	**Book Detail**	**Year of Publication**
1	Mechanical Metallurgy by G E Dieter, NewYork McGraw-Hill.	1986
2	Surface Engineering & Heat Treatment By: P.H Morton I.I.T, Brooke field, (1991).	1991.
3	Metal Forming: Processes and Analysis by B. Avitzur McGraw Hill Book Company (UK)	1968
4	Metalworking science & Engineering by Edward M Mielnik (1991) McGraw Hill Series in Materials Science and Engineering.	1991
5	Metals Hand book, Vol.10, Failure Analysis and Prevention, (10th Edition), Jaico, 1999.	1999

MOOCS Links

Sr. No	Link
1.	http://nptel.ac.in/courses/112107248/ Fundamentals of Surface Engineering: Mechanisms, Processes and Characterizations by Dr. D. K. Dwivedi ,IIT Roorkee

Course Name	**:**	**Fabrications and Processing of Advance Materials**
Course Code	**:**	
Credits	**:**	**3**
L T P	**:**	**2 1/2 2*1/2**
Segments	**:**	**1-6**

Total No. Lectures:-28
Total No. Tutorial hours:-07
Total No. Lab hours:-14

Course Objectives:

1. To understand about the fabrication techniques of advanced materials.
2. To understand the properties and behaviour of advanced bio-materials
3. To gain the knowledge to operate CNC machining centres for fabrication of micro-dimensional components and turbine blades.
4. To gain the knowledge of fabrication of modern IC engine piston rings.

Course Contents:

Sr. No	**Course Contents**	**No. of Lectures**
1.	Overview on advance materials and fabrication in micro-nano dimension based on Taniguchi techniques, character and properties of biomaterials, polyester and polymers. E-glass and S-glass fibre composites.	04
2.	Fabrication Techniques: Advanced multiphase material, photo-elastic materials, glass fibres, Organic and Thermoplastics like Tg, POC, PVC, PET, PEN, Polimmide, PTFE, Biomaterials, plastic and polymers.	06
3.	Properties of advanced materials: Fatigue and Fracture, Design considerations from fatigue point of view, Residual and proof stresses, Creep, Deformation mechanism maps, choice of materials for creep resistance, Selection of materials for various engineering applications.	06
4.	Utilization of Advanced CNC Machining Centres for fabrication of advanced conductive and non conductive materials turbine blades and micro-dimensional gears, Fabrication of SGCI for modern IC engine piston rings.	05
5.	Patterning, Subtractive, Additive processes for micro-fabrication of advanced materials.	03
6.	Characterisation of Advance Materials after fabrication by Photoemission Spectroscopy, EDS, residual stress measurement, Optical microscopy, Scanning Electron Microscopy, Scanning Tunnelling Microscopy, Transmission Electron Microscopy, Thermal characterization.	04

Lab Work

Sr. No	Lab. Contents	No. of Hours
1.	To fabricate the turbine blades and micro-dimensional gears on CNC Machine.	06
2.	To study and analyse the surface topography by using various techniques.	04
3.	To fabricate SGCI piston rings.	04

Course Outcomes

At the end of the course, students will be able to:	
1	Understand fabrication techniques of advanced materials.
2	Understand the properties and behavior of advanced bio-materials
3	The knowledge to operate CNC machining centres for fabrication of micro-dimensional components and turbine blades.
4	The knowledge of fabrication of modern IC engine piston rings.

Bibliography:

Sr. No	**Book Detail**	**Year of Publication**
1	Metal Fabrication Technology by S Mukharjee PHI Publication	2010
2	Elements of X-ray Diffraction by B D Cullity and S R Stock, Prentice hall.	2001.
3	Fabrication Engineering, S.A. Campbell, Oxford University Press 4th Edition	2012

Classical Books:

Sr. No	**Book Detail**	**Year of Publication**
1	Mechanical Metallurgy by George E. Dieter	1989

MOOCS Links

Sr. No	Link
1.	http://nptel.ac.in/courses/112104162/ Advanced manufacturing process for micro system fabrication by Dr. Shantanu Bhattacharya, IIT Kanpur

Course Name	**:**	**Manufacturing Management & Logistic Systems**
Course Code	**:**	
Credits	**:**	**3**
L T P	**:**	**2 - 1/2 – 2*1/2**
Segments	**:**	**1-6**

Total No. Lectures:-28
Total No. Tutorial hours:-07
Total No. Lab hours:-14

Course Objectives:

1. To provide basic understanding on management of manufacturing systems.
2. To determine proper location and design the plant suitable layout.
3. To provide basic understanding and application of suitable methods of sales forecasting for various firms, to identify suitable techniques for job assignments on various machines.
4. To provide understating of latest scheduling techniques.
5. To provide basic understanding, recent trends and potential of Supply Chain Management

Course Contents:

Sr. No	Course Contents	No. of Lectures
1.	Manufacturing Systems: Types and Applications, Facilities location and Layout, Mathematical Models for single facility location using Euclidean and Rectilinear distances. Layout Design– Heuristic algorithms: CRAFT, ALDEP and CORELAP.	07
2.	Methods of forecasting: Time Series, Correlation and regression analysis, exponential smoothing for seasonal data. Measuring forecasting accuracy.	07
3.	Sequencing and Job scheduling. Inventory control Systems, MRP, MRP-II and ERP. Project Management Techniques, Project scheduling with resource constraints.	07
4.	Supply Chain Management: Objectives and Key elements: sourcing, distribution strategy, customer service strategy, Generic activities, architecture of supply Chain, Recent trends and Future potential: Reverse logistics, JIT –II, Milk Round System, Bar coding, Hub and spoke concept and other latest concepts	07

Lab Work

Sr.No	Lab. Contents	No. of Hours
1.	Case Study based on Layout Design of industry using Heuristic algorithms-CRAFT, ALDEP and CORELAP.	2
2.	Discussion on the collected data on the Design of plant layouts	2
3.	Case Study based on forecasting methods to compute the future demands, using actual sales and production data of industry.	2
4.	Case Study based on calculation of forecasting errors using MAD, Bias and MAPE methods	2
5.	Case Study based on job sequencing and job scheduling of nearby industries	2
6.	Case Study to compute the EOQs and conduct the ABC analysis on some items of an industry.	2
7.	Discussion on the collected data on the inventory levels of the industries	2

Course Outcomes

At the end of the course, students will:	
1	Understand the basic concepts of various types of manufacturing systems.
2	Understand the basic concepts and applications of forecasting techniques
3	Understand the various aspects of Plant location and layouts
4	Understand the concepts inventory control models of Materials Management, MRP and MRP-II.
5	Come up with new ideas for Sequencing and scheduling of jobs in the industry.
6	Understand the concepts of Project management techniques in actual projects.
7	Understand the concepts of Supply Chain Management and implementation in various firms

Bibliography:

Sr. No	**Book Detail**	**Year of Publication**
1	Production Management: Buffa and Sarin, John Wiley Publication.	2007
2	Operations Research – An Introduction: A.H. Taha, Macmillan Co., New York	2007
3	Manufacturing Operations and Supply chain management (The Lean Approach): Taylor & Brunt, Business Press Thomson Learning, NY	2000
4	Computer Aided Production Management: P. B. Mahapatra, PHI, India	2004
5	Fundamentals of Supply Chain Management, by Dawei Lu, Ventus Publishing Aps	2011

Classical Books:

Sr. No	**Book Detail**	**Year of Publication**
1	Operation Research: Gupta and Hira, S. Chand Publication, Delhi	1976
2	Logistic Management- The Integrated Supply Chain Process by Donalad Bowersox, McGraw Hill, NY.	1996

Course Name	**:**	**Advanced Metal Cutting, Measurement and Analysis**
Course Code	**:**	
Credits	**:**	**3**
L T P	**:**	**2 ½ 2*1/2**
Segments	**:**	**1-6**

Total No. Lectures:-28
Total No. Tutorial hours:-07
Total No. Lab hours:-14

Course Objectives:

1. To provide knowledge about the principles of metal cutting, clear understanding about the mechanics of cutting of advanced materials.
2. To provides knowledge about the factors critical to economical design of machining processes essential for manufacturing industry.
3. To provide knowledge about the measurement procedure and techniques of tool wear, cutting forces, chip dimensions, surface roughness heights and analysis for machinability of the advanced materials.
4. To provide knowledge for design of dynamometer and use of transducer in measurement of cutting force during metal cutting.

Course Contents:

Sr. No	Course Contents	No. of Lectures
1.	Review on machinability. Kinematics of metal cutting. Steriometry of cutting tools, Tool geometry and tool point reference systems. Rake angle: method of master line and interrelationship.	04
2.	Mechanics and dynamics of shearing strain and factors involved in chip formation analysis. Chip reduction coefficient, effect of cutting variables. Effect of nose radius and inter relationship between various standard systems.	04
3.	Tool failure and form stability criterion. Analysis of brittle fracture, wear and criterion of cutting tools. Tool life equations and optimum tool life. Forces system and determination of cutting forces. Ernst and Merchants upper bond solution, Merchant's second solution and machining constant. Selection of cutting tools.	05
4.	Correlation of standard mechanized test. Tool life test. Measurements techniques: BUL and BUE, tool wear, chip length and thickness, cutting forces, surface roughness heights.	05
5.	Design requirement of dynamometers and transducers, Methods and measurement of cutting forces during turning, drilling and milling. Effect of cutting variables on cutting forces. Test to identify machinability index.	05
6.	Economics in machining and multi-pass cutting, Gilbert's Model, Optimal cutting speed for Maximum production; Maximum profit cutting speed, objective criteria for optimization, Machined surface metallurgy and topography, Analysis the effect of process parameters and insert geometry on machinability during cutting of composite, ceramics, plastics, biomaterials and super alloys.	05

Lab Work

Sr. No	Lab. Contents	No. of Hours
1.	To measure the cutting forces during turning, drilling and verify it with theoretically calculated values.	07
2.	To measure the build up edge, tool wears and machined surface roughness heights and analyse.	07

Course Outcomes

At the end of the course, students will have:	
1	Understanding of the basic concepts of metal cutting and measurement of cutting forces on conventional and CNC Machines
2	Understanding of the concepts about the generation of cutting forces and tool wears.
3	Understanding of the various aspects of mechanism of chip formation.
4	Understand the concept of failure of cutting tools.
5	Understand about the application of machining technique and selection of proper tool for advanced materials machining

Bibliography:

Sr. No	**Book Detail**	**Year of Publication**
1	Metal Cutting Principles, M. C. Shaw, CBS Publishers & Distributors (December 1, 2002)	2002
2	Manufacturing Science by Amitava Ghosh, and Asok kumar Mallik, Affiliated East-West Press Private Limited, New Delhi,	2010
3	Metal Cutting - Theory and Application, Janez Kopac, University of Banjaluka, Faculty of Mechanical Engineering,	2010

Classical Books:

Sr. No	**Book Detail**	**Year of Publication**
1	Metal Cutting Theory and Practice, A. Bhattacharyya, Central book, Publisher, Calcutta-9,	1984

MOOCS Links

Sr. No	Link
1.	http://nptel.ac.in/courses/112105233/ Metal Cutting and Machine tools by Dr. Asimava Roy Choudhury, IIT Kharagpur

OPEN ELECTIVE

Course Name	**:**	**MEMS and Micro System Design**
Course Code	**:**	
Credits	**:**	**3**
L T P	**:**	**2 1/2 2*1/2**
Segments	**:**	**1-6**

Total No. Lectures:-28
Total No. Tutorials:-07
Total No. Practicals:-14

Course Objectives:

1. To provide the basic concepts of product design, product features, which will in still and inculcate the confidence in the students to create a new product of desired features.
2. To explore the world of micro-electro-mechanical devices and systems by looking into their material properties, fabrication technologies, basic structural mechanics, calibration, and testing

Course Contents:

Sr. No	Course Contents	No. of Lectures
1.	Micro-Electro-Mechanical-Systems (MEMS) and micro-system products; Multidisciplinary nature of micro-systems; Scaling laws in miniaturization;	05
2.	Application of micro-system in the industries; Intrinsic characteristics of MEMS; Sensors; Micro-actuation through thermal forces; SMA-Piezo electric crystals and electrostatic forces.	05
3.	Magnetic actuation; Micro-grippers; Micro-motors; Micro-valves; Micro pumps; Micro accelerometers; Materials.	06
4.	Mechanics and design of micro-systems; Piezo-resistors; Micro-fabrication and micro-etching. Applications of MEMS.	06
5.	Rapid Prototyping (RP) Methods; Liquid based RP methods-stereo-lithography apparatus (SLA), solid ground curing (SGC), solid creation system (SCS), etc.; Solid based RP methods: Fused deposition modeling (FDM), laminated object manufacturing (LOM), etc.; Powder based RP methods– selective laser sintering (SLS), 3D printing (3DP), ballistic particle manufacturing (BPM).	06

Lab Work

Sr. No	Lab. Contents	No. of Hours
1.	Project on Rapid Prototyping through fabrication of miniature component on 3D printing.	07
2.	Project on fabrication of miniature components utilising micro etching and additive processes.	07

Course Outcomes

At the end of the course, students will:	
1	Be able to apply different techniques used in product design and development
2	Be able to familiar with the important concepts applicable to MEMS
3	Be able to identify the basic devices to be used in any MEMS systems
4	Be able to design, analyze and test the MEMS
5	Be able to apply the MEMS for different industrial applications

Bibliography:

Sr. No	Book Detail	Year of Publication
1	The MEMS Handbook, Design and Fabrication, 2nd Edition, Mohamed Gad-el-Haq, Taylor and Francis	2005
2	MEMS and Micro system Design and Manufacturing: TR Hsu, Tata McGraw Hill	2017
3	Foundation of MEMS: C Liu, Pearson Education	2017
4	Micro sensors, MEMS and Smart devices: JW Gardner, VK Varadhan, John Wiley & Sons	2001
5	Nano structure and Nano materials, synthesis, properties and applications: G Cao, Ying, World Scientific Publishing Co.	2011
6	Nano Scale Science and Technology: Robert K, Ian WH, Mark Geoghegan	2005

Classical Books:

Sr. No	Book Detail	Year of Publication
1	Product Design and Manufacturing: Chitale, AK and Gutpa, RC, Prentice Hall.	1997
2	Rapid Prototyping: Principles and Applications in Manufacturing: Chua, CK and Leong, KF, John Wiley & Sons.	1997

Course Name	**:**	**Maintenance and Reliability Engineering**
Course Code	**:**	
Credits	**:**	**3**
L T P	**:**	**2 1 0**
Segments	**:**	**1-6**

Total No. Lectures:-28
Total No. Tutorials:-14

Course Objectives:

1. To provide basic understanding on the contribution of maintenance towards achieving competitive advantage in the industries.
2. To understand the concepts and issues of Maintenance in both manufacturing and service organization, Planning of maintenance function; material policy for maintenance, and spare parts management.
3. To provide understanding on the Reliability and Maintainability,
4. To provide reliability structure and optimum design configuration of series, parallel and combinations

Course Contents:

Sr. No	Course Contents	No. of Lectures
1.	Overview of Maintenance, objectives, responsibilities of the maintenance department, Types of maintenance: corrective, operating practices in Maintenance, Planning of maintenance function; materials procurement policies for maintenance.	05
2.	Management of spare parts, inventory control, Safety aspect in maintenance, Total productive maintenance, Computerized Maintenance information system, Condition monitoring, Maintenance aspect of electronics equipments, Economic aspect of Maintenance,	05
3.	Destructive & Non- destructive testing and semi destructive testing, liquid penetration test, magnetic particle test,	04
4.	Probability distributions, Reliability and Maintainability, Bath-tub curve, Hazard Rate concept, Quantitative estimation of reliability of parts, Reliability, maintainability, failure, availability, Reliability structure and optimum design configuration of series, parallel, combination of series and parallel, redundancy structure.	07
5.	Mean time to failure (MTTF), Mean time between failures (MTBF), mean time to repair (MTTR), Statistical estimation of Reliability Indices, Machine failure pattern: Breakdown time distribution, Design for reliability and maintainability, Reliability aspect of Electronics equipments.	07

Course Outcomes

At the end of the course, students will:	
1	Understand the Maintenance Concepts, objectives and characteristics of maintenance engineering, responsibilities of the maintenance department.
2	Understand the concepts of various strategies, philosophies, schemes of maintenance management.
3	Understand the concepts of Planning strategies and policies for maintenance, and spare parts management.
4	Come up with new ideas for the applications of maintenance engineering in the maintenance of particular type of machines and plants.

5	Understand the concepts of Reliability and Maintainability, Bathtub curve, Hazard Rate concept, Quantitative estimation of reliability of parts, Reliability, maintainability, failure, availability.
6	Understand the concepts of configuration of series, parallel, combination of series and parallel, redundancy structure,
7	Understand the concepts of Economic aspect and use of quality control in maintenance.

Bibliography:

Sr. No	Book Detail	Year of Publication
3	Maintenance Planning and Control by Enthory Kelly, EW Publication, N. Delhi.	2006
4	A text Book of Reliability and Maintenance Engineering: Alakesh Manna, I. K. International Publishing House Pvt. Ltd., New Delhi.	2011
5	Reliability Engineering: L.S. Srinath , 4th Edn., East West Press.	2005

Classical Books:

Sr. No	Book Detail	Year of Publication
1	Preventive Maintenance by Terry Weriman, Reston Publishing Co.	1984
2	Principle of Planned maintenance by Clifton, R. H, McGraw Hill Pub.	1974
3	Reliability Engineering: K. K. Aggarwal, Springer Pub.	1993

MOOCS Links

Sr. No	Link
1.	http://nptel.ac.in/courses/112104162/ Advanced manufacturing process for micro system fabrication by Dr. Shantanu Bhattacharya, IIT Kanpur

Course Name	**:**	**Fabrication Techniques of Advance & Smart Materials**
Course Code	**:**	
Credits	**:**	**3**
L T P	**:**	**2 1/2 2*1/2**
Segments		**1-6**

Total No. Lectures:-28
Total No. Tutorials:-07
Total No. Practicals:-14

Course Objectives:

1. To provide knowledge about the chemical, physical, mechanical properties, and behaviour of materials as well as engineering applications of advanced materials.
2. To provides the brought idea and knowledge about the recent trend in advanced and smart materials.
3. To provide knowledge about the fabrication and manufacturing processes of the different advanced and smart materials.

Course Contents:

Sr. No	Course Contents	No. of Lectures
1.	Review on engineering materials, Conductive, Semi-conductive and Insulating materials: properties, behaviors, fabrication techniques and industrial applications.	06
2.	Advanced and Smart Materials: ceramics, composites, nano-materials, refractory materials, optical fibres, piezoelectric, electrostrictive, magnostrictive, plastics, polymer, bio-materials. Their properties, advantages, disadvantages, scope and industrial applications.	06
3.	Amo-ferrous and shape memory alloy, advanced brazing and soldering materials, Cermets, UCON, SIALON, Borazon: properties, scope and engineering applications.	04
4.	Concept of advanced fabrication and manufacturing. Micro manufacturing, micro and nano fabrication: methods and techniques, limitation and applications.	04
5.	Lithography, Fabrication process of Si-Wafer, Etching, Bonding and packaging, Film deposition and doping, CVD and PVD,	04
6.	SOC and SIP, Smart technological system fabrication, Industrial applications of micro components and micro systems.	04

Lab Work

Sr. No	Lab. Contents	No. of Hours
1.	Project on pattering of advance materials.	05
2.	Project on fabrication of micro-components via subtractive processes	05
3.	Project on fabrication of SOP	04

Course Outcomes

At the end of the course, students will have:	
1	Understand the basic concepts of various advanced and smart engineering materials.
2	Understand the various aspects of material characteristics through gathering the knowledge on various property of the advanced materials
3	Understand about the chemical composition of such materials and their industrial applications.
4	Able to select suitable and alternative materials for fabrication of smart technology system.
5	Understand about the micro and nano-fabrication techniques.
6	Understand the basic concepts about the applications of advanced and micro fabrication techniques, and able to select appropriate and alternative materials for smart system.
7	Able to fabricate the smart technological system.

Bibliography:

Sr. No	Book Detail	Year of Publication
1	Design, Fabrication, Properties and Applications of Smart and Advanced Materials: XuHOu, CRC Press, Taylor & Francis Group	2016
2	Advanced Engineering Materials and Modeling: Ashutosh Tiwari, N. Arul Murugan and Rajeev Ahuja, John Wiley & Sons	2016
3	Bio Material: An Introduction, Joon Park & R.S. Lakes, third Edition, Springer,	2007
4	Design, Fabrication, Properties and Applications of Smart and Advanced Materials: XuHOu, CRC Press, Taylor & Francis Group	2016
5	Micro and Nano Fabrications: Hans H. Gatzen, Volker Saile, Jurg Leuthold, Springer,	2015
6	Bio Material: An Introduction, Joon Park & R.S. Lakes, third Edition, Springer	2007

Course Name	**:**	**Advance Internal Combustion Engine Technology**
Course Code	**:**	
Credits	**:**	**3**
L T P	**:**	**2 1/2 2*1/2**
Segments	**:**	**1-6**

Total No. Lectures:-28
Total No. Tutorials:-07
Total No. Practicals:-14

Course Objectives:

1. To impart basic and advanced knowledge on fuel combustion engines.
2. To provide basic understanding related to thermo-chemistry, chemical kinetics, transport phenomena including mass transfer required for understanding of intricate combustion process.
3. To give students comprehensive idea of mechanisms of combustion generated air pollution and the techniques that can be used to control them.

Course Contents:

Sr. No	Course Contents	No. of Lectures
1.	Fuels for I.C. Engines and their characteristics, combustion in S.I. and C.I. Engines, knocking, delay, fuel spray and mixing, and other abnormalities, combustion chambers, pollutant formation and control including catalytic converters, Advanced theory of carburetion.	07
2.	Cooling and governing of engine, Ignition system: conventional and advanced electronic systems, supercharging, variable compression ratio engine, exhaust emissions, its measurement and control, Fault diagnosis of S.I. and C.I. Engines.	07
3.	Theories of premixed laminar and turbulent flames; concepts of ignition, flame stabilization, extinction and quenching, methods of solving laminar flame problems; effects of different variables on flame speed; methods of measuring flame velocity; flame quenching, non-pre-mixed systems; Burke-Schumann's theory of laminar diffusion flames; Droplet burning; Laminar diffusion flames.	08
4.	Theories of gaseous diffusion flames; droplet and spray combustion: theories of atomization spray combustion models, spray combustion characteristics and design of burners; mechanism and kinetics of coal combustion; fluidized bed combustion.	06

Lab Work

Sr. No	Lab. Contents	No. of Hours
1.	Study the use of blended fuels on variable compression ratio engine	06
2.	Study and analysis of knocking and other abnormalities in IC engines	04
3.	Project on design and modification in latest carburetion and ignition systems.	04

Course Outcomes

At the end of the course, students will:	
1.	Gain knowledge about the internal combustion engine technology.
2.	Gain knowledge about the fundamentals of thermodynamics in internal combustion engines.
3.	Gain information to follow recent developments about the internal combustion engine technology.

Bibliography:

Sr. No	Book Detail	Year of Publication
1.	V. Ganeshan: I. C. Engines, 5th Edition, 2016	2016
2.	Heywood: Internal Combustion Engine Fundamental, 2nd Edition, 2011	2011
3.	W. W. Pulkrabek: Engineering Fundamentals of I. C. Engines, 4th Edition, 2016	2016
4.	C.R. Ferguson and A.T. Kirkpatrick, Internal Combustion Engines, 3rd Edition, 2015	2015
5.	Turns: An Introduction to Combustion: Concepts and Applications, 6th Edition, 2011	2011
6.	K. K. Kuo, Principles of Combustion, 4th Edition, 2010	2010
7.	Applied combustion, by Eugene L. Keating. 3rd Edition, 2007	2007

MOOCS Links

Sr. No	Link
1.	http://nptel.ac.in/courses/101104070/ Introduction to combustion-I by Prof. D P Mishra IIT Kanpur
2.	http://nptel.ac.in/courses/101104072/ Introduction to combustion-II by Prof. D P Mishra IIT Kanpur