SRI MANAKULA VINAYAGAR
ENGINEERING COLLEGE
(An Autonomous Institution)

Puducherry

DEPARTMENT OF MECHANICAL ENGINEERING

M.TECH.

MANUFACTURING ENGINEERING

(REGULATIONS - 2020)

CURRICULUM AND SYLLABI

20 years of ACADEMIC EXCELLENCE

Head
Department of Mechanical Engineering
Sri Manakula Vinayagar Engineering College
Madagadipet, Puducherry - 605 107.

COLLEGE VISION AND MISSION

Vision

To be globally recognized for excellence in quality education, innovation and research for the transformation of lives to serve the society.

Mission

M1: Quality Education:

To provide comprehensive academic system that amalgamates the cutting edge technologies with best practices.

M2: Research and Innovation:

To foster value-based research and innovation in collaboration with industries and institutions globally for creating intellectuals with new avenues.

M3: Employability and Entrepreneurship:

To inculcate the employability and entrepreneurial skills through value and skill based training.

M4: Ethical Values:

To instill deep sense of human values by blending societal righteousness with academic professionalism for the growth of society.

DEPARTMENT VISION AND MISSION

Vision

The Mechanical Engineering department strives to be recognized as an excellent academic and research center for creating outstanding Engineers, Entrepreneurs and Leaders

Mission

M1: Professional Skills:

To provide quality education to enhance students inter-personal and intra-personal skills

M2: State-of-art facilities:

To render excellent infrastructure facilities and laboratories to excel as skilled professionals

M3: Research Exposure:

To Strengthen Research and Development within the department through industrial associations

M4: Employability:

To put enthusiastic exertions to enhance employability and entrepreneurship skills of students

M5: Human Values:

To empower students with professional ethics and human values to serve the society

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PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO1: Technical knowledge

To foster our young graduates with cogent technical knowledge so as to make them employable

PEO2: Real-Time Applications

To apply the acquired knowledge in the field of Mathematics, Science and Engineering in developing real-time projects

PEO 3: Design Ability

To design a system, component or process to meet the desired needs within realistic constraints such as manufacturing, economy, environmental sustainability, social, health and safety

PEO 4: Ethics

To prepare the students to become entrepreneurs with professional attitude in the broader ethical perspective

PEO 5: Life - Long Learning

To craft curiosity among students for life-long learning through self-study

PROGRAMME OUTCOMES (POs)

Upon Completion of the two years of the Master of Manufacturing Engineering Degree

PO1: Exploration of Research:

An ability to independently carry out research/investigation and development work to solve practical problems.

PO2: Technical Skill:

An ability to write and present a substantial technical report/document.

PO3: Expertise in Academics:

Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.

PO4: Problem solving:

An ability to discriminate, analyze, evaluate and synthesize the technologies to provide solution for multidimensional engineering problems.

PO5: Usage of Modern Tools:

Create, select, learn and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to complex engineering activities with an understanding of the limitations.

PO6: Ethical Practices and Social Responsibility:

Acquire professional and intellectual integrity, professional code of conduct, ethics of research and scholarship, consideration of the impact of research outcomes on professional practices and an understanding of responsibility to contribute to the community for sustainable development of society.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO 1: Impart knowledge in the latest technologies to provide opportunities in the field of manufacturing systems.

PSO2: Apply modern computational, analytical, simulation tools and techniques to face the challenges in manufacturing and its integration.

PSO3: Develop research aptitude and cater to the increasing need for better solutions to complex and contemporary problems in manufacturing processes.

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SEMESTER – I											
Sl. No.	Course Code	Course Title	Category	Periods			Credits	Max. Marks		
				L	T	P		CAM	ESM	Total
Theory											
1	P20BST105	Engineering Probability and Statistics	BS	2	2	0	3	40	60	100
2	P20MET101	Mechanical Behavior of Materials	PC	3	0	0	3	40	60	100
3	P20MET102	Automation in Manufacturing	PC	3	0	0	3	40	60	100
4	P20MET103	Tool Design Engineering	PC	3	0	0	3	40	60	100
5	P20CCT101	Research Methodology and IPR	PC	3	0	0	2	40	60	100
6	P20MEE1XX	Professional Elective- I *	PE	3	0	0	3	40	60	100
Practical											
7	P20MEP101	Computer Aided Engineering Laboratory	PC	0	0	4	2	50	50	100
8	P20CCP101	Technical Report Writing and Seminar	PC	0	0	4	2	100	0	100
Audit Course											
9	P20ACT10X	Audit Course -I **	AC	0	0	2	0	100	0	100
Employability Enhancement Course											
10	P20MEC1XX	Employability Enhancement Course –I #	EEC	0	4	0	0	100	0	100
Total							21	590	410	1000

SEMESTER – II											
Sl. No.	Course Code	Course Title	Category	Periods			Credits	Max. Marks		
				L	T	P		CAM	ESM	Total
Theory											
1	P20MET204	Advanced Manufacturing Processes	PC	3	0	0	3	40	60	100
2	P20MET205	Micro Electro Mechanical Systems(MEMS) and Nano Technology	PC	3	0	0	3	40	60	100
3	P20MET206	Metal Cutting Theory and Practice	PC	3	0	0	3	40	60	100
4	P20MET207	Industrial Robotics and Material Handling Systems	PC	3	0	0	3	40	60	100
5	P20MEE2XX	Professional Elective –II *	PE	3	0	0	3	40	60	100
6	P20MEE2XX	Professional Elective- III *	PE	3	0	0	3	40	60	100
Practical											
7	P20MEP202	Advanced Manufacturing Laboratory.	PC	0	0	4	2	50	50	100
8	P20CCP202	Seminar on ICT a hands on approach	CC	0	0	4	2	100	0	100
Audit Course											
9	P20ACT20X	Audit Course-II **	AC	0	0	2	0	100	0	0
Employability Enhancement Course											
10	P20MEC2XX	Employability Enhancement Course-II #	EEC	0	0	4	0	100	0	100
Total							22	590	410	1000

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SEMESTER – III										
Sl. No.	Course Code	Course Title	Category	Periods			Credits	Max. Marks		
				L	T	P		CAM	ESM	Total
Theory										
1	P20MEE3XX	Professional Elective- IV *	PE	3	0	0	3	40	60	100
2	P20MEE3XX	Professional Elective- V *	PE	3	0	0	3	40	60	100
3	P20MEE3XX	Professional Elective- VI *	PE	3	0	0	3	40	60	100
Practical										
4	P20MEW301	Project Phase - I	PW	0	0	12	6	50	50	100
5	P20MEW302	Internship	PW	0	0	4	2	100	0	100
Employability Enhancement Course										
6	P20MES301	NPTEL/GIAN/MOOC	MC	0	0	4	0	100	0	100
Total							17	370	230	600

**** Professional Elective Courses are to be selected from the list given in Annexure I***
\# Employability Enhancement Courses are to be selected from the list given in Annexure II
***** Audit Courses are to be selected from the list given in Annexure III***

SEMESTER – IV										
Sl. No.	Course Code	Course Title	Category	Periods			Credits	Max. Marks		
				L	T	P		CAM	ESM	Total
Project Work										
1	P20MEW403	Project Phase - II	PW	0	0	24	12	50	50	100
Total							12	50	50	100

(PC – Professional Core, PE – Professional Elective, AC- Audit course, EEC – Employability Enhancement Course BS-Basic Science)

Credit Distribution

Semester-I	Semester -II	Semester -III	Semester -IV	Total
21	22	17	12	72

- MC and EEC course are not considered for CGPA calculation

Total number of credits required to complete
M.Tech in Manufacturing Engineering : **72 credits**

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ANNEXURE - I

PROFESSIONAL ELECTIVE COURSES

Sl. No.	Course Code	Course Title
Professional Elective – I (Offered Semester-I)		
1	P20MEE101	Advanced Additive Manufacturing
2	P20MEE102	Precision Engineering
3	P20MEE103	Virtual Manufacturing
4	P20MEE104	Manufacturing of Automotive Components
5	P20MEE105	Cellular Manufacturing Systems
Professional Elective – II (Offered Semester-II)		
1	P20MEE201	Mechatronics in Manufacturing
2	P20MEE202	Information Technology In Manufacturing Applications
3	P20MEE203	Artificial Intelligence and Expert Systems
4	P20MEE204	Design of Hydraulic and Pneumatic system
5	P20MEE205	Instrumentation and Control
Professional Elective – III (Offered Semester-III)		
1	P20MEE301	Mechatronic System Design
2	P20MEE302	Composite materials analysis and applications
3	P20MEE303	Integrated Product Development And Processes
4	P20MEE304	Advanced Finite Element Analysis
5	P20MEE305	Tribology in Design
Professional Elective – IV (Offered Semester-III)		
1	P20MEE401	Design for manufacturing and Assembly
2	P20MEE402	Design and Analysis of Experiments
3	P20MEE403	Advanced Optimization Techniques and Applications
4	P20MEE404	Industrial Design and Ergonomics
5	P20MEE405	Manufacturing system simulation
Professional Elective – V (Offered Semester-III)		
1	P20MEE501	Production and Operations Management
2	P20MEE502	Enterprise Resource Planning
3	P20MEE503	Lean Manufacturing and Six Sigma
4	P20MEE504	Supply Chain management
5	P20MEE505	Human Factors in Engineering
Professional Elective – VI (Offered Semester-III)		
1	P20MEE601	Advances in Casting and Welding Processes
2	P20MEE602	Fluid Power Automation
3	P20MEE603	Technology Management
4	P20MEE604	Engine Management Systems
5	P20MEE605	Maintenance and Reliability Engineering

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ANNEXURE - II

EMPLOYABILITY ENHANCEMENT COURSES

Sl. No.	Course Code	Course Title
1	P20MECX01	CATIA
2	P20MECX02	CNC Programme
3	P20MECX03	Rapid Prototyping
4	P20MECX04	3D Printing and Scanning
5	P20MECX05	Fusion 360
6	P20MECX06	Solidworks
7	P20MECX07	Autodesk Inventor
8	P20MECX08	CFD
9	P20MECX09	Creo (Modeling and Simulation)
10	P20MECX10	Ansys -Multiphysics
11	P20MECX11	Automation-I (Pneumatics)
12	P20MECX12	Automation-II (Hydraulic)
13	P20MECX13	CAD/CAM
14	P20MECX14	Industry 4.0
15	P20MECX15	Piping Design
16	P20MECX16	Deep Learning
17	P20MECX17	NDT Level I&II
18	P20MECX18	Safety Course (Boiler)
19	P20MECX19	Six Sigma
20	P20MECX20	Tool Designing

ANNEXURE - III

AUDIT COURSES

Sl. No.	Course Code	Course Title
1	P20ACTX01	English for Research Paper Writing
2	P20ACTX02	Disaster Management
3	P20ACTX03	Sanskrit for Technical Knowledge
4	P20ACTX04	Value Education
5	P20ACTX05	Constitution of India
6	P20ACTX06	Pedagogy Studies
7	P20ACTX07	Stress Management by Yoga
8	P20ACTX08	Personality Development Through Life Enlightenment Skills
9	P20ACTX09	Unnat Bharat Abhiyan

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P20BST105 ENGINEERING PROBABILITY AND STATISTICS

L	T	P	C	Hrs
2	2	0	3	45

Course Objectives

- To learn the fundamental concepts of probability theory and its distribution
- To introduce the basic concepts of two dimensional random variables.
- To acquaint the knowledge of testing of hypothesis for small and large samples.
- To understand the application of design of experiments.
- To understand the importance of control chart for measurement of X and R charts.

Course Outcomes

After completion of the course, the students will be able to

CO1 – Understand the concepts of discrete probability and random variables. **(K3)**
CO2 – Understand the independent and identically distributed random variables. **(K2)**
CO3 – Apply the applications of testing of hypothesis. **(K3)**
CO4 – Apply the concepts of randomized design and latin square design. **(K3)**
CO5 – Apply X and R chart in the applications of engineering problems. **(K3)**

UNIT I PROBABILITY AND RANDOM VARIABLES **(9 Hrs)**

Probability – The axioms of probability – Conditional probability – Baye's theorem – Discrete and continuous random variables – Moments – Moment generating functions – Binomial, Poisson, Geometric, Uniform, Exponential and Normal distributions.

UNIT II TWO – DIMENSIONAL RANDOM VARIABLES **(9 Hrs)**

Joint distributions – Marginal and conditional distributions – Covariance – Correlation and linear regression – Transformation of random variables – Central limit theorem (for independent and identically distributed random variables).

UNIT III TESTING OF HYPOTHESIS **(9 Hrs)**

Sampling distributions – Estimation of parameters – Statistical hypothesis – Large sample tests based on Normal distribution for single mean and difference of means -Tests based on t, Chi-square and F distributions for mean, variance and proportion – Contingency table (test for independent) – Goodness of fit.

UNIT IV DESIGN OF EXPERIMENTS **(9 Hrs)**

One way and two way classifications – Completely randomized design – Randomized block design – Latin square design – 2 factorial design.

UNIT V CONTROL CHART **(9 Hrs)**

Control charts for measurements (X and R charts) – Control charts for attributes (p, c and np charts) – Tolerance limits – Acceptance sampling.

Text Books

1. Roy D Yates and David J Goodman, "Probability and Stochastic Processes - A friendly Introduction for Electrical and Computer Engineers", John Wiley & Sons, New Delhi, 2012.
2. T. Veerarajan, "Probability, Statistics and Random Process", McGraw Hill Education, 2015.
3. Dougles C Montgomery and George C Runger, "Applied Statistics and Probability for Engineers", Wiley, New Delhi, 2012.

Reference Books

1. Saeed Ghahramani, "Fundamentals of Probability with Stochastic Processes", Prentice Hall, New Jersy, 2014.
2. J.Medhi, "Stochastic Processes", New Age International Publishers, New Delhi, 2014.
3. J. Ravichandran , "Probability and Statistics for Engineers", Wiley, New Delhi, 2019.

4. Arak M. Mathai, Hans J. Haubold, "Probability and Statistics: A Course for Physicists and Engineers", Oxford University Press, 5th Edition, 2016.
5. A. Chandrasekaran and G. Kavitha, "Probability, Random Process, Queueing Theory and Statistics", Dhanam Publications, 1st Edition, 2011

Web References

1. http://web.sonoma.edu/esee/courses/ee345/
2. https://nptel.ac.in/courses/111/105/111105090/
3. https://www.math.ucla.edu/~tom/Prob StatJ.html.
4. https://www.cambridge.org/core/journals/probability-in-the-engineering-and-informational-sciences.
5. https://nptel.ac.in/courses/111/105/111105041/

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)						Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
1	3	1	1	2	1	1	2	1	2
2	2	1	1	2	1	1	2	1	2
3	3	1	1	2	1	1	2	1	2
4	3	1	1	2	1	1	2	1	2
5	2	1	1	2	1	1	2	1	2

Correlation Level: 1- Low, 2 - Medium, 3 - High

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P20MET101 **MECHANICAL BEHAVIOR OF MATERIALS**

L	T	P	C	Hrs
3	0	0	3	45

Course Objectives

- To impart knowledge in the fields of Strengthening Mechanisms.
- To understand the basics of elasticity and plasticity of metals and polymers.
- To equip students with a wide ranging knowledge of high temperature materials problem.
- Defining and solving the engineering problems related to ruptures
- To understand various types of failures and design approach.

Course Outcomes

After completion of the course, the students will be able to

CO1 – Understand various strengthening mechanisms and solid solution. **(K2)**

CO2 – Understand the plastic deformation of metal and polymers. **(K2)**

CO3 – Analysis of creep failures under high temperature applications. **(K3)**

CO4 – Understand fatigue failure mechanism and protect the metals from fatigue damage. **(K2)**

CO5 – Understand brittle and ductile fractures mechanics of material. **(K2)**

UNIT I STRENGTHENING MECHANISMS **(9 Hrs)**

Introduction - Grain Boundaries and Deformation - Strengthening from grain boundaries - low angle grain boundaries - Yield point phenomenon - strain aging - solid solution strengthening - Deformation of two phase aggregates - Strengthening from fine particles - Fiber strengthening - Strengthening due to point defects - Martensite strengthening - cold worked structure - strain hardening - annealing of cold worked metal - Bauschinger effect - Preferred Orientation.

UNIT II THEORY OF ELASTICITY AND PLASTICITY **(9 Hrs)**

Elasticity Theory: The State of Stress and strain, elastic stress-strain relation, anisotropy, elastic behaviour of metals, ceramics and polymers. Plasticity: Hydrostatic and Deviatoric stress, Octahedral stress, yield criteria and yield surface, texture and distortion of yield surface, true stress and true strain, flow rules, strain hardening, Ramberg Osgood equation, stress -strain relation in plasticity, plastic deformation of metals and polymers

UNIT III CREEP **(9 Hrs)**

Creep and Stress Rupture - High temperature materials problem - Time dependent Mechanical Behaviour - creep curve - stress rupture test - structural changes - Mechanisms - Deformation mechanism Maps - Activation energy for steady state creep - super plasticity - fracture at elevated temperature – High Temperature alloys - Presentation of Engineering creep data - Prediction of long time properties

UNIT IV FATIGUE **(9 Hrs)**

Stress cycles - S - N curve - Statistical nature - Effect of mean stress - cyclic stress - strain curve - low cycle fatigue - strain life equation - structural features - Fatigue crack Propagation - Effect of stress concentration -size effect - surface effects & fatigue - Fatigue under combined effects - cumulative fatigue damage.

UNIT V FRACTURES **(9 Hrs)**

Fracture - Types of fracture in Metals - Theoretical Cohesive strength of metals - Griffith theory of brittle fracture - Fracture of single crystals - Metallographic aspects - Fractography - Dislocation theories of brittle fracture - Ductile fracture - Notch effects - concept of fracture curve - Fracture under combined stresses -Effect of high hydrostatic pressure on fracture.- Fracture Mechanics - Strain energy release rate - stress intensity factor - Fracture toughness and design. sequence effects - Effect of Metallurgical variables and fatigue - Design for fatigue - machine design approach - local strain approach - corrosion fatigue - Effect of temperature on fatigue.

Text Books

1. L.B. Freund and S. Suresh,,,,Thin Film Materials"", Cambridge University Press, 2003.
2. H.E.Davis. G.E Troxell , W.Hauck, "The Testing of Engineering Materials", McGraw-Hill,2007.
3. Thomas H. Courtney, "Mechanical Behavior of Materials", Mc Graw Hill , Second Edition, 2012.

Reference Books

1. Broek.D, Elementary Engineering Fracture Mechanics, 4th Edition.,Martinus Nijhoff Publishing , The Hague, 2008.
2. Marc Andr"e Meyers and Krishan Kumar Chawla, "Mechanical Behavior of Materials" Cambridge University Press, 2009.
3. George E. Dieter, "Mechanical Metallurgy", McGraw Hill Education, Third Edition, New Delhi, 2013.
4. Bhargava, A. K and Sharma, C. P, "Mechanical Behaviour and testing of Materials" PHI Learning Pvt. Ltd., Delhi. 2014.
5. Norman E. Dowling, "Mechanical Behavior of Materials", Pearson Education, Fourth Edition, 2015.

Web References

1. https://nptel.ac.in/courses/113/102/113102080/
2. https://www.coursera.org/learn/material-behavior
3. https://www.ntnu.edu/studies/courses/TMM4140/2016/1
4. https://nptel.ac.in/content/storage2/courses/112108150/pdf/PPTs/MTS
5. https://ocw.mit.edu/courses/mechanical-engineering/2-002-mechanics-and-materials-ii-spring-2004

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)						Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
1	3	1	3	3	2	1	3	2	3
2	2	1	2	3	2	-	3	2	3
3	3	1	3	3	1	-	3	3	3
4	3	1	3	3	2	-	3	3	3
5	3	2	3	3	2	1	3	3	3

Correlation Level: 1- Low, 2 - Medium, 3 - High

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P20MET102 **AUTOMATION IN MANUFACTURING**

L	T	P	C	Hrs
3	0	0	3	45

Course Objectives

- To impart knowledge in the field of Automated Manufacturing system.
- Illustrate the basic concepts of automation in production lines.
- To understand the fundamentals of automation in multi station assembly machines.
- Describe the importance of automated material handling and storage systems.
- To understand automated inspection principles and strategies in manufacturing.

Course Outcomes

After completion of the course, the students will be able to

CO1 – Understand the basic types, levels, strategies of automation. **(K2)**
CO2 – Explain the basic components and their functions of automated production line system. **(K2)**
CO3 – Understand the quantitative analysis of assembly systems. **(K2)**
CO4 – Understand various storage system and transportation requirements of automated systems. **(K2)**
CO5 – Apply appropriate process control strategy to an automated system. **(K3)**

UNIT I INTRODUCTION **(9 Hrs)**

Facilities – Manual work systems, worker-machine systems and automated systems. Manufacturing support systems, Automation in Production systems – Automated Manufacturing systems, Computerized manufacturing support systems, Manual labour in Production systems, Automation principles and strategies.

UNIT II AUTOMATED PRODUCTION LINES **(9 Hrs)**

Fundamentals- System configurations, work part transfer mechanisms, Storage buffers, and Control of the production line. Applications – Machining systems and System Design Considerations. Analysis of Transfer lines – Transfer lines with No internal parts storage, Transfer lines with internal storage buffers.

UNIT III AUTOMATED ASSEMBLY SYSTEMS **(9 Hrs)**

System configurations, Parts delivery at workstations, and applications, quantitative analysis of assembly systems-Parts Delivery System at Workstations, Multi-Station Assembly Machines, Single Station Assembly Machines, Partial Automation.

UNIT IV AUTOMATED MATERIAL TRANSPORT & STORAGE SYSTEMS **(9 Hrs)**

Automated Material Transport & Storage systems: Automated Guided Vehicle (AGV) Systems, Types and applications, Vehicle Guidance Technology, Vehicle Management and Vehicle safety. Automated Storage/Retrieval Systems (ASRS) and Carousel Storage Systems.

UNIT V AUTOMATED INSPECTION SYSTEMS **(9 Hrs)**

Quality in Design and manufacturing, inspection principles and strategies, automated inspection, contact Vison-contact, CMM. Manufacturing support systems. Quality function deployment, computer aided process planning, concurrent engineering, shop floor control, just in time and lean production.

Text Books

1. Nagrath and Mittal, "Robotics and Control", Tata McGraw-Hill, 2003.
2. Saeed B.Nniku, "Introduction to robotics- Analysis, Systems, Application", Prentice Hall of India Pvt. Ltd., 2003.
3. Sebastian Thurn, "Principles of Robot Motion: Theory, Algorithms, and Implementations" , Prentice Hall of India, 2005.
4. Steve LaValle, "Planning Algorithms", Cambridge Univ. Press, New York, 2006.
5. Spong and Vidhyasagar, "Robot Dynamics and Control", John Wiley and sons, 2008.

Reference Books

1. P. Radhakrishnan, S. Subramanyan and V. Raju, 'CAD/CAM/CIM', New Age International (P) Ltd., New Delhi, 2009.
2. S.R.Deb and Sankha Deb, 'Robotics Technology and Flexible Automation', Tata McGraw Hill,Second Edition, New Delhi, 2010.
3. Peter Corke, 'Robotics, Vision and Control: Fundamental Algorithms in MATLAB', Springer, 2011.
4. Nicholas Odrey, Mikell Groover, Roger Nagel, Ashish Dutta, 'Industrial Robotics (SIE): Technology, Programming and Applications', McGraw Hill, 2012.
5. Mikell P. Groover, 'Automation, Production Systems and Computer-Integrated Manufacturing', Pearson Publisher, Fourth Edition, 2016.

Web References

1. https://nptel.ac.in/courses/108/105/108105063/
2. https://www.automationmag.com/
3. https://www.springer.com/gp/book/9783319771786.
4. https://library.automationdirect.com/industrial-automation-top-10-trends/
5. https://nptel.ac.in/courses/112/102/112102011/

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)						Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
1	3	-	3	3	1	1	3	2	3
2	1	-	2	3	1	1	3	1	3
3	2	-	2	2	1	-	3	3	3
4	3	-	2	3	1	-	3	3	3
5	3	2	3	3	1	1	3	3	3

Correlation Level: 1- Low, 2 - Medium, 3 - High

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P20MET103 **TOOL DESIGN ENGINEERING**

L	T	P	C	Hrs
3	0	0	3	45

Course Objectives

- To understand the importance of Tool design and cutting force analysis.
- Apply Geometric Tolerancing principles in the designs of tooling.
- Evaluate and select appropriate materials for tooling applications.
- Design, develop, and evaluate cutting tools and work holders for a manufactured product.
- To educate the student about the structure, forces involved in single point and multipoint cutting tools

Course Outcomes

After completion of the course, the students will be able to

CO1 - Understand the basic motions involved in a machine tool. **(K2)**
CO2 - Design machine tool structures. **(K3)**
CO3 - Design and analyze systems for specified speeds and feeds. **(K4)**
CO4 - Understand control strategies for machine tool operations. **(K2)**
CO5 - Understand the dynamic measurement of forces and vibrations in machine tools. **(K2)**

UNIT I STATIC AND DYNAMIC STIFFNESS, FORCE ANALYSIS **(9 Hrs)**

Static stiffness and compliance- deformation caused by weight, Forces- deformation caused by cutting forces forced vibrations, self-excited vibrations, Force distribution in different parts of Lathe, Drilling machine, Milling machine and Planning machines

UNIT II DESIGN OF STRUCTURES **(9 Hrs)**

Beds, columns and housing for maximum strength and rigidity – cast and welded construction – CNC machine tools - structure – main drive and feed drive- ball screws- automatic tool changers- chip conveyors- tool magazines- tool turrets.

UNIT III DESIGN OF SLIDE WAYS **(9 Hrs)**

Selection of materials- integrated and attached ways- hydro-static guide ways-aero-static guide ways-antifriction guide ways- design of friction guide ways- plastic inserted guide ways and LM guide ways.

UNIT IV DESIGN OF MACHINE TOOL SPINDLES AND DRIVES **(9 Hrs)**

Design requirements – standards – selection of spindle bearings- materials for spindles- typical spindle design - design consideration of Electrical, Mechanical and Hydraulic drives in machine tools.

UNIT V DYNAMIC MEASUREMENT **(9 Hrs)**

The Dynamics of cutting process - physical causes of chatter- theory of machine tool chatter- chatter in different types of machine tools- milling machines, lathes and grinding machines - the theory of chatter with several degree of freedom - chatter suppression. Design of control mechanisms – selection of standard components - dynamic measurement of forces and vibrations in machine tools - use of vibration dampers.

Text Books

1. G.Sen.and A.Bhattacharya, 'Principles of Machine Tools'. Vol.2, NCB. Calcutta, 2010.
2. S.A Tobias, 'Machine tool Vibration' ,Blackie and Son Limited, London, 2010.
3. N.Acherkan, 'Machine Tool Design'. Vol. 3 & 4, MIR Publishers, Moscow, 2012.
4. F.Steve,Krar, R.Arthur. Gill and Peter Smid, 'Technology of machine tools', McGraw Hill Education (India) Pvt. Ltd., 2013.
5. N. K Mehta, 'Machine Tool Design and Numerical Control - ED 3', McGraw Hill Co., New Delhi, 2013.

Reference Books

1. Edwrd G Hoffman, 'Jigs and Fixtures Design', Thomson Learning, 2010.
2. Cyril Donaldson, George H Lecain and V.Goold , 'Tool Design', Tata McGraw Hill, 2012.
3. B.Hans ,Kief Helmut ,A. Roschiwal, 'CNC Handbook' , Mcgraw Hill Company, New York, 2013.

4. P H Joshi, 'Machine Tool Hand Book, Design and Operation', McGraw Hill, 2013.
5. Michael Mattson, 'CNC Programming: Principles and Applications', Cengage Learning India Pvt Ltd., New Delhi, 2014.

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1. https://American Society of Mechanical Engineering-tool design.
2. https://nptel.ac.in/courses/112/105/112105126/
3. https://www.coursera.org/lecture/software-design-methods-tools.
4. https://wwlw.engineeringtoolbox.com/asme-d_7.htm
5. https://nptel.ac.in/content/storage2/courses/112105127/pdf/LM-10.

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)						Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
1	3	-	2	3	1	1	2	2	2
2	2	1	3	3	2	1	3	2	3
3	3	-	3	2	1	1	3	3	3
4	3	1	3	3	1	1	3	3	3
5	3	2	3	3	1	1	3	3	3

Correlation Level: 1- Low, 2 - Medium, 3 - High

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P20CCT101 **RESEARCH METHODOLOGY AND IPR**

L	T	P	C	Hrs
3	0	0	2	30

Course Objectives

- To understand some basic concepts of research and its methodologies
- To identify appropriate research topics
- To disseminate knowledge on patents, patent regime in India and abroad and registration aspects
- To disseminate knowledge on trademarks and registration aspects
- To aware about current trends in IPR and Govt. steps in fostering IPR

Course Outcomes

After completion of the course, the students will be able to

CO1 - Understand research problem formulation and analyze research related information. **(K2)**

CO2 - Understand that today's world is controlled by Computer, Information, but tomorrow world will be ruled by ideas, concept, and creativity. **(K2)**

CO3 - Adequate knowledge on patent and copyright for their innovative research works. **(K2)**

CO4 - Understand that IPR protection provides an incentive to inventors for further Intellectual Property Right to be promoted among students in general & engineering in particular. **(K2)**

CO5 - Understand and developing their idea or innovations. **(K2)**

UNIT I RESEARCH PROBLEM AND SCOPE FOR SOLUTION (9 Hrs)

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations.

UNIT II FORMAT (9 Hrs)

Effective literature studies approaches, analysis Plagiarism, Research ethics, Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

UNIT III PROCESS AND DEVELOPMENT (9 Hrs)

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT

UNIT IV PATENT RIGHTS (9 Hrs)

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. Unit 6: New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

UNIT V NEW DEVELOPMENTS IN IPR (9 Hrs)

New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

Text Books

1. Mousami V. Munot, Vinayak Bairagi "Research Methodology A Practical and Scientific Approach" CRC Press, 2019.
2. Nithyananda, K V. (2019). Intellectual Property Rights: Protection and Management. India, IN: Cengage Learning India Private Limited.

Reference Books

1. P.Neeraj and D Khusdeep, 'Intellectual Property Rights'. India, IN: PHI learning Private Limited, 2014.
2. World Intellectual Property Organization "Understanding Copyrights and Related Rights"WIPO 2016.

3. V KAhuja, 'Law relating to Intellectual Property Rights'. India, IN: Lexis Nexis, 2017.
4. Ranjit Kumar "Research Methodology A Step-by-Step Guide for Beginners" SAGE Publications 2018.
5. Dipankar Deb, Rajeeb Dey Valentina E. Balas, Engineering Research Methodology, Springer Singapore,2019.

Web References

1. https://nptel.ac.in/courses/121/106/121106007/
2. https://nptel.ac.in/courses/107/108/107108011/
3. https://nptel.ac.in/courses/109/105/109105115/.
4. https://www.wipo.int/about-p/en/
5. https://www.ipindia.nic.in/

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)						Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
1	2	1	1	2	1	1	2	1	2
2	2	1	2	3	1	1	2	2	3
3	3	1	2	2	1	1	2	2	3
4	2	1	2	3	1	1	3	3	3
5	3	2	3	3	1	1	2	2	3

Correlation Level: 1- Low, 2 - Medium, 3 - High

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P20MEP101 COMPUTER AIDED ENGINEERING LABORATORY

L	T	P	C	Hrs
0	0	4	2	30

Course Objectives

- To understand the computer aided drafting software such as SOLID WORKS and CATIA.
- To understands various features in 3D Modeling software.
- To model the 3D images.
- To understand the assembly and drafting techniques using software assistance.
- To understand the general steps of finite element methods.

Course Outcomes

After completion of the course, the students will be able to

CO1 – Use SOLID WORKS and CATIA software tool bars and menus to draw 2D model. **(K3)**
CO2 – Model the 3D mechanical components with dimensioning. **(K3)**
CO3 – Model the parts such as springs, automobile wheel. **(K3)**
CO4 – Derive equations in finite element methods for 3D problems. **(K5)**
CO5 – Use customized FEM software for real application of CAD. **(K6)**

List of Experiments

1. SOLID WORKS

A. 2D drawing of machine elements
B. 3D drawing of machine elements
C. 3D assembly drawing of machine elements
D. Detail Drawing of machine elements

2. CATIA

A. Sketcher
B. Part design
C. Assembly drawing of machine element
D. Sheet metal design

3. FEA

A. Analysis of cantilever beam using ANSYS Workbench
B. Two-dimensional truss using ANSYS Workbench
C. 3D Plane stress rectangular block with hole using ANSYS Workbench
D. Buckling analysis on linear materials using ANSYS APDL

Reference Books

1. K. J. Bathe, "Finite Element Procedures", Prentice Hall, 1996.
2. Micheal E. Mortenson, "Geometric Modelling", Tata McGraw Hill Publishers, 1997.
3. Rogers and J. Alan Adams, "Elements of Computer Graphics", Tata McGraw Hill, 2002.
4. Ibrahim Zeid, "Mastering CAD/CAM", Tata McGraw Hill, 2007.
5. K. Lalit Narayan, K. Mallikarjuna Rao and MMM. Sarcar, "Computer Aided Design and Manufacturing",Printice Hall India Publishers, 2008.
6. R. Chandraputla, D. Ashok and Belegundu, "Introduction to Finite Elements in Engineering", Prentice Hall, 2011.

Web References

1. https://nptel.ac.in/courses/112/104/112104031/
2. https://nptel.ac.in/courses/112/102/112102101/
3. https://www.lynda.com/CATIA-tutorials/750155-0.html
4. https://catiatutor.com/
5. https://www.javelin-tech.com/3d/technology/solidworks-software/

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)						Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
1	2	1	2	2	3	2	3	3	2
2	3	1	2	2	3	2	3	3	2
3	2	1	2	2	3	2	3	3	2
4	2	1	2	2	3	2	3	3	2
5	3	1	2	2	3	2	3	3	2

Correlation Level: 1- Low, 2 - Medium, 3 - High

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P20CCP101 **TECHNICAL REPORT WRITING AND SEMINAR**

L	T	P	C	Hrs
0	0	4	2	45

Course Objectives

- Selecting a topic based on interest
- Objective formulation
- To develop their scientific and technical reading and writing skills that they need to understand and construct research articles
- To obtain information from a variety of sources (i.e., Journals, dictionaries, reference books) and then place it in logically developed ideas
- Process in reading

Course Outcomes

After completion of the course, the students will be able to

CO1 - Selecting a subject, narrowing the subject into a topic **(K2)**

CO2 - Stating an objective and collecting the relevant bibliography (at least 15 journal papers) **(K2)**

CO3 - Studying the papers and understanding the author's contributions and critically analyzing each paper. **(K2)**

CO4 - Preparing a working outline and linking the papers and preparing a draft of the paper **(K3)**

CO5 - Preparing conclusions based on the reading of all the papers and Writing the Final Paper and giving final Presentation **(K3)**

Activity	Instructions	Submission week	Evaluation
Selection of area of interest and Topic	select an area of interest, topic and state an objective	2nd week	**3 %** Based on clarity of thought, current relevance and clarity in writing
Stating an Objective			
Collecting Information about area & topic	1. List 1 Special Interest Groups or professional society 2. List 2 journals 3. List 2 conferences, symposia or workshops 4. List 1 thesis title 5. List 3 web presences (mailing lists, forums, news sites) 6. List 3 authors who publish regularly in your area 7. Attach a call for papers (CFP) from your area.	3rd week	**3%** (the selected information must be area specific and of international and national standard)
Collection of Journal papers in the topic in the context of the objective – collect 20 & then filter	• provide a complete list of references you will be using- Based on your objective -Search various digital libraries and Google Scholar • When picking papers to read - try to: - Pick papers that are related to each other in some ways and/or that are in the same field so that you can write a meaningful survey out of them. - Favour papers from well-known journals and conferences,in the field (as indicated in other Favour more recent papers, - Pick a recent survey of the field so you can quickly gain	4th week	6% (the list of standard papers and reason for selection)

	an overview,Find relationships with respect to each other and to your topic area(classification scheme/categorization) - Mark in the hard copy of papers whether complete work or section/sections of the paper are being considered		
Reading and notes for first 5 papers	Reading Paper Process For each paper form a Table answering the following questions: • What is the main topic of the article? • What was/were the main issue(s) the author said they want to discuss? • Why did the author claim it was important? • What simplifying assumptions does the author claim to be making? • What did the author do? • How did the author claim they were going to evaluate their work and compare it to others? • What did the author say were the limitations of their research? • What did the author say were the important directions for future research? • Conclude with limitations/issues not addressed by the paper (from the perspective of survey)	6th week	8% (The table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper)
Reading and notes for next 5 papers	Repeat Reading Paper Process	7th week	8% (the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper
Draft outline 1 and Linking papers	Prepare a draft Outline, your survey goals, along with a classification / categorization diagram	8th week	8% (this component will be evaluated based on the linking and classification among the papers)
Abstract	Prepare a draft abstract and give a presentation	9th week	6% (Clarity, purpose and conclusion) 6% Presentation & Viva Voce
Introduction Background	Write an introduction and background sections	10th week	5% (clarity)

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Sections of the paper	Write the sections of your paper based on the classification / categorization diagram in keeping with the goals of your survey	11thweek	10% (this component will be evaluated based on the linking and classification among the papers)
Conclusions	Write your conclusions and future work	12th week	5% (conclusions)
Final Draft	Complete the final draft of your paper	13th week	10% (formatting, English, Clarity and linking) 4% Plagiarism Check Report
Seminar	A brief 15 slides on your paper	14th & 15th week	10% (based on presentation and Viva-voce)

P20MEC1XX **EMPLOYABILITY ENHANCEMENT COURSE - I**

L	T	P	C	Hrs
0	0	4	-	50

Students shall choose an International certification course offered by the reputed organizations like Google, Microsoft, IBM, Texas Instruments, Bentley, Autodesk, Eplan and CISCO, etc. The duration of the course is 40-50 hours specified in the curriculum, which will be offered through Centre of Excellence.

Pass /Fail will be determined on the basis of participation, attendance, performance and completion of the course. If a candidate Fails, he/she has to repeat the course in the subsequent years. Pass in this course is mandatory for the award of degree.

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P20MET204 **ADVANCED MANUFACTURING PROCESSES**

L	T	P	C	Hrs
3	0	0	3	45

Course Objectives

- To introduce machining principles in the manufacturing processes, and to obtain precision components and products by using non-conventional machining technologies.
- To provide basic understanding on laser beam machining and Plasma arc machining.
- To understand the performance and characterization of Electron beam machining and Electro chemical machining processes.
- To provide knowledge on various special metal forming process.
- To understand the principles and methods of surface coating.

Course Outcomes

After completion of the course, the students will be able to

CO1 - Understand the working principle of different types of non conventional machining processes. **(K2)**

CO2 - Understand the concept of working principles of Laser beam and plasma arc machining process. **(K2)**

CO3 - Illustrate the characterization of Electro beam and Electro chemical machining. **(K3)**

CO4 - Understand the principles of special metal forming processes. **(K2)**

CO5 - Apply various techniques on surface coating to achieve fine surface finish. **(K3)**

UNIT I MODERN MACHINING PROCESS - I **(9 Hrs)**

Introduction, need ,AJM, Parametric Analysis, Process capabilities, USM –Mechanics of cutting, models, Parametric Analysis, WJM –principle, equipment ,process characteristics , performance, EDM – principles, equipment, generators, analysis of R-C circuits, MRR , Surface finish, WEDM.

UNIT II MODERN MACHINING PROCESS - II **(9 Hrs)**

Laser Beam Machining – Principle of working, equipment, Material removal rate, Process parameters, performance characterization, Applications. Plasma Arc Machining – Principle of working, equipment, Material removal rate, Process parameters, performance characterization, Applications.

UNIT III MODERN MACHINING PROCES - III **(9 Hrs)**

Electron Beam Machining - Principle of working, equipment, Material removal rate, Process parameters, performance characterization, Applications. Electro Chemical Machining – Principle of working, equipment, Material removal rate, Process parameters, performance characterization, Applications.

UNIT IV MODERN MACHINING PROCESS - IV **(9 Hrs)**

High energy rate forming, electromagnetic forming, explosive forming, high speed hot forging, high velocity extrusion, high speed forming machines, peen forming, study of various process parameters.

UNIT V SURFACE TREATMENT **(9 Hrs)**

Scope, Cleaners, Methods of cleaning, Surface coating types, and ceramic and organic methods of coating, economics of coating. Electro forming, Chemical vapour deposition, thermal spraying, Ion implantation, diffusion coating, Diamond coating and cladding

Text Books

1. Kalpakijian, Manufacturing Engineering and Technology, Addison Wesley, 2008.
2. V.K.Jain Advanced Machining Processes, Allied Publications. 2009.
3. Chang Liu, Foundation of MEMS, Pearson, 2012.
4. R. A. Lindburg, Process and Materials of Manufacturing, 7 th edition, PHI 2013.
5. John A Schey, 'Introduction to Manufacturing Processes' McGraw Hill, 2013.

Reference Books

1. Sanjay K Mazumdar,"Composite Manufacturing: Materials, Product and Process Engineering", CRC Press, 2010.
2. E. Paul De Garmo, J T Black and Ronald A Kohjer, "Materials and Processes in Manufacturing", John Wiley India, 2011.
3. Philip F Ostwald and Jairo Munoz, "Manufacturing Processes and Systems", John Wiley India, New Delhi, 2013.
4. J P,Kaushish, "Manufacturing Processes", Prentice Hall India, 2013.
5. Mikell P Grover, "Principles of Modern Manufacturing (SI Version)", John Wiley & Sons, 2014

Web References

1. https://nptel.ac.in/courses/112/107/112107078/
2. https://www.coursera.org/learn/advanced-manufacturing-process-analysis
3. https://www.classcentral.com/course/advanced-manufacturing-process-analysis-8154
4. https://www.iitk.ac.in/me/advanced-manufacturing-processes.
5. https://nptel.ac.in/courses/112/107/112107145/

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)						Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
1	3	2	2	1	1	1	3	2	2
2	3	2	2	1	1	1	3	2	2
3	3	2	2	2	1	1	3	2	2
4	3	2	2	1	1	1	3	2	2
5	3	1	1	1	1	1	3	2	2

Correlation Level: 1- Low, 2 - Medium, 3 - High

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P20MET205	MICRO ELECTRO MECHANICAL SYSTEMS AND NANOTECHNOLOGY	L	T	P	C	Hrs
		3	0	0	3	45

Course Objectives

- To introduce the basic concepts of micro systems and advantages of miniaturization.
- To teach the fundamentals of micro fabrication techniques and micromachining.
- To provide an exposure on different sensors - MEMS devices.
- To impart knowledge of properties and fabrication methods Nano materials.
- To make an analysis and investigation on the Nano materials and characterization of various scanning techniques.

Course Outcomes

After completion of the course, the students will be able to

CO1 - Understand the basics of MEMS materials, properties and applications. **(K2)**
CO2 - Outline the process of Bulk Micro Machining techniques. **(K2)**
CO3 - Illustrate different types of MEMS Sensors and actuators **(K4)**
CO4 - Identify the Nano material's structure, Properties and compare the fabrication process. **(K4)**
CO5 - Analyze the properties of Nano materials using different characterization methods. **(K4)**

UNIT I OVER VIEW OF MEMS AND MICROSYSTEMS **(9 Hrs)**

Definition – historical development – fundamentals – properties, micro fluidics, design and fabrication micro-system, microelectronics, working principle and applications of micro system.

UNIT II MEMS FABRICATION PROCESSES **(9 Hrs)**

Substrates and wafers, silicon as substrate material, mechanical properties of Si, Silicon Compounds silicon piezo resistors, Gallium arsenide, quartz, polymers for MEMS, conductive polymers. Photolithography, photo resist applications, light sources, in implantation, diffusion process exudation – thermal oxidation, silicon diode, chemical vapour deposition, sputtering - deposition by epitaxy – etching – bulk and surface machining – LIGA process Micro system packaging –considerations packaging – levels of micro system packaging die level, device level and system level.

UNIT III MICRO DEVICES AND MATERIALS **(9 Hrs)**

Sensors – classification – signal conversion ideal characterization of sensors micro actuators, mechanical sensors – measurands displacement sensors, pressure and flow sensors, micro actuators – smart materials – applications.

UNIT IV SCIENCE OF NANO MATERIALS **(9 Hrs)**

Classification of Nano structures – effect of the nanometer length scale effects of Nano scale dimensions on various properties – structural, thermal, chemical, mechanical, magnetic, optical and electronic properties – effect of nanoscale dimensions on biological systems. Fabrication methods – Top down processes – bottom up process.

UNIT V CHARACTERIZATION OF NANO MATERIALS **(9 Hrs)**

Nano-processing systems – Nano measuring systems – characterization – analytical imaging techniques – microscopy techniques, electron microscopy scanning electron microscopy, transmission electron microscopy, transmission electron microscopy, scanning tunneling microscopy, atomic force microscopy, diffraction techniques – spectroscopy techniques – Raman spectroscopy, 3D surface analysis – Mechanical, Magnetic and thermal properties – Nano positioning systems.

Text Books

1. Tai – Ran Hsu, "MEMS and Microsystems Design and Manufacture", Tata-McGraw Hill, New Delhi,2002.
2. Charles P Poole, Frank J Owens, "Introduction to Nano technology", John Wiley and Sons, 2003.
3. Chang Liu, "Foundations of MEMS" , Pearson Education International, 2006.
4. G.K. Ananthasuresh, K.J. Vinoy, S. Gopalakrishnan, K.N. Bhat, V.K. Aatre, "Micro and Smart Systems", Wiley India, First Edition, 2010.

5. Ray F. Egerton, "Physical Principles of Electron Microscopy: An Introduction to TEM, SEM, and AFM" Springer ,2010.

Reference Books

1. Julian W. Hardner, "Micro Sensors, Principles and Applications", CRC Press 2002.
2. Mark Madou, "Fundamentals of Micro fabrication", CRC Press, New York, 2005.
3. Guozhong Cao, "Nanostructures and Nanomaterials- Synthesis, Properties & applications", Imperial College Press, 2006.
4. Douglas A Skoog, "Principles of instrumental analysis", Cengage, 2014.
5. Yadong Yin, "Handbook of synthetic methodologies and protocols of nanomaterials", World Scientific 2019.

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1. https://nptel.ac.in/courses/117/105/117105082/
2. https://nptel.ac.in/courses/118/104/118104008/
3. https://ocw.mit.edu/courses/mechanical engineering/2-674-micro-nano-engineering
4. https://nptel.ac.in/courses/108/108/108108113/
5. https://nptel.ac.in/courses/113/106/113106093/

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)						Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
1	3	2	2	1	1	1	3	2	2
2	3	2	1	2	1	-	3	2	2
3	3	1	2	2	1	-	3	2	2
4	3	2	1	1	1	-	3	2	2
5	3	3	3	3	3	3	3	2	2

Correlation Level: 1- Low, 2 - Medium, 3 - High

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P20MET206 **METAL CUTTING THEORY AND PRACTICE**

L	T	P	C	Hrs
3	0	0	3	45

Course Objectives

- To acquire and understand the Significance of Machining and geometry of cutting tool.
- To impart the knowledge of basic methodology of metal cutting.
- To study the source of heat generation and machinability of the tool.
- To study the characteristics of tool material and its properties.
- To design the geometry of Milling Cutters and Mechanics of Milling process.

Course Outcomes

After completion of the course, the students will be able to

CO1 - Understand the concept of tool geometry and derive their interrelationships. **(K2)**
CO2 - Understand the mechanics of tool chip formation and its theory. **(K2)**
CO3 - Apply the basic knowledge on identifying the source of heat generation and to calculate the tool life. **(K3)**
CO4 - Identify the cutting tool materials and cutting fluids based on its properties. **(K4)**
CO5 - Analyze and design the geometry of milling cutters and drilling tools. **(K4).**

UNIT I INTRODUCTION **(9 Hrs)**

Overview of the course, Examination and Evaluation patterns, Classification of Mfg. Processes, History of Machining, Scope and Significance of Machining. Geometry of Cutting Tools: Geometry of single-point cutting tool: Tool-in hand system, ASA system, Significance of various angles of single point cutting tools, Orthogonal Rake System (ORS), Conversions between ASA and ORS systems – Graphical and Analytical Methods, Normal Rake System (NRS) & relation with ORS .

UNIT II MECHANICS OF MACHINING PROCESSES **(9 Hrs)**

Orthogonal and Oblique cutting, Mechanics of Chip formation: Types of chips, chip-breakers, Chip reduction coefficient, shear angle, shear strain, Built- Up-Edge and its effect in metal cutting, Merchant"s analysis of metal cutting process - Various forces, power and specific energy in cutting, Problems on Tool Geometry and Mechanics of Machining, Theories of Metal Cutting: Ernst & Merchant, theory, Modified Merchant"s theory, Lee & Shaffer Theory, Chip-tool Natural Contact Length – Hahn"s Analysis Stress distribution at Chip-Tool Interface – Zorev"s Analysis, Machining with controlled contact cutting, Chip breakers.

UNIT III THERMAL ASPECTS IN MACHINING **(9 Hrs)**

Sources of heat generation, Effects of temperature, Determination of cutting temperature using analytical methods, Determination of cutting temperature using experimental methods, Methods of Controlling Cutting Temperature. Tool wear, Tool life, Machinabilty and Machining Economics: Wear Mechanisms, Types of tool wear, Tool Life and Machinability, A brief treatment for single pass turning operations, Problems on Economics of Machining.

UNIT IV CUTTING TOOL MATERIALS **(9 Hrs)**

Desirable Properties of tool materials, Characteristics of Cutting Tool Materials, Indexable inserts , Coated tools. Cutting Fluids: Functions, characteristics and types, Selection of cutting fluids.

UNIT V GEOMETRY OF CUTTERS **(9 Hrs)**

Drill Geometry & Mechanics of Drilling Process, Geometry of Milling Cutters and Mechanics of Milling process, Mechanics of Grinding (plunge grinding and surface grinding), Grinding wheel wear. Oblique Cutting: Mechanics of Oblique Cutting.

Text Books

1. M. C. Shaw, "Metal cutting-Principles and Practices", Cambridge University press. 2005
2. Rao PN, "Manufacturing Technology–Metal Cutting and Machine Tools", TMH, New Delhi, 2013.
3. Bhattacharya A, "Metal Cutting: Theory and Practice", New Central Book Agency, Kolkata, 2007
4. Winston A. Knight and Geoffrey Boothroyd, "Fundamentals of Machining and Machine Tools", Taylor & Francis Group, 2005.

5. Trent, E. M. and P. K. Wright, "Metal Cutting", 4th edition., Butterworth-Heinemann, 2000

Reference Books

1. 1.Wilson. FW, "Fundamentals of Tool Design" ASTME PHI 2010.
2. Steve F. Krar, Arthur R. Gill and Peter Smid, "Technology of machine tools", Mcgraw Hill Education (India) Pvt. Ltd., 2013.
3. Rao. P.N, "Manufacturing Technology – Metal Cutting and Machine Tools", Tata McGraw-Hill, New Delhi, 2003.
4. Roy. A.Lindberg, "Process and Materials of Manufacture", Fourth Edition, PHI/Pearson Education 2006.
5. David Son, Lacain and Goud, "Tool Design", Tata Me Graw Hill, 2012.

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1. https://nptel.ac.in/courses/112/105/112105233/
2. https://nptel.ac.in/courses/112/105/112105127/
3. https://www.classcentral.com/course/swayam-metal-cutting-and-machine-tools-10105
4. https://www.coursera.org/learn/machine-design1
5. https://www.coursef.com/sandvik-training-handbook?rid=5f0ac5a84bd4c8097e79e2ba.

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1	3	2	2	1	1	1	3	2	2
2	3	2	1	2	1	1	3	2	2
3	3	1	1	2	1	1	3	2	2
4	3	2	1	2	1	1	3	2	2
5	3	3	3	3	3	2	3	2	2

Correlation Level: 1- Low, 2 - Medium, 3 - High

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P20MET207	INDUSTRIAL ROBOTICS AND MATERIAL HANDLING SYSTEM	L	T	P	C	Hrs
		3	0	0	3	45

Course Objectives

- To introduce the basic concepts, parts of robots and types of robots.
- To familiarize the types drive systems for robot, sensors and their applications in robots and programming of robots.
- To design the robots based on the application.
- To provided the understanding of implementing the robots in industrial application.
- To have a wide knowledge on the utilization of Robot in material handling system.

Course Outcomes

After completion of the course, the students will be able to

CO1 - Understand the basic principle of Robot design, its types and components. **(K2)**
CO2 - Apply the knowledge of principle working of Robot, thereby selection of parts is carried out. **(K3)**
CO3 - Chose the model and adopted for the industrial usage. **(K3)**
CO4 - Integrating the robots in industrial application. **(K4)**
CO5 - Apply their knowledge of robots in material handling. **(K3)**

UNIT I INTRODUCTION **(9 Hrs)**

Types of industrial robots, Load handling capacity, general considerations in Robotic material handling, material transfer, machine loading and unloading, CNC machine tool loading, Robot centered cell. Robots for inspection: Robotic vision systems, image representation, object recognition and categorization, depth measurement, image data compression, visual inspection, software considerations.

UNIT II END EFFECTORS **(9 Hrs)**

Gripper force analysis and gripper design for typical applications, design of multiple degrees of freedom, active and passive grippers.

UNIT III SELECTION OF ROBOT **(9 Hrs)**

Factors influencing the choice of a robot, robot performance testing, economics of robotisation, Impact of robot on industry and society. Robot work cell design and control–Safety in Robotics–Robot cell layouts–Multiple obots and Machine interference–Robot cycle time analysis. Industrial application of robots. Automation types-Need for Automation, Hydraulic & Pneumatic Comparison–ISO symbols for fluid power elements, Hydraulic, pneumatic – Selection criteria- Industrial automation.

UNIT IV APPLICATIONS OF ROBOTS IN WELDING **(9 Hrs)**

Application of Robots in continuous arc welding, Spot welding, Spray painting, assembly operation, cleaning, robot for underwater applications.

UNIT V ADVANCED MATERIAL HANDLING **(9 Hrs)**

Concepts of material handling ,principles and considerations in material handling systems design, conventional material handling systems-industrial trucks,mono rails, rail guided vehicles, conveyor systems, cranes and hoists, advanced material handling systems, automated guided vehicle systems, automated storage and retrieval systems(ASRS),barcode technology, radiofrequency identification technology

Text Books

1. Richard D Klafter, Thomas Achmielewski and Mickael Negin, 'Robotic Engineering – An integrated Approach', Prentice Hall India, New Delhi, 2001.
2. Mikell P Groover, "Automation, Production Systems, and Computer-Integrated Manufacturing", Pearson Education, 2015.
3. Fruchtbaum J, Bulk Materials Handling Handbook, CBS Publishers and Distributors, 1997.
4. Siddharth Roy, Introduction to material handling, New Age Publications, 2008.
5. David Cook, Robot building for beginners, *Apress, December 2009, Second Edition*

Reference Books

1. James A Rehg, 'Introduction to Robotics in CIM Systems', Prentice Hall of India, 2002.
2. Deb S R, "Robotics Technology andFlexible Automation", Tata McGraw Hill, New Delhi, 1994.
3. K.S. Fu, Gonzalez, R.C. and Lee, C.S.G., Robotics Control, Sensing, Vision and Intelligencell, McGraw Hill, 1987. Koren,Y., Robotics for Engineersll, McGraw-Hill, 1987.
4. Kozyrey, Yu. 'Industrial Robots', MIR Publishers Moscow, 1985.
5. Klafter, R.D., Chmielewski, T.A. and Negin,M.,'Robotics Engineering – An Integrated Approach', Prentice-Hall of India Pvt. Ltd., 1984.

Web References

1. https://nptel.ac.in/courses/112/101/112101098/
2. https://www.coursera.org/courses?query=robotics
3. https://nptel.ac.in/courses/112/102/112102011/
4. https://nptel.ac.in/courses/112/107/112107289/
5. https://nptel.ac.in/courses/112/107/112107143/

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)						Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
1	3	2	2	1	1	1	3	2	2
2	3	2	2	2	1	1	3	2	2
3	3	2	2	2	1	1	3	2	2
4	3	2	2	2	1	1	3	2	2
5	3	3	3	3	3	2	3	2	2

Correlation Level: 1- Low, 2 - Medium, 3 - High

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Madagadipet, Puducherry - 605 107.

P20MEP202 **ADVANCED MANUFACTURING LABORATORY**

L	T	P	C	Hrs
0	0	4	2	30

Course Objectives

- Students will gain a practical knowledge of various manufacturing processes.
- To understands various machining parameters which affect surface roughness.
- To acquire knowledge of CNC machines and operations.
- To understand various tool geometry.
- To acquire knowledge of 3D Printing and its applications in Manufacturing Industry.

Course Outcomes

After completion of the course, the students will be able to

CO1 – Understand the cutting forces in machining processes. **(K2)**
CO2 – Develop a practical understanding of advanced manufacturing processes. **(K3)**
CO3 – Understand the tool maker microscope and surface roughness measurements. **(K2)**
CO4 – Generated G codes and Perform CNC milling operations. **(K6)**
CO5 – Develop new product using 3D printer. **(K6)**

List of Experiments

1. Study of the morphology of chips produced from different materials sand machining Processes.
2. Effect of tool geometry on chip flow direction in simulated orthogonal cutting conditions.
3. Study of cutting ratio/chip thickness ratio in simulated orthogonal cutting with different materials and tool geometry.
4. Roughness of machined surface. Influence of tool geometry and feed rate.
5. Study of operation of tool and cutter grinder, twist drill grinder, Centreless grinder
6. Determination of cutting forces in turning.
7. Inspection of parts using tool makers microscope, roughness and form tester.
8. Study of CNC VMC part programming fundamentals and writing part program.
9. Study and demonstration of CNC VMC.
10. Study and use of 3-D modelling software to generate .STL file
11. Experimental Study on 3D Printing.
12. Experiments using 3D printer.

Reference Books

1. Radhakrishnan and Subramanian, CAD/CAM/CIM, New Age Publishers, 2nd Edition, 2000
2. M.P. Groover, Automation, Production systems and Computer Integrated Manufacturing Systems, PHI Publishers, 2010
3. Serope Kalpakjain and Steven R. Schmid, Manufacturing Engineering and Technology, Pearson Publisher, 2010.
4. R.K.Jain, Advanced machining process, Allied Publications, 2011.
5. Prashant K. Ambadekar, Advanced Manufacturing Process, Nirali Prakashan,2017.

Web References

1. https://nptel.ac.in/courses/112/107/112107078/
2. https://nptel.ac.in/courses/112/104/112104162/
3. https://nptel.ac.in/courses/112/104/112104265/
4. https://nptel.ac.in/content/storage2/courses/112105127/pdf/LM-09.pdf
5. https://3dprinting.com/what-is-3d-printing/

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)						Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
1	2	1	2	2	3	1	3	2	3
2	2	1	2	2	3	1	3	2	3
3	2	1	2	2	3	1	3	2	3
4	3	1	3	3	3	2	3	3	3
5	3	1	3	3	3	1	3	3	3

Correlation Level: 1- Low, 2 - Medium, 3 - High

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P20CCP202	SEMINATR ON ICT:A HANDS- ON APPROACH	L	T	P	C	Hrs
		0	0	4	2	45

Course Objectives

- To develop their technical reading and presentation skills that they need to understand and present using ICT Tools.
- To obtain information from a variety of sources (i.e., Journals, dictionaries, reference books) and practice to present.

Course Outcomes

After completion of the course, the students will be able to

CO1 - Select a topic, narrowing the topic into presentation.
CO2 - State an objective and use the relevant ICT tools to make the presentation effective.
CO3 - Study the topic and understanding the contributions and prepare report.
CO4 - Prepare a working demo.
CO5 - Prepare conclusions based on the reading of the topic and giving final Presentation.

The methodology used is "learning by doing", a hands-on approach, enabling the students to follow their own pace. The teacher, after explaining the project, became a tutor, answering questions and helping students on their learning experience.

ICT skills

- Understand ICT workflow in the respective domain choosed.
- Manage multitasking.
- Deal with main issues using tech in class.
- Record, edit and deliver audio and video.
- Automate assessments and results.

Scope

- Perspective in order to design activities in class.
- Understand the process of creating audiovisuals.

Teaching tools

- Different ways to create audiovisual activities.
- Handle audiovisual editors.
- Collaborative working.
- Individualize learning experience.
- Get instant feedback from students.

Each one of the students will be assigned an ICT Topic and the student has to conduct a detailed study on the assigned topic and prepare a report, running to 30 or 40 pages for which a demo to be performed followed by a brief question and answer session. The demo will be evaluated by the internal assessment committee (comprising of the Head of the Department and two faculty members) for a total of 100 marks.

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)						Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
1	-	3	1	1	3	3	3	-	-
2	-	3	1	1	3	2	3	-	-
3	-	3	1	1	3	2	3	-	-
4	-	3	1	1	3	2	3	-	-
5	-	3	1	1	3	2	3	-	-

Correlation Level: 1- Low, 2 - Medium, 3 - High

P20MEC2XX	EMPLOYABILITY ENHANCEMENT COURSE - I	L	T	P	C	Hrs
		0	0	4	-	50

Students shall choose an International certification course offered by the reputed organizations like Google, Microsoft, IBM, Texas Instruments, Bentley, Autodesk, Eplan and CISCO, etc. The duration of the course is 40-50 hours specified in the curriculum, which will be offered through Centre of Excellence.

Pass /Fail will be determined on the basis of participation, attendance, performance and completion of the course. If a candidate Fails, he/she has to repeat the course in the subsequent years. Pass in this course is mandatory for the award of degree.

P20MEW301 **PROJECT PHASE - I**

L	T	P	C
0	0	12	6

Aim & Objective:

The project work aims to develop the work practice and to apply theoretical and practical tools/techniques for solving real life problems related to industry and current research. The objective of the project work is to improve the professional competency and research attitude by touching the areas which are not covered in theory or laboratory classes.

- The project work shall be a design project/experimental project and/or computer simulation project on any of the topic in manufacturing engineering or related field.
- The project work shall be allotted individually on different topics.
- The students shall be encouraged to do their project work in the parent institute itself. In exceptional cases the students shall be permitted to undertake continue their project outside the parent institute with appropriate permission from Head of the institution through the Project Coordinator.
- Department shall constitute an Evaluation Committee to review the project work.
- The Evaluation committee shall consist of at least three faculty members namely internal guide, project coordinator and another expert in the specified area of the project.

The student is required to undertake the project phase I during the third semester and the same shall be continued in the 4th semester (Phase II). Phase I consist of preliminary thesis work, Three reviews of the work and the submission of preliminary report. First review shall highlight the topic, objectives and origin of problem, second review shall highlight, Literature survey, methodology and expected results. Third review shall evaluate the progress of the work, preliminary report and scope of the work which shall be completed in the 4th semester. Also the evaluation of project phase - I shall be done externally.

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P20MEW302 **INTERNSHIP**

L	T	P	C
0	0	0	2

Students should undergo training or internship during summer / winter vacation at Industry/ Research organization / University (after due approval from the Programme Academic Coordinator and Department Consultative Committee (DCC). In such cases, the internship/training should be undergone continuously (without break) in one organization. Normally no extension of time is allowed. However, DCC may provide relaxation based on the exceptional case. The students are allowed to undergo three to four weeks of internship in established industry / Esteemed institution during vacation period. The student should give presentation and submit report to DCC. The Internship is assessed internally for 100 marks.

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		L	T	P	C	Hrs
P20MES301	**NPTEL/ GIAN/ MOOC**	**0**	**0**	**0**	**-**	**-**

Student should register online courses like MOOC / SWAYAM / NPTEL etc. approved by the Department committee comprising of HoD, Programme Academic Coordinator and Subject Experts. Students have to complete relevant online courses successfully. The list of online courses is to be approved by Academic Council on the recommendation of HoD at the beginning of the semester if necessary, subject to ratification in the next Academic council meeting. The Committee will monitor the progress of the student and recommend the grade (100% Continuous Assessment pattern) based on the marks secured in online examinations. The marks attained for this course is not considered for CGPA calculation.

P20MEW403 **PROJECT PHASE - II**

L	T	P	C
0	0	24	12

Aim and Objective:

The project work aims to develop the work practice and to apply theoretical and practical tools/techniques for solving real life problems related to industry and current research. The objective of the project work is to improve the professional competency and research attitude by touching the areas which are not covered in theory or laboratory classes.

- The project work shall be a design project/experimental project and/or computer simulation project on any of the topic in manufacturing engineering or related field.
- The project work shall be allotted individually on different topics.
- The students shall be encouraged to do their project work in the parent institute itself. In exceptional cases the students shall be permitted to undertake continue their project outside the parent institute with appropriate permission from Head of the institution through the Project Coordinator.
- Department shall constitute an Evaluation Committee to review the project work.
- The Evaluation committee shall consist of at least three faculty members namely internal guide, project coordinator and another expert in the specified area of the project.

Project phase II is a continuation of project phase I which started in the third semester. There shall be three reviews in the fourth semester, first in the beginning of the semester, second in the middle of the semester and the Third at the end of the semester. First review is to evaluate the progress of the work and planned activity; second review shall be presentation and discussion. Third review shall be a pre-submission presentation before the evaluation committee to assess the quality and quantity of the work done. This would be a pre qualifying exercise for the students for getting approval for the submission of the thesis. At least one technical paper shall be prepared for possible publication in journals or conferences. The technical paper shall be submitted along with the thesis. The final evaluation of the project shall be done externally.

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PROFESSIONAL ELECTIVES - I

P20MEE101 **ADVANCED ADDITIVE MANUFACTURING**

L	T	P	C	Hrs
3	0	0	3	45

Course Objectives

- To impart the fundamentals of additive manufacturing processes as well as design for additive manufacturing.
- To understand the economics of additive manufacturing as compared to traditional subtractive manufacturing.
- To learn Additive techniques like 3D printing, selective laser sintering, stereo lithography, multi-jet modelling, laminated object manufacturing, and others.
- Opportunity to design, engineer and fabricate an actual multi-component object using advanced/additive manufacturing devices and processes
- To understand the latest trends and business opportunities in AM, distributed manufacturing and mass customization.

Course Outcomes

After completion of the course, the students will be able to

CO1- Understand the fundamentals for additive manufacturing and various process. **(K2)**
CO2 - Understand the various types of Pre-processing, processing, post-processing errors in AM. **(K2)**
CO3 - Understand the applications of AM in aerospace, automotive and biomedical fields. **(K2)**
CO4 - Apply the features of various AM software's. **(K3)**
CO5 - Analyses the methodology to manufacture the products using with various prototyping. **(K4)**

UNIT I INTRODUCTION (9 Hrs)

Prototyping fundamentals: Need for time compression in product development, Need for Additive Manufacturing, Historical development, Fundamentals of Additive Manufacturing, AM Process Chain, Advantages and Limitations of AM, Commonly used Terms, Classification of AM process, Fundamental Automated Processes: Distinction between AM and CNC, other related technologies.

UNIT II LIQUID-BASED AM SYSTEMS (9 Hrs)

Stereo lithography Apparatus (SLA): Models and specifications, Process, working principle, photopolymers, photo polymerization, Layering technology, laser and laser scanning, Applications, Advantages and Disadvantages, Case studies. Solid ground curing (SGC): Models and specifications, Process, working principle Applications, Advantages and Disadvantages, Case studies. Poly jet: Process, Principle, working principle, Applications, Advantages and Disadvantages, Case studies. Micro fabrication.

Solid-based AM Systems: Laminated Object Manufacturing (LOM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Fused Deposition Modeling (FDM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Multi-Jet Modelling (MJM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies.

UNIT III POWDER BASED AM SYSTEMS (9 Hrs)

Selective laser sintering (SLS): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Three-dimensional Printing (3DP): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Laser Engineered Net Shaping (LENS): Models and specifications, Process, working principle,

Applications, Advantages and Disadvantages, Case studies. Electron Beam Melting (EBM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies.

Rapid Tooling: Introduction to Rapid Tooling (RT), Conventional Tooling Vs RT, Need for RT. Rapid Tooling Classification: Indirect Rapid Tooling Methods: Arc Spray Metal Deposition, Investment Casting, Sand Casting, 3D Keltool process. Direct Rapid Tooling: Direct AIM, LOM Tools, DTM Rapid Tool Process, EOS Direct Tool Process and Direct Metal Tooling using 3DP.

UNIT IV AM DATA FORMATS (9 Hrs)

Reengineering for Digital Representation, STL Format, STL File Problems, Consequence of Building Valid and Invalid Tessellated Models, STL file Repairs: Generic Solution, Other Translators, Newly Proposed Formats. Mesh Refining by Sub division Techniques. AM Software's: Need for AM software, Features of various AM soft ware's like Magics, Mimics, Solid View, View Expert, 3D View, Velocity 2, Rhino, STL View 3 Data Expert and 3D doctor, Surgi Guide, 3-matic, Simplant, Mesh Lab.

UNIT V APPLICATIONS (9 Hrs)

Application – Material Relationship, Application in Design, Application in Engineering, Analysis and Planning, Aerospace Industry, Automotive Industry, Jewelry Industry, Coin Industry, GIS application, Arts and Architecture. RP Medical and Bioengineering Applications: Planning and simulation of complex surgery, Customized Implants & Prosthesis, Design and Production of Medical Devices, Forensic Science and Anthropology, Visualization of Biomolecules. W eb Based Rapid Prototyping Systems

Text Books

1. Chua C.K., Leong K.F. and LIM C.S ,Rapid prototyping: Principles and Applications , World Scientific publications, Third Edition, 2010.
2. Thomas. G.B, and Finney R.L, Calculus, Pearson Education, 2007.
3. D.T. Pham and S.S. Dimov, -Rapid Manufacturingll, Springer, 2001
4. Terry Wohlers, – Wholers Report 2000ll, W ohlers Associates, 2000.
5. Ian Gibson, Davin Rosen, Brent Stucker -Additive Manufacturing Technologies, Springer, 2nd Ed, 2014.

Reference Books

1. Ian Gibson, David W. Rosen, Brent Stucker, Additive manufacturing technologies: rapid prototyping to direct digital manufacturing Springer, 2010.
2. Andreas Gebhardt, Understanding additive manufacturing: rapid prototyping, rapid tooling, rapid manufacturing, Hanser Publishers, 2011.
3. L. Lu, J. Fuh and Y.-S. Wong, Laser-induced materials and processes for rapid prototyping, Kluwer Academic Press, 2001
4. Zhiqiang Fan and Frank Liou, Numerical modeling of the additive manufacturing (AM) processes of titanium alloy, InTech, 2012.
5. C.K. Chua, K.F. Leong and C.S. Lim, Rapid prototyping: principles and applications, 3rd Edition, World Scientific, 20 10.

Web References

1. https://nptel.ac.in/courses/112/104/112104265/
2. https://www.coursera.org/learn/generative-design-additive-manufacturing
3. https://nptel.ac.in/courses/112/107/112107078/
4. https://www.youtube.com/watch?v=7L42aRs68WI
5. https://www.youtube.com/watch?v=e9TY3v7ULE0

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)						Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
1	3	2	3	1	3	2	2	1	3
2	3	2	3	1	3	2	2	1	3
3	3	2	3	1	3	2	2	1	3
4	3	2	3	1	3	2	2	1	3
5	3	2	3	1	3	2	2	1	3

Correlation Level: 1- Low, 2 - Medium, 3 - High

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P20MEE102 **PRECISION ENGINEERING**

L	T	P	C	Hrs
3	0	0	3	45

Course Objectives

- To give the basic precision engineering methodology and state-of-the-art concepts for designing high-precision CNC machines and products.
- To get the knowledge about datum system, geometric analysis and applications
- To understand the tolerance charting techniques and worksheet preparations.
- To teach the novel design principles leading to improved machine performance and reliability.
- To apply the acquired knowledge to other design efforts and fields as well.

Course Outcomes

After completion of the course, the students will be able to

CO1 - Apply fits and tolerances for parts and assemblies according to ISO standards.**(K3)**
CO2 - Apply selective assembly concept for quality and economic production. **(K3)**
CO3 - Using principles of dimensional chains for individual features of a part or assembly. **(K4)**
CO4 - Evaluate the part and machine tool accuracies. **(K5)**
CO5 - Analyze the causes for dimensional and geometrical errors prior to and during machining and suggest remedies. **(K4)**

UNIT I CONCEPTS OF ACCURACY **(9 Hrs)**

Introduction – Concept of Accuracy of Machine Tools – Spindle ad Displacement Accuracies – Accuracy of numerical Control Systems – Errors due to Numerical Interpolation Displacement Measurement System and Velocity Lags. Geometric Dimensioning and Tolerancing: Tolerance Zone Conversions – Surfaces, Features, Features of Size, Datum Features – Datum Oddly Configured and Curved Surfaces as Datum Features, Equalizing Datums –Datum Feature of Representation – Form Controls, Orientation Controls – Logical Approach to Tolerancing.

UNIT II DATUM SYSTEMS **(9 Hrs)**

Design of freedom, Grouped Datum Systems – different types, two and three mutually perpendicular grouped datum planes; Grouped datum system with spigot and recess, pin and hole; Grouped Datum system with spigot and recess pair and tongue – slot pair – Computation of Transnational and rotational accuracy, Geometric analysis and application.

UNIT III TOLERANCE ANALYSIS **(9 Hrs)**

Process Capability, Mean, Variance, Skewness, Kurtosis, Process Capability Metrics, CP, CPK, Cost aspects, Feature Tolerances, Geometric Tolerances. Tolerance Charting Techniques-Operation Sequence for typical shaft type of components, Preparation of Process drawings for different operations, Tolerance worksheets and centrally analysis, Examples. Design features to facilitate machining; Datum Features – functional and manufacturing. Components design – Machining considerations, Redesign for manufactured, Examples

UNIT IV SURFACE FINISH **(9 Hrs)**

Review of relationship between attainable tolerance grades and different machining process. Cumulative effect of tolerances sure fit law, normal law and truncated normal law.

UNIT V MEASURING SYSTEM **(9 Hrs)**

In process or in-situ measurement of position of processing point- Post process and on-machine Measurement of dimensional features and surface-mechanical and optical measuring systems.

Text Books

1. James D. Meadows, Geometric Dimensioning and Tolerancing, Marcel Dekker Inc. 2007
2. Murthy R. L Precision Engineering in Manufacturing, New Age International (P) limited, 2005.
3. Murthy R. L., Precision Engineering in Manufacturing, New Age International (P) limited, 1996.
4. Kalpakjian S, Manufacturing Engineering and Technology. 3rd Ed. Addision-Wesley Publishing Co.,New York, 2001.

Reference Books

1. Richard Leach, Stuart T. Smith, Basics of Precision Engineering, CRC Press, 2018
2. V C Venkatesh, Precision Engineering, Tata Mcgraw-Hill, 2007
3. Zheng Yi Jiang, Yun Hae Kim Nanotechnology and Precision Engineering, Trans Tech Publications, 2013
4. Gerhard Pahl,Engineering Design- A Systematic Approach ,Springer, 2007.
5. Nakzavawa H, Principles of Precision Engineering, Oxford University Press, 2004.

Web References

1. https://nptel.ac.in/courses/112/104/112104028/
2. https://ocw.mit.edu/courses/mechanical-engineering/2-75-precision-machine-design-fall-2001/
3. https://mech.nitk.ac.in/course/principles-precision-engineering
4. https://nptel.ac.in/courses/112/107/112107242/
5. https://www.coursera.org/lecture/machine-learning/

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)						Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
1	3	2	3	2	3	2	1	3	2
2	3	2	3	2	3	2	1	3	2
3	3	2	3	2	3	2	1	3	2
4	3	2	3	2	3	2	1	3	2
5	3	2	3	2	3	2	1	3	2

Correlation Level: 1- Low, 2 - Medium, 3 - High

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P20MEE103 **VIRTUAL MANUACTURING**

L	T	P	C	Hrs
3	0	0	3	45

Course Objectives

- To understand the principles and techniques of virtual manufacturing.
- To learn the graphic data representation and virtual prototyping.
- To enable application of simulation to manufacturing systems
- To provide knowledge on enterprise modelling system and e-supply chain.
- To understand the application of virtual manufacturing in material processing.

Course Outcomes

After completion of the course, the students will be able to

CO1 - Understand the basics of virtual manufacturing system. **(K2)**
CO2 - Develop prototype and visualize in 3D. **(K3)**
CO3 - Simulate the prototype for assembly and production lines. **(K4)**
CO4 - Create of network in manufacturing systems that are electronically linked. **(K6)**
CO5 - Apply virtual assembly tools for improving product design. **(K3)**

UNIT I INTRODUCTION **(9 Hrs)**

Definitions, scope of Virtual Manufacturing, Methods and tools used in Virtual manufacturing, Paradigms of VM: Design-centered VM, Production-centered VM and Control-centered VM. Generic VM Issues - relationships between VM, Virtual Prototyping, the Virtual Enterprise. Role of object oriented technology in VM

UNIT II PRODUCT DATA VISUALIZATION **(9 Hrs)**

Graphics fundamentals, graphics data representation, polygonal based operations, LOD management, lighting and coloring, illumination, and shading. Virtual reality and its applications: computer animation, viewing in 3D, input/output devices, virtual and augmented reality, virtual design, virtual prototyping and virtual manufacturing.

UNIT III MANUFACTURING PROCESS SIMULATION **(9 Hrs)**

Factory level, Machine level, Component level, Process level. Integrated Simulation Method to Support Virtual Factory Engineering. Application of Virtual Reality Simulation of a Mechanical Assembly Production Line. Case studies using CATIA, SOLIDCAST, PROCAST, OPTICAST simulation software.

UNIT IV DISPERSED NETWORK MANUFACTURING **(9 Hrs)**

Virtual factory, enterprise collaborative modeling system, virtual manufacturing (VM) system, Web-based work flow management, collaborative product commerce, applications of multi-agent technology, e-supply chain

UNIT V APPLICATIONS OF VM IN MATERIALS PROCESSING **(9 Hrs)**

VM for sheet metal processing, Virtual machining and inspection system (VMIS), Virtual Assembly Tools for Improving Product Design

Text Books

1. Milan Gregor and Stefan Medvecky, Digital Factory – Theory and Practice, Engineering the Future, LaszloDudas (Ed.), 2010
2. Khan, W asim Ahmed, Raouf, Cheng, Kai, _'Virtual Manufacturing", Springer, 2011.
3. Gerardus Blokdyk, Virtual manufacturing network A Complete Guide" Kindle Edition, 2018.

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1. Prashant Banerjee,"Virtual Manufacturing",W iley,2001.
2. S.K Ong, A.Y.C Nee, Virtual and Augmented Reality Applications in Manufacturing", Springer, 2004.
3. Hamid Noori, W. B. Lee, Dispersed Network Manufacturing: An Emerging Form of Collaboration Networks", springer 2009
4. Paul Obiora Kanife, Computer Aided Virtual Manufacturing Using CREO Parametric", Springer, 2016.
5. Murat. Gunal, Simulation for Industry 4.0: Past, Present, and Future, springer 2019.

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1. https://nptel.ac.in/courses/106/105/106105195/
2. https://www.youtube.com/watch?v=2cCMty9v3Tg
3. https://www.youtube.com/watch?v=xCsOs4LRm6c
4. https://www.youtube.com/watch?v=zLMgdYl82IE
5. https://www.youtube.com/watch?v=bPC4pr790BE

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)						Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
1	3	2	2	2	3	3	1	1	3
2	3	2	2	2	3	3	1	1	3
3	3	2	2	2	3	3	1	1	3
4	3	2	2	2	3	3	1	1	3
5	3	2	2	2	3	3	1	1	3

Correlation Level: 1- Low, 2 - Medium, 3 - High

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P20MEE104	MANUFACTURING OF AUTOMOTIVE COMPONENTS	L	T	P	C	Hrs
		3	0	0	3	45

Course Objectives

- To acquire basic knowledge about in modern casting, forging, molding and machining processes followed in automotive components.
- To impart knowledge of production process for transmission components.
- To analyze detail about the advance welding using robots for making body components.
- To understand the importance of heat treatment for chassis components.
- To learn the application of coating for auto components.

Course Outcomes

After completion of the course, the students will be able to

CO1 – Understand the materials and manufacturing methods of engine components. **(K2)**
CO2 – Understand the casting technology for manufacturing of transmission components. **(K2)**
CO3 – Apply the thermoforming and hydro forming techniques for developing body components **(K3)**
CO4 – Analyses the materials and manufacturing methods for brakes. **(K4)**
CO5 – Investigation the various coating principles and its applications. **(K4)**

UNIT I ENGINE COMPONENTS **(9 Hrs)**

Overview -Material selection and Manufacturing methods for the Engine Components. Engine block- Casting-Conventional and expendable pattern. Cylinder head- Casting, machining and thermal barrier coating. Crank shaft, connecting rod, camshaft-Forging, and machining and heat treatment. Piston Gravity, squeeze, die casting, machining and finishing. Gudgeon Pin -Machining and Finishing, Valve forging, friction welding, machining, thermal barrier coating, heat treatment and surface improvement. Cylinder Liners, Piston ring - Centrifugal, HPDC, LPDC, machining and finishing. Castings Processes for Oil pan and Carburettors. Push Rods, Rocker Arm , Tappets, Spark Plug- Forging, Machining, Finishing and Heat treatment.

UNIT II TRANSMISSION COMPONENTS **(9 Hrs)**

Overview – Material selection and Manufacturing methods for transmission system. Flywheel -Casting and Machining. Clutch – Friction plate, clutch housing, pressure plate conventional and fine blanking, composite friction lining. Methods of Gear manufacture – Gear hobbing and gear Shaping machines – gear generation – gear finishing and shaving – Grinding and lapping of hobs and shaping cutters -gear honing -gear broaching. Gearbox -Casting, precision forging, powder metallurgy, heat treatment and finishing. Propeller shaft - Continuous casting, extrusion, dies heat treatment and surface hardening. Axle-Differential -Axle Shaft - Bearing -fasteners-Forging, casting and machining. Leaf and coil spring -Forging and machining, composite leaf spring and wrap forming of coil spring.

UNIT III BODY COMPONENTS **(9 Hrs)**

Surface treatment -Plastics – Plastics in Automobile vehicles -Processing of plastics – Body Panel - Thermoforming and hydro forming, press forming, stretch forming. Emission control system -catalytic converter -Hydro forming of exhaust manifold and lamp housing. Welding -Resistance welding and other welding processes with the use of Robots in Body weldment. Instrument Panel -Principle of injection molding, injection molding of instrument panel. Bumpers -Molding of bumpers, reinforced reaction injection molding, Manufacture of polymer panels.

UNIT IV CHASSIS COMPONENTS **(9 Hrs)**

Material selection and manufacturing methods for Vehicle Frame Manufacturing, W heel drum, Brake drum, Brake shoes, wheel rim and wheel housing manufacturing. Steering systems, shock absorbers, dead axle - casting, forging, machining and finishing operation- Heat treatment procedures for chassis components.

UNIT V COATING APPLICATIONS **(9 Hrs)**

Tire and tube manufacturing, spray painting, powder coating, Prototype Manufacturing -RPT,3-D Printing, chemical vapour deposition, physical vapour deposition, cryogenic grinding of powders, sealants, sound proof materials, structural adhesives, MMC liners – Selection of materials for Auto components.

Text Books

1. Heldt.P.M, High speed combustion engines, xford publishing Co., New York, 1990
2. A S John, "Introduction to Manufacturing Processes", Tata McGraw -Hill, 2012.
3. B.P. Bhardwaj, The Complete Book on Production of Automobile Components and Allied Products"", NIIR Project Consultancy Services, 2014.
4. Kalpakjian, Manufacturing Engineering and Technology, Pearson Education, 2015
5. P M Heldt, High Speed Combustion Engines"", Oxford IBH publishing Co., Calcutta, 2016.

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1. Gupta K.M. Automobile Engineering Vol.I & II, Umesh Publishers, 2000.
2. Kalpakjian, Manufacturing Processes For Engineering Materials, Pearson Education, 2009.
3. Rusinoff, Forging and Forming of metalsll, D.B.Taraporevala Son & Co.Pvt Ltd., Mumbai, 2009.
4. Geoffrey Davies, Materials for Automobile Bodies, Elsevier, 2012.
5. Giancarlo Genta, The Automotive Chassis: Volume 1: Components Design, Springer, 2014.

Web References

1. http://www.madehow.com/Volume1/Automobile.html
2. https://nptel.ac.in/courses/112/105/112105127/
3. https://www.automotivemanufacturingsolutions.com/new-methods-for-manufacturing/6623.article/
4. https://www.youtube.com/watch?v=jdFrBtHeJbs&list=PLSGws_74K01-g9nnTMBssGURHawYYQfMQ
5. https://www.youtube.com/watch?v=hs7bABMtOMI&list=PLyqSpQzTE6M9G2SNxKfsVEjcM9MlJau4F

COs/POs/PSOs Mapping

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	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
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2	3	2	2	2	3	2	1	2	3
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4	3	2	2	2	3	2	1	2	3
5	3	2	2	2	3	2	1	2	3

Correlation Level: 1- Low, 2 - Medium, 3 - High

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P20MEE105 **CELLULAR MANUFACTURING SYSTEMS**

L	T	P	C	Hrs
3	0	0	3	45

Course Objectives

- To study in detail about the Concepts and applications of Cellular manufacturing systems.
- To develop the detail about Traditional and non-traditional approaches of Problem solving.
- To design the implementation of cellular manufacturing system.
- To learn in detail about Performance measurement.
- To create in detail about Human and economical aspects of CMS.

Course Outcomes

After completion of the course, the students will be able to

CO1 - Understand the basic components about applications of Cellular manufacturing systems. **(K2)**
CO2 - Understand the differences between Traditional and non-traditional approaches of Problem solving. **(K2)**
CO3 - Value the principle of cellular manufacturing system and cost estimation models. **(K3)**
CO4 - Importance the performance measurement of manufacturing system. **(K4)**
CO5 - Perform case studies on CMS. **(K4)**

UNIT I INTRODUCTION **(9 Hrs)**

Introduction to Group Technology, Limitations of traditional manufacturing systems, characteristics and design of groups, benefits of GT and issues in GT.

UNIT II CMS PLANNING AND DESIGN **(9 Hrs)**

Problems in GT/CMS - Design of CMS - Models, traditional approaches and non- traditional approaches - Genetic Algorithms, Simulated Annealing, Neural networks.

UNIT III IMPLEMENTATIONOF GT/CMS **(9 Hrs)**

Inter and Intra cell layout, cost and non-cost based models, establishing a team approach, Managerial structure and groups, batch sequencing and sizing, life cycle issues in GT/CMS.

UNIT IV PERFORMANCE MEASUREMENT AND CONTROL **(9 Hrs)**

Measuring CMS performance - Parametric analysis - PBC in GT/CMS, cell loading, GT and MRP –framework.

UNIT V COMPUTER MODEL **(9 Hrs)**

Conventional Vs group use of computer models in GT/CMS, Human aspects of GT/CMS - cases.

Text Books

1. Burbidge, J.L. Group " Technology in Engineering Industry ", Mechanical Engineering pub.London, 2017.
2. Kamrani, A.K, Parsaei, H.R and Liles, D.H. (Eds), " Planning, design and analysis of cellular manufacturing systems ", Elsevier, 2011.
3. Mikell.P.Groover Automation, Production Systems and Computer Integrated Manufacturingll, Prentice Hall of India, 2008.
4. Nanua Singh - System Approach in Computer Integrated Design and Manufacturing" , John Wiley and Sons, Inc.2013
5. Nagendra Parashar, B. S., Cellular Manufacturing Systems: An Integrated Approachll PHI Learning, 2010.

Reference Books

1. Radhakrishnan P, SubramanyanS.and Raju V., -CAD/CAM/CIMll, 2nd Edition, New Age International (P) Ltd, New Delhi, 2000
2. Thomas A. Boucher- „Computer Automation in Manufacturing: An Introduction", Chapman and Hall, 2014.
3. YoramKoren - „Computer Control of Manufacturing Systems", Macgraw Hill Internationl Book Company 2014.

4. Askin, R.G. and Vakharia, A.J., G.T " Planning and Operation, in The automated factory Hand Book: Technology and Management, TAB Books , NY, 2015.
5. Irani, S.A. Cellular Manufacturing Systems, Hand Book,Wiley, 2016.

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2. https://www.sciencedirect.com/topics/engineering/cellular-manufacturing
3. https://www.coursera.org/courses?query=lean%20manufacturing
4. https://swayam.gov.in/nd1_noc19_me45/preview
5. https://www.youtube.com/results?search_query=CELLULAR+MANUFACTURING+SYSTEMS+nptel

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2	3	1	1	1	3	3	2	2	3
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4	3	1	1	1	3	3	2	2	3
5	3	1	1	1	3	3	2	2	3

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PROFESSIONAL ELECTIVES - II

P20MEE201 **MECHATRONICS IN MANUFACTURING**

L	T	P	C	Hrs
3	0	0	3	45

Course Objectives

- To acquire basic knowledge detail about the Concepts and applications of mechatronics.
- To learn the detail about microprocessors.
- To study the implementation of sensors.
- To apply in detail about Performance of systems models.
- To study in detail about selection of mechatronics systems.

Course Outcomes

After completion of the course, the students will be able to

CO1 - Understand the basic components about applications of mechatronics.**(K2)**
CO2 - Understand the different types of microprocessors. **(K2)**
CO3 - Describe the working principle of different sensors. **(K3)**
CO4 - Gained knowledge about system models. **(K4)**
CO5 - Achieve knowledge about selection of mechatronics systems. **(K4)**

UNIT I INTRODUCTION (9 Hrs)

Introduction to Mechatronics systems and components, Principles of basic electronics– Digital logic, number system logic gates, Sequence logic flip flop system, JK flip flop, D-flip flop.

UNIT II MICROPROCESSORS (9 Hrs)

Microprocessors and their applications – Microcomputer computer structure/microcontrollers, Integrated circuits – signal conditioning processes, various types of amplifiers, low pass and high pass filters.

UNIT III SENSORS (9 Hrs)

Sensors and transducers. Displacement, position proximity sensors, velocity, force sensors. Fluid presence temperature, liquid level and light sensors. Selection of sensors, Actuators, Pneumatic and hydraulic systems, Mechanical actuation system, Electrical actuation system. Other Electrical/Electronic hardware in Mechatronics system.

UNIT IV SYSTEM MODELS (9 Hrs)

Engineering Systems, rotational, translation, elected mechanical, Hydraulic mechanical system, System Transfer functions, First-second order system in series.

UNIT V APPLICATIONS (9 Hrs)

Sensors line encoders and revolvers, stepper and servomotors Ball screws, solenoids, line actuators and controllers with application to CNC system, robots, consumer electronics products etc, Design of a Mechatronics Product using available software CAD packages MATLAB and SIMULINK.

Text Books

1. Mechatronics by W. Bolton, published by Addison Worley Longman Pvt. Ltd., India Brander, Delhi 2012
2. Automation Production System and CIMS by Mikel P Groover, Prentice Hall of India Pvt. Ltd, New Delhi, 2011.
3. Devadas Shetty and Richard A.Kolk, —Mechatronics systems designll, PWS Publishing Company, 2010
4. Boucher, T. O.,Computer automation in manufacturing - an Introduction, Chapman and Hall, 1996.
5. J. Edward Carryer, et al., Introduction to Mechatronic Design, Prentice Hall, 1st edition, 2010.

Reference Books

1. John R. Hackworth & Frederick D. Hackworth Jr, Programmable Logic Controllers – Programming Methods and Applications, Pearson (2011).
2. Senturia Stephen D., Microsystem Design, Springer US, (2013).

3. Smaili.A and Mrad.F , "Mechatronics integrated technologies for intelligent machines", Oxford university press, 2010
4. Boltan, W., Mechatronics: electronic control systems in mechanical and electrical engineering, Longman,Singapore, 1999.
5. Godfrey C. Onwubolu, "Mechatronics Principles and Applications", Elsevier, 2007.

Web Resources

1. https://www.captechu.edu/blog/role-of-mechatronics-in-manufacturing/
2. https://nptel.ac.in/courses/112/103/112103174/
3. https://www.isa.org/intech/20170403/
4. http://cas.res.in/pdf/Mechatronics%20Syllabus.pdf
5. https://www.youtube.com/watch?v=5UNmi61jmno

COs/POs/PSOs Mapping

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Correlation Level: 1- Low, 2 - Medium, 3 - High

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P20MEE202	INFORMATION TECHNOLOGY IN MANUFACTURING APPLICATIONS	L	T	P	C	Hrs
		3	0	0	3	45

Course Objectives

- To study in detail about the concept of automation and manufacturing systems.
- To apply the role of IT in controlling department of manufacturing system.
- To determine the implementation CNC part programming.
- To study in detail about application of IT in material handling and quality control systems.
- To develop the role of sourcing, information technology, pricing and revenue management, and coordination in a supply chain.

Course Outcomes

After completion of the course, the students will be able to

CO1 - Understand the basic components about applications of IT in automation. **(K2)**
CO2 - Understand the application of IT in controlling department. **(K2)**
CO3 - Gained knowledge about role of IT in part programming. **(K3)**
CO4 - Achieve knowledge about IT system used in material handling and quality control systems. **(K4)**
CO5 - Evaluator and select the best supplier for a firm or organisation using IT. **(K5)**

UNIT I INTRODUCTION TO AUTOMATION **(9 Hrs)**

Basic Elements of an Automated Systems, Advanced Automation Functions, Levels of automation, Automation Principles & Strategies, concept of automation; types of automation; flexibility, degree, level and yardstick of automation; Components of automation, Introduction to NC/CNC/DNC.

UNIT II CONTROLLERS **(9 Hrs)**

Introduction to Programmable logical controller (PLC): Discrete Control using PLC & PLC network, Introduction, Micro PLC, Programming a PLC, Logic Functions, input & output Modules, PLC Processors, PLC Instructors, Documenting a PLC System, Timer & counter Instructions, Comparison & data Handling instructions, Sequencing Instructions, Mask Data representation.

UNIT III CNC PART PROGRAMMING **(9 Hrs)**

Axes identification, coordinate system, movements and interpolation with other axis, Application of rotary axis, Manual programming for CNC turning and Milling– offline, Programming formats, Tool offsets, Type of compensations and cutting parameters, Introduction to G codes and M codes for CNC Turning and Milling, single and multipass canned cycle in turning, drilling canned cycles in milling, sub programing.

UNIT IV AUTOMATED MATERIAL HANDLING AND QUALITY CONTROL **(9 Hrs)**

Types of equipment, functions, analysis ,conveyor systems, automated guided vehicle systems(AGVs), guidance, routing and control, Automated Storage and Retrieval systems (AS/RS),Components, Controls and applications, Integration of automated material handling and storage systems to manufacturing environment. Introduction to CMM, Non-Contact Inspection Method.

UNIT V SUPPLY CHAIN MANAGEMENT **(9 Hrs)**

Managing Cross-Functional Drivers in a Supply Chain: Sourcing Decisions- Make or buy decisions, Third- and fourth-party logistics providers, Sourcing Processes. Pricing and Revenue Management in a Supply Chain, Information Technology in a Supply Chain, Coordination in a Supply Chain.

Text Books

1. Ghosh A., Malik A. K., -Manufacturing Sciencell East West Press, 2010.
2. Chopra, S., and Meindl, P. -Supply Chain Management, strategy, planning, and operation second edition, 2014.
3. Qi Luo, Wei Deng Information Technology for Manufacturing Systems IV, Trans Tech Publications Limited 2013

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1. Nicholas J.Aquilano and Richard B. Chase ,Production and Operations Management Manufacturing and Services, 2015.
2. Jain R K, Production Technology: Manufacturing Processes, Technology and Automationll Khanna Publication 2014.
3. Richard C. Dorf, Technology Management Handbook, CRC,2009
4. Joseph M. Putti, Management-A Functional Approach, McGraw Hill, 2007
5. Gerard H.Ganynor, Handbook of Technology Management, McGraw –Hill professional, 2007

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1. https://www.researchgate.net/publication/258555726_Information_Technology_in_Manufactring
2. https://nptel.ac.in/courses/106/105/106105195/
3. https://cdn.ymaws.com/www.atmae.org/resource/resmgr/JIT/lawless082200.pdf
4. https://www.youtube.com/watch?v=wePXwnRk3nk
5. https://www.youtube.com/watch?v=zRiVS7qtqIA

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1	3	1	3	1	2	2	1	2	2
2	3	1	3	1	2	2	1	2	2
3	3	1	3	1	2	2	1	2	2
4	3	1	3	1	2	2	1	2	2
5	3	1	3	1	2	2	1	2	2

Correlation Level: 1- Low, 2 - Medium, 3 - High

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P20MEE203 ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS

L	T	P	C	Hrs
3	0	0	3	45

Course Objectives

- To acquire knowledge of Fuzzy Rule based systems.
- To understand the concept of Grouped datum system.
- To analyze neural network architectures.
- To learn Cumulative effect of tolerances.
- To understand the applications of AI in robots

Course Outcomes

After completion of the course, the students will be able to

CO1 - Grow knowledge about Fuzzy Logic Principles.**(K1)**
CO2 - Demonstrate awareness of informed search and exploration methods. **(K2)**
CO3 - Understand the fundamentals of Neural networks and its application. **(K2)**
CO4 - Demonstrate proficiency developing applications in an 'AI language', expert system shell. **(K3)**
CO5 - Apply artificial intelligence in manufacturing process and robots. **(K3)**

UNIT I INTRODUCTION TO FUZZY LOGIC (9 Hrs)

Basic concepts in Fuzzy Set theory – Operations of Fuzzy sets – Fuzzy relational equations – Propositional, Predicate Logic – Inference – Fuzzy Logic Principles – Fuzzy inference – Fuzzy Rule based systems – Fuzzification and defuzzification – Types.

UNIT II FUZZY LOGIC APPLICATIONS (9 Hrs)

Design of freedom, Grouped Datum Systems – different types, two and three mutually perpendicular grouped datum planes; Grouped datum system with spigot and recess, pin and hole; Grouped Datum system with spigot and recess pair and tongue – slot pair – Computation of Transnational and rotational accuracy, Geometric analysis and application.

UNIT III ARTIFICIAL NEURAL NETWORK (9 Hrs)

Fundamentals of Neural networks – Neural network architectures – Learning methods – Taxonomy of Neural Network Architectures – Standard back propagation Algorithms – Selection of various parameters – Variations

UNIT IV ARCHITECTURES OF ANN (9 Hrs)

Review of relationship between attainable tolerance grades and different machining process. Cumulative effect of tolerances sure fit law, normal law and truncated normal law.

UNIT V APPLICATION OF AI IN ROBOTS (9 Hrs)

Artificial intelligence - Basics - Goals of artificial intelligence - AI techniques - problem representation in AI - Problem reduction and solution techniques - Application of AI and KBES in Robots.

Text Books

1. Jacek M. Zurada, Introduction to Artificial Neural Systems,Jaico Publishing House, 1994
2. E Rich, K Knight, Artificial Intelligence, 3rd Edition, Tata McGraw Hill, 2009.
3. C.S. Krishnamoorthy, S. Rajeev, Artificial Intelligence and Expert Systems for Engineers, CRC Press, 2018

Reference Books

1. Simon Haykin, Neural Networks - A comprehensive foundation, Prentice Hall, 2nd Edition, 1998.
2. S. Rajasekaran, GA VijayalakshmiPai, Neural Networks, Fuzzy Logic and Genetic Algorithms", Prentice Hall of India Private Limited, 2003.
3. Rajendra Akerkar, Introduction to Artificial Intelligencell, PHI Learning, 2005.
4. Paolo Traverso, Daniel Dochev, Marco Pistore, Artificial Intelligence: Methodology, Systems, and Applicationsll, 13th International Conference, AIMSA 2008.
5. Patterson, Introduction to Artificial Intelligence, Pearson India, 2015.

Web Resources

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2. https://www.youtube.com/watch?v=AETGmGYy0UU&list=PLKWzCJ0iOapF6IF50BayqMNpgOJq2ugZR.
3. https://www.youtube.com/watch?v=fV2k2ivttL0&list=PLCD819D1E1C4F91C3
4. https://www.youtube.com/watch?v=pKeVMlkFpRc.
5. https://www.youtube.com/watch?v=lYnt9P6eQAE&list=PLrP-pAdcAQntNGCzKobL8H-Clr_yBlFhf

COs/POs/PSOs Mapping

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Correlation Level: 1- Low, 2 - Medium, 3 - High

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P20MEE204 DESIGN OF HYDRAULIC AND PNEUMATIC SYSTEMS

L	T	P	C	Hrs
3	0	0	3	45

Course Objectives

- To draw symbols used in hydraulic systems.
- To operate different types of valves used in hydraulic systems
- To develop efficient hydraulic circuits
- To maintain different valves and auxiliaries.
- To assemble pumps and motors to rectify problems.

Course Outcomes

After completion of the course, the students will be able to

CO1 - Understand the various concepts of hydraulics systems **(K2)**
CO2 - Apply safety valve and pressure for various applications **(K3)**
CO3 - Identify various accessories use in hydraulic and pneumatic system **(K3)**
CO4 - Calculate design and constructional details of pumps and motors. **(K4)**
CO5 - Analysis and maintenance details of pumps and motors. **(K4)**

UNIT I OIL HYDRAULIC SYSTEMS AND HYDRAULIC ACTUATORS (9 Hrs)

Hydraulic Power Generators – Selection and specification of pumps, pump characteristics. Linear and Rotary Actuators – selection, specification and characteristics. Actuators (Cylinder): Types of mounting, Computations of force. Power Pack: Reservoir & its capacity, Power pack designs.

UNIT II CONTROL AND REGULATION ELEMENTS (9 Hrs)

Pressure - direction and flow control valves - relief valves, non-return and safety valves – actuation systems. Pressure Boosters: Pressure applied in one direction, Pressure applied in both directions, Pressure applied & intensified in both directions, Advantages of pressure boosters.

UNIT III HYDRAULIC CIRCUITS (9 Hrs)

Reciprocation, quick return, sequencing, synchronizing circuits - accumulator circuits - industrial circuits - press circuits - hydraulic milling machine - grinding, planning, copying, - forklift, earth mover circuits- design and selection of components - safety and emergency mandrels.

UNIT IV PNEUMATIC SYSTEMS AND CIRCUITS (9 Hrs)

Pneumatic fundamentals - control elements, position and pressure sensing - logic circuits – switching circuits - fringe conditions modules and these integration - sequential circuits - cascade methods - mapping methods - step counter method - compound circuit design - combination circuit design.

UNIT V INSTALLATION, MAINTENANCE AND SPECIAL CIRCUITS (9 Hrs)

Pneumatic equipment- selection of components - design calculations – application -fault finding hydro pneumatic circuits - use of microprocessors for sequencing - PLC, Low cost automation – Robotic circuits.

Text Books

1. K. Hiraniya Singh, Pneumatic and Hydraulic SystemsI.K. International Publishing House Pvt. Limited, 2017.
2. Ilango Sivaraman, Introduction to Hydraulics and PneumaticsII Prentice Hall India Pvt., Limited,2017
3. James R. Daines, Martha J. Daines, Fluid Power Hydraulics and Pneumatics, Goodheart- Willcox Company, Incorporated, 2018

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1. Jagadeesha T, Hydraulics and Pneumatics, I.K. International Publishing House Pvt. Limited, 2015
2. Ian C. Turner, Engineering Applications of Pneumatics and Hydraulics, CRC Press, 2014
3. Nicolae Vasiliu, Daniela Vasiliu, Constantin LINOIU, Radu Puhalschi, Simulation of Fluid Power Systems with Simcenter Amesim, CRS Press, 2018

4. R.H. Warring, Some Aspects of Hydraulics in Mechanical Handling and Mobile Equipmentll Elsevier Science, · 2014
5. R.B. Walters, Hydraulic and Electro Hydraulic Control Systems, Springer Netherlands · 2012

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1. https://www.digimat.in/nptel/courses/video/112105047/L01.html
2. https://www.youtube.com/watch?v=8xd7cWvMrvE
3. https://www.youtube.com/watch?v=UGozt4Lum4Q
4. https://www.youtube.com/watch?v=8xd7cWvMrvE
5. https://www.youtube.com/watch?v=dxAsr14DW6Y&list=PLbMVogVj5nJTKwm1WjlutrAEZrLE995Ja

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	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
1	3	2	3	2	2	2	2	2	3
2	3	2	3	2	2	2	2	2	3
3	3	2	3	2	2	2	2	2	3
4	3	2	3	2	2	2	2	2	3
5	3	2	3	2	2	2	2	2	3

Correlation Level: 1- Low, 2 - Medium, 3 - High

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P20MEE205 **INSTRUMENTATION AND CONTROL**

L	T	P	C	Hrs
3	0	0	3	45

Course Objectives

- To study in detail about the concept of instrumentation and control system.
- To learn about control systems of displacement and temperature.
- To apply about control systems of pressure.
- To utilize about control systems of level and flow.
- To understand about control systems of acceleration and speed.

Course Outcomes

After completion of the course, the students will be able to

CO1 - Recognize the basic components of instrumentation and control systems. **(K1)**
CO2 - Understand the application of displacement and temperature gauges. **(K2)**
CO3 - Expand knowledge about instruments used for pressure gauging. **(K3)**
CO4 - Apply knowledge about in instruments used for level and flow gauging. **(K3)**
CO5 - Analysis knowledge about instruments used to measure acceleration and speed. **(K4)**

UNIT I INTRODUCTION (9 Hrs)

Definition — Basic principles of measurement — Measurement systems, generalized configuration and functional descriptions of measuring instruments — examples. Dynamic performance characteristics — sources of error, Classification and elimination of error.

UNIT II MEASUREMENT OF DISPLACEMENT AND TEMPERATURE (9 Hrs)

Measurement of Displacement: Theory and construction of various transducers to measure displacement — Piezo electric, Inductive, capacitance, resistance, ionization and Photo electric transducers, Calibration procedures. Measurement of Temperature: Classification — Ranges — Various Principles of measurement — Expansion, Electrical Resistance — Thermistor — Thermocouple — Pyrometers — Temperature Indicators.

UNIT III MEASUREMENT OF PRESSURE (9 Hrs)

Measurement of Pressure: Units — classification — different principles used. Manometers, Piston, Bourdon pressure gauges, Bellows — Diaphragm gauges. Low pressure measurement — Thermal conductivity gauges — ionization pressure gauges, Mcleod pressure gauge.

UNIT IV MEASUREMENT OF LEVEL AND FLOW (9 Hrs)

Measurement of Level: Direct method — Indirect methods — capacitative, ultrasonic, magnetic, cryogenic fuel level indicators — Bubbler level indicators. Flow Measurement: Rotameter, magnetic, Ultrasonic, Turbine flow meter, Hot — wire anemometer, Laser Doppler Anemometer (LDA).

UNIT V MEASURING INSTRUMENTS (9 Hrs)

Measurement of Speed: Mechanical Tachometers — Electrical tachometers — Stroboscope, Non- contact type of tachometer. Measurement of Acceleration and Vibration: Different simple instruments — Principles of Seismic instruments — Vibro meter and accelerator meter using this principle.

Text Books

1. D.S Kumar ,Measurement Systems: Applications & Design Anuradha Agencies. 2010.
2. C.Nakra and K.K.Choudhary Instrumentation, measurement & analysis TMH.2014.
3. Gene F Franklin, J David Powell, Abbas Emami Naeini, Feedback Control of Dynamic Systems, 4th Ed, Pearson Education Asia, 2002
4. Graham C Goodwin, Stefan F Graebe, Mario E Salgado, Control System Design, Prentice Hall India, 2003.
5. P. C. Sen, Principles of Electrical Machines & Power Electronics, John Wiley, 2003.

Reference Books

1. R.K. Jain , Mechanical and Industrial Measurements, Khanna Publishers.2015.
2. A.K. Tayal , Instrumentation & Mech. Measurements Galgotia Publications.2013.

3. C.S.Rangan, V.S.V.Mani and G.R.Sarma - Instrumentation Devices and systems ", Tata McGraw Hill, 2013
4. A.J.Baauvans -Digital Instrumentation ", McGraw Hill, 2012.
5. M.P.Groover - Automation, Production Systems and computer integrated manufacturing ", Prentice Hall 2012.

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2. https://nptel.ac.in/courses/103/105/103105064/
3. https://www.smartzworld.com/notes/instrumentation-and-control-systems
4. https://www.coursera.org/courses?query=control%20systems
5. https://www.youtube.com/watch?v=DAwXk77DXUM&list=PLUtfVcb-iqn_Dq6RnkCaOaLjPDu3cmxpo

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)						Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
1	3	1	2	2	3	2	2	2	3
2	3	1	2	2	3	2	2	2	3
3	3	1	2	2	3	2	2	2	3
4	3	1	2	2	3	2	2	2	3
5	3	1	2	2	3	2	2	2	3

Correlation Level: 1- Low, 2 - Medium, 3 - High

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PROFESSIONAL ELECTIVES - III

		L	T	P	C	Hrs
P20MEE301	MECHATRONIC SYSTEM DESIGN	3	0	0	3	45

Course Objectives

- To acquire knowledge about the concept of Mechatronics design process.
- To learn about basic system modelling.
- To understand the engineering system and dynamic response.
- To know the elements of real time interfacing and data acquisition system.
- To study about design of Mechatronics system through case studies.

Course Outcomes

After completion of the course, the students will be able to

CO1 - Understand the basics and key elements of Mechatronics design process. **(K2)**

CO2 - Familiar with basic system modelling. **(K2)**

CO3 - Understand the concepts of engineering system and dynamic response of the system. **(K2)**

CO4 - Explain the concepts of real time interfacing and data acquisition. **(K2)**

CO5 - Illustrate the concepts of design of Mechatronics system. **(K4)**

UNIT I INTRODUCTIONTO DESIGN OF MECHATRONICS (9 Hrs)

System Key elements - Mechatronics design process -design parameters - mechatronics and traditional design - Advanced approaches in mechatronics design - Introduction to industrial design, modelling, simulation and analysis - Ergonomics and safety.

UNIT II BASIC SYSTEM MODELLING (9 Hrs)

Introduction – model catagories – model development – Simulation using softwares – verification and validation – Mathematical modelling : Basic system modelling – mechanical electrical, fluid and thermal. Measurement of Temperature: Classification — Ranges — Various Principles of measurement — Expansion, Electrical Resistance — Thermistor — Thermocouple — Pyrometers — Temperature Indicators.

UNIT III MECHATRONIC SYSTEM MODELLING (9 Hrs)

Engineering systems: Rotational – translational, electro-mechanical, pneumatic-mechanical, hydraulic-mechanical, micro electro mechanical system – Dynamic responses of system: first order, second order system – Performance measures.

UNIT IV REAL TIME INTERFACING (9 Hrs)

Introduction - Selection of interfacing standards- elements of data acquisition and control systems -Overview of I/O process -general purpose I/O cards and its installation -Data conversion process -Application software's - Man machine interface.

UNIT V APPLICATIONS (9 Hrs)

Motion control using DC Motor, AC Motor and Servomotor – Temperature control of hot/cold reservoir – Pick and place robot – Car parking barriers – Motion and temperature control of washing machine – Auto focus camera, exposure control.

Text Books

1. Devdasshetty, Richard A. Kolk, Mechatronics System Design, 2nd Edition,Cengage Learning 2011.
2. Georg pelz, —Mechatronic Systems: Modeling and simulationll with HDLs, John wiley and sons Ltd, 2013.
3. Clarence W. De Silva- Mechatronic Systems, CRC Press 01 October 2007.

Reference Books

1. Bradley, D.Dawson, N.C. Burd and A.J. Loader, —Mechatronics: Electronics in Products and Processesll, CRC Press 1991 , First Indian print 2016.
2. De Silva, —Mechatronics: A Foundation Coursell, Taylor and Francis, Indian Reprint, 2015.

3. P.Beer & Johnson, Vector Mechanics for Engineers and Scientists Statics and Dynamics, TataMcGraw Hill, New Delhi, 2014.
4. Shingley.J.E., Theory of Machines and Mechanisms, 2nd Edition, McGraw Hills Inc, 2014.
5. JE. Shigley, Mechanical Engineering Design, McGraw Hill International, 2011.

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2. https://nptel.ac.in/courses/112/103/112103174/
3. http://www.umt.fme.vutbr.cz/images/opory/Design%20of%20Mechatronic%20Systems/1UM.pdf
4. https://elearning.ju.edu.jo/course/view.php?id=5735
5. https://www.newcastle.edu.au/course/MECH3500

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)						Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
1	2	1	2	3	1	1	1	2	3
2	2	1	2	3	1	1	1	2	2
3	2	1	2	3	1	1	1	2	2
4	2	1	2	3	1	1	1	2	3
5	2	1	2	3	1	1	1	2	3

Correlation Level: 1- Low, 2 - Medium, 3 - High

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P20MEE302	COMPOSITE MATERIALS ANALYSIS AND APPLICATIONS	L	T	P	C	Hrs
		3	0	0	3	45

Course Objectives

- To study the concept of composite materials and its importance.
- To understand the basic structure of composites.
- To learn the stress-strain relationship of Composites.
- To learn about laminated composites.
- To know the applications of composite materials.

Course Outcomes

After completion of the course, the students will be able to

CO1 – Explain the basics of composite materials. **(K1)**
CO2 – Understand the behaviour and specialties of orthotropic materials. **(K2)**
CO3 – Understand the behavior of Laminated composites. **(K2)**
CO4 – Analyse the failures in composite materials. **(K4)**
CO5 – Know appropriate applications where a particular composite can be used. **(K2)**

UNIT I INTRODUCTIONTO COMPOSITE MATERIALS **(9 Hrs)**

Definitions: Composite material, Fiber, Matrix. Types of Fibers and Raw Fiber Properties, Types of Matrix, Prepegs, Fillers and other Additives.

UNIT II BASIC STRUCTURE OF COMPOSITES **(9 Hrs)**

Mechanical Behaviour of Composite Materials. Lamina, Laminate: The basic building block of a Composite.

UNIT III ANALYSIS OF LAMINATED COMPOSITES **(9 Hrs)**

Laminates, Basic Assumptions, Strain-Displacement Relationship, Stress- Strain Relationships, Equilibrium Equations, Laminate Stiffness, Determination of Lamina Stresses and Strains, Types of Laminate Configuration, Balanced Laminate, Anti-symmetric Laminate, .Stress-strain relationships. Engineering Constants. Stress strain relations of a Thin Lamina. Examples.

UNIT IV FAILURE THEORIES **(9 Hrs)**

Micromechanics of Failure of Unidirectional Lamina, Anisotropic Strength and Failure Theories, Importance of Shear Strength, Choice of Failure Criteria, Examples.

UNIT V APPLICATIONS OF COMPOSITES **(9 Hrs)**

Advantages of Composite Materials and Structures. Applications and Use of Composite materials in aerospace, automotive, marines and constructional field.

Text Books

1. Autar K. Kaw,"Mechanics of Composite Materials", 2nd edition, CRC Press, 2006.
2. M. Daniel, O. Ishai,"Engineering Mechanics of Composite Materials", Oxford University Press, 2006.
3. Madhujit Mukhopadhyayg, 'Mechanics of Composite Materials and Structures", Universities press, 2010.
4. R M Jones, "Mechanics of Composite Materials",CRC Press,2014.

Reference Books

1. Prashant Kumar, "Elements of Fracture Mechanics", Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2009.
2. Michael W, Hyer, "Stress analysis of fiber Reinforced Composite Materials", Mc-Graw Hill International,2009.
3. Krishan K. Chawla,"Composite Material Science and Engineering", Springer, 3rd Edition, 2012.
4. F. W. Wendt, H. Liebowitz, N. Perrone, Mechanics of Composite Materials, Elsevier,2013.
5. B.D. Agarwal, L.J. Broutman and K. Chandrashekhara, Analysis and performance of fiber composites, 4th Edition, John Wiley & Sons, 2017.

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2. https://nptel.ac.in/courses/112/104/112104168/
3. https://nptel.ac.in/courses/101/104/101104010/
4. https://www.coursera.org/lecture/material-behavior
5. https://www.udemy.com/course/fundamentals-of-composite-materials/

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)						Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
1	1	1	2	2	3	2	2	1	3
2	1	1	2	1	3	2	2	1	3
3	1	1	2	2	3	2	2	1	3
4	2	1	2	2	3	2	2	1	3
5	3	2	2	1	3	2	2	1	3

Correlation Level: 1- Low, 2 - Medium, 3 - High

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P20MEE303 **INTEGRATED PRODUCT DEVELOPMENT AND PROCESS**

L	T	P	C	Hrs
3	0	0	3	45

Course Objectives

- To study the basic concepts of product design and process.
- To understand the product specifications, methods of selection and testing.
- To demonstrate knowledge of product architecture.
- To understand the approach of integrated process design for industry applications.
- To understand the principle of prototyping and project planning.

Course Outcomes

After completion of the course, the students will be able to

CO1 – Explain conceptual product models using creativity and product design techniques **(K1)**

CO2 – Understand various testing methodologies for product design **(K2)**

CO3 – Understand product architecture and its role in product development. **(K2)**

CO4 – Explore diverse strategies to conceptualize and generate original and relevant solutions to design problems. **(K2)**

CO5 – Create and commercialize new products. **(K6)**

UNIT I INTRODUCTION **(9 Hrs)**

Need for IPPD-Strategic importance of Product development – integration of customer, designer,material supplier and process planner, Competitor and customer - Behaviour analysis. Understanding customer-promoting customer understanding-involve customer in development andmanaging requirements - Organization process management and improvement.

UNIT II CONCEPT GENERATION, SELECTION AND TESTING **(9 Hrs)**

Plan and establish product specifications. Task - Structured approaches - clarification – searchexternallyand internally-Explore systematically -reflect on the solutions and processes – conceptselection - methodology - benefits. Implications - Product change - variety – component standardization - product performance - manufacturability – Concept Testing Methodologies.

UNIT III PRODUCT ARCHITECTURE **(9 Hrs)**

Product development management - establishing the architecture -creation - clustering – geometriclayout development - Fundamental and incidental interactions - related system level design issues– secondary systems -architecture of the chunks - creating detailed interface specifications-PortfolioArchitecture.

UNIT IV INDUSTRIAL DESIGN **(9 Hrs)**

Integrate process design - Managing costs - Robust design – Integrating CAE, CAD, CAM tools –Simulating product performance and manufacturing processes electronically - Need for industrialdesign-impact – design process - investigation of customer needs - conceptualization - refinement -management of the industrial design process – technology driven products - user - driven products- assessing the quality of industrial design.

UNIT V PRODUCT DEVELOPMENT **(9 Hrs)**

Definition - Estimation of Manufacturing cost-reducing the component costs and assembly costs –Minimize system complexity – Prototype basics - Principles of prototyping - Planning for prototypes– Economic Analysis - Understanding and representing tasks-baseline project planning – acceleratingthe project-project execution.

Text Books

1. George E Dieter, Engineering Design 3rd Edition McGraw Hill, 2001.
2. Karl T. Ulrich,Product Design and Development,Tata McGraw Hill International, 2003.
3. Edward B. Magrab, Satyandra K. Gupta , F. Patrick McCluskey, Peter andborn,Integrated Product and Process Design and Development: The Product Realization Process, CRC Press; 2nd edition 2009.

Reference Books

1. Ken Hurst,Engineering Design Principles,Elsevier, 1999.
2. Staurt Pugh, "Tool Design – Integrated Methods for successful Product Engineering", AddisonWesley Publishing, New York, NY, 1991
3. Otto, ProductDesign, Pearson Education India, 2001
4. Pahl, W Beitz J Feldhusun, K G Grote, Engineering Design 3rd Edition, Springer2007.
5. Sven G. BilénIntroduction to Engineering Design, McGraw Hill Learning Solutions, 2008
6. Steven Eppinger, Karl Ulrich,Product Design and Development McGraw-Hill Higher Education,2015

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3. https://alison.com/course/rethinking-the-product-development-process
4. https://www.udemy.com/topic/product-development/
5. https://onlinecourses.swayam2.ac.in/imb19_mg01/preview

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)						Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
1	1	1	1	1	3	1	2	1	1
2	1	1	1	1	3	1	2	2	1
3	2	1	1	1	3	1	2	2	2
4	2	1	1	1	3	1	2	2	2
5	2	2	2	2	3	1	2	2	3

Correlation Level: 1- Low, 2 - Medium, 3 - High

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P20MEE304 **ADVANCED FINITE ELEMENT ANALYSIS**

L	T	P	C	Hrs
3	0	0	3	45

Course Objectives

- To introduce advanced elements used in FE analysis.
- To learn nonlinear analysis of structure.
- To understand formulation of dynamic problems in FEM
- To learn the Finite Element Method applied to Heat Transfer applications.
- To build the ability to model and to solve complex problems in engineering.

Course Outcomes

After completion of the course, the students will be able to

CO1 - Understand the Finite Element Formulation procedure for structural Problems. **(K2)**
CO2 - Analyse the Non-linear problems using FEA **(K4)**
CO3 - Solve Problems involving dynamics using FEA. **(K3)**
CO4 - Formulate and solve simple heat transfer and fluid mechanics problems. **(K3)**
CO5 - Understand the concept of adaptive finite element. **(K2)**

UNIT I BENDING OF PLATES AND SHELLS **(9 Hrs)**

Review of Elasticity Equations - Bending of Plates and Shells - Finite Element Formulation of Plate and Shell Elements - Confirming and non-Confirming Elements -Co and C1 Continuity Elements - Application and examples.

UNIT II NON - LINEAR PROBLEMS **(9 Hrs)**

Introduction - Iterative Techniques - Material non - linearity - Elasto Plasticity -Plasticity - Visco Plasticity - Geometric Non linearity - Large displacement Formulation - Application in Metal Forming Process & Contact Problems.

UNIT III DYNAMIC PROBLEM **(9 Hrs)**

Direct formulation - Free, Transient and Forced Response - Solution Procedures - Subspace Iterative Technique - Houbolt, Wilson, New mark - Methods - Examples.

UNIT IV FLUID MECHANICS AND HEAT TRANSFER **(9 Hrs)**

Governing Equations of Fluid Mechanics - In viscid and Incompressible Flow Potential formulations - Slow Non -Newtonian Flow - Metal and polymer -Forming – Navier Strokes Equation - Steady and Transient Solution.

UNIT V ERROR ESTIMATES AND ADAPTIVE REFINEMENT **(9 Hrs)**

Error norms and Convergence rates - h refinement with adaptivity – Adaptive refinement.

Text Books

1. T R Chandrupatla and A D Belegundu, "Introduction to Finite Elements in Engineering", Pearson Education, New Delhi, 2007.
2. Logan D L, "A First Course in the Finite Element Method", Thomson Learning,2007.
3. Alavala, PHI "Finite Element Methods", McGraw Hill Co., New Delhi, 2013.

Reference Books

1. P.Seshu, "Finite Element Analysis", Prentice-Hall of India Pvt. Ltd., New Delhi, 2007.
2. S.Rajasekaran, Finite Element Analysis in Engineering Design, S Chand, 2008.
3. J.N.Reddy. "An Introduction to the Finite Element Method", 3rd Edition, Tata McGraw-Hill,2014.
4. T.J.R. Hughes,The Finite Element Method, McGraw-Hill, 2015.
5. H. Lee, „„Finite Element Simulations with ANSYS Workbench 16"", SDC Publications, 2015.

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2. https://www.coursera.org/learn/finite-element-method.
3. https://www.coursera.org/lecture/software-design-methods-tools.
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COs/POs/PSOs Mapping

COs	Program Outcomes (POs)						Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
1	2	1	2	2	3	1	1	2	1
2	2	1	2	2	3	-	1	2	1
3	2	1	2	2	3	-	1	2	2
4	2	1	2	3	3	1	1	2	2
5	2	1	2	3	3	-	1	2	2

Correlation Level: 1- Low, 2 - Medium, 3 - High

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P20MEE305 **TRIBOLOGY IN DESIGN**

L	T	P	C	Hrs
3	0	0	3	45

Course Objectives

- To impart knowledge in the friction , wear and lubrication aspects of machine
- To understand the material properties which influence the tribological characteristics of surfaces.
- To understand the behavior of different types bearings
- To learn Hydrostatic lubrication of Pad bearing
- To understand the concept of hydrodynamic lubrication theory

Course Outcomes

After completion of the course, the students will be able to

CO1 - Understand various rolling frictions and its properties **(K2)**

CO2 - Analyze the properties of lubricants and application **(K4)**

CO3 - Identify parameters of sliding contact in different lubrication regimes **(K3)**

CO4 - Design and select appropriate bearings for a given application **(K4)**

CO5 - Analyze type of wear and volume of wear in metallic and polymer surface **(K4)**

UNIT I SURFACE INTERACTION AND FRICTION **(9 Hrs)**

Topography of Surfaces – Surface features-Properties and measurement – Surface interaction – Adhesive Theory of Sliding Friction –Rolling Friction-Friction properties of metallic and non-metallic materials – friction in extreme conditions –Thermal considerations in sliding contact

UNIT II WEAR AND SURFACE TREATMENT **(9 Hrs)**

Types of wear – Mechanism of various types of wear – Laws of wear –Theoretical wear models- Wear of Metals and Non metals – Surface treatments – Surface modifications – surface coatings methods. Surface Topography measurements –Laser methods – instrumentation - International standards in friction and wear measurements.

UNIT III LUBRICANTS AND LUBRICATION REGIMES **(9 Hrs)**

Lubricants and their physical properties- Viscosity and other properties of oils –Additives-and selection of Lubricants- Lubricants standards ISO,SAE,AGMA, BIS standards – Lubrication Regimes –Solid Lubrication-Dry and marginally lubricated contacts- Boundary Lubrication- Hydrodynamic lubrication — Elasto and plasto hydrodynamic - Magneto hydrodynamic lubrication – Hydro static lubrication – Gas lubrication.

UNIT IV THEORY OF HYDRODYNAMIC AND HYDROSTATIC LUBRICATION **(9 Hrs)**

Reynolds Equation,-Assumptions and limitations-One and two dimensional Reynolds Equation Reynolds and Sommerfeld boundary conditions- Pressure wave, flow, load capacity and friction calculations in Hydrodynamic bearings-Long and short bearings-Pad bearings and Journal bearings Squeeze film effects-Thermal considerations-Hydrostatic lubrication of Pad bearing- Pressure , flow , load and friction calculations-Stiffness considerations- Various types of flow restrictors in hydrostatic bearings.

UNIT V LUBRICATIONS **(9 Hrs)**

Rolling contacts of Elastic solids- contact stresses – Hertzian stress equation- Spherical and cylindrical contacts-Contact Fatigue life- Oil film effects- Elasto Hydrodynamic lubrication Theory- Soft and hard EHL-Reynolds equation for elasto hydrodynamic lubrication- - Film shape within and outside contact zones-Film thickness and friction calculation- Rolling bearings- Stresses and deflections Traction drives.

Text Books

1. S.K.Basu, S.N.Sengupta &B.B.Ahuja ,"Fundamentals of Tribology", Prentice –Hall of India Pvt Ltd , New Delhi, 2005.
2. G.W.Stachowiak& A.W .Batchelor , Engineering Tribology, Butterworth - Heinemann, UK, 2005
3. Ross Beckett Engineering Tribology, Larsen and Keller Education, 2017.

Reference Books

1. Stachowaik, G.W., Batchelor, A.W., Engineering Tribology, 3rd Ed., Elsevier, 2010.
2. Majumdar B.C, Introduction to bearings, S. Chand & Co., Wheeler publishing, 1999.
3. Andras Z. Szeri, Fluid film lubrication theory and design, Cambridge University press, 1998.
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COs/POs/PSOs Mapping

COs	Program Outcomes (POs)						Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
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3	3	1	2	1	2	2	1	2	3
4	3	1	2	1	2	2	1	2	3
5	3	1	2	1	2	2	1	2	3

Correlation Level: 1- Low, 2 - Medium, 3 - High

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PROFESSIONAL ELECTIVES - IV

P20MEE401	DESIGN FOR MANUFACTURING AND ASSEMBLY	L	T	P	C	Hrs
		3	0	0	3	45

Course Objectives

- To identify the manufacturing constraints that influences the design of parts and part systems.
- To understand the Design for Manufacturability (DFM) methodology
- To understand the design principles of metal joining
- To learn the concepts of automatic assembly systems
- To learn the fundamental principles of Manual Assembly.

Course Outcomes

After completion of the course, the students will be able to

CO1 - Understand the quality aspects of design for manufacture and assembly **(K2)**

CO2 - Understand various casting methods **(K2)**

CO3 - Design for metal joining such as weldments, forging and blanking **(K3)**

CO4 - Describe the different automatic assembly transfer systems **(K3)**

CO5 - Design assembly fits for Manual Assembly **(K3)**

UNIT I INTRODUCTION (9 Hrs)

Design philosophy steps in Design process - General Design rules for manufacturability - basic principles of design Ling for economical production - creativity in design. Materials: Selection of Materials for design Developments in Material technology - criteria for material selection – Material selection interrelationship with process selection process selection charts.

UNIT II MACHINING PROCESS (9 Hrs)

Overview of various machining processes - general design rules for machining - Dimensional tolerance and surface roughness - Design for machining - Ease - Redesigning of components for machining ease with suitable examples. General design recommendations for machined parts.

Metal Casting: Appraisal of various casting processes, selection of casting process, - general design considerations for casting - casting tolerances - use of solidification simulation in casting design - product design rules for sand casting.

UNIT III METAL JOINING (9 Hrs)

Appraisal of various welding processes, Factors in design of weldments - general design guidelines - pre and post treatment of welds - effects of thermal stresses in weld joints - design of brazed joints. Forging - Design factors for Forging - Closed dies forging design - parting lines of dies drop forging die design - general design recommendations. Extrusion & Sheet Metal Work: Design guidelines for extruded sections - design principles for Punching, Blanking, Bending, Deep Drawing - Keeler Goodman Forming Line Diagram - Component Design for Blanking. Plastics: Viscoelastic and Creep behavior in plastics – Design guidelines for Plastic components – Design considerations for Injection Moulding.

UNIT IV AUTOMATIC ASSEMBLY (9 Hrs)

Development of the assemble process, choice of assemble method assemble advantages social effects of automation. Automatic Assembly Transfer Systems: Continuous transfer, intermittent transfer, indexing mechanisms, and operator - paced free – transfer machine.

UNIT V DESIGN OF MANUAL ASSEMBLY (9 Hrs)

Design for assembly fits in the design process, general design guidelines for manual assembly, development of the systematic DFA methodology, assembly efficiency, classification system for manual handling, classification system for manual insertion and fastening, effect of part symmetry on handling time, effect of part thickness and size on handling time, effect of weight on handling time, parts requiring two hands for manipulation, effects of combinations of factors, effect of symmetry effect of chamfer design on insertion operations, estimation of insertion time.

Text Books

1. Assembly Automation and Product Design/ Geoffrey Boothroyd/ Marcel Dekker Inc., NY,1992.
2. Engineering Design - Material & Processing Approach/ George E. Deiter/McGraw Hill Intl. 2nd Ed. 2000
3. Automation Production System and CIMS by Mikel P Groover, Prentice Hall of India Pvt. Ltd, New Delhi, 2011.
4. Hand Book of Product Design/ Geoffrey Boothroyd/ Marcel and Dekken, N.Y. 1990.
5. M. P. Groover, Automation, Production Systems and Computer-Integrated Manufacturing, 4th edition, Pearson Education, 2016

Reference Books

1. T. O. Boucher and A. Yalçin, Design of Industrial Information Systems, 1st edition, Elsevier, 2006
2. Geoffrey Boothroyd, Peter Dewhurst & Winston Ansthony Knight, Product Design for Manufacturing and Assembly,CRC Press, 2010
3. Guy L. Curry and R. M. Feldman, Manufacturing Systems Modeling and Analysis, 1st edition, Butterworth-Heinemann, 2009.
4. S. B. Gershwin, Manufacturing Systems Engineering, 1st edition, Prentice Hall PTR, 1993
5. W. J. Hopp and M. L. Factory Physics, 3rd edition, Waveland Press, 2011.

Web Resources

1. https://nptel.ac.in/courses/112/104/112104028/
2. https://nptel.ac.in/courses/112/103/112103174/
3. https://swayam.gov.in/nd1_noc20_me12/preview
4. https://www.coursera.org/courses?query=manufacturing
5. https://nptel.ac.in/courses/107/103/107103012/

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)						Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
1	2	1	2	2	3	1	1	2	3
2	2	1	2	2	3	1	1	2	3
3	2	1	2	2	3	1	1	2	3
4	2	1	2	2	3	1	1	2	3
5	2	1	2	2	3	1	1	2	3

Correlation Level: 1- Low, 2 - Medium, 3 - High

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P20MEE402	DESIGN AND ANALYSIS OF EXPERIMENTS	L	T	P	C	Hrs
		3	0	0	3	45

Course Objectives

- To study about the concept of experimental design fundamentals.
- To understand single factor experiments.
- To learn about multifactor experiments.
- To understand special experimental designs.
- To learn the robust design.

Course Outcomes

After completion of the course, the students will be able to

CO1 - Understand the basics of experimental design fundamentals. **(K2)**

CO2 - Explain various single factor experiments. **(K1)**

CO3 - Explain the different multifactor experiments. **(K1)**

CO4 - Understand the Response Surface Methodology for optimization studies. **(K2)**

CO5 - Illustrate the steps in experimentation. **(K4)**

UNIT I EXPERIMENTAL DESIGN FUNDAMENTALS (9 Hrs)

Importance of experiments, experimental strategies, basic principles of design, terminology, ANOVA, steps in experimentation, sample size, normal probability plot, and linear regression model.

UNIT II SINGLE FACTOR EXPERIMENTS (9 Hrs)

Completely randomized design, Randomized block design, Latin square design, Statistical analysis, estimation of model parameters, model adequacy checking, pair wise comparison tests.

UNIT III MULTIFACTOR EXPERIMENTS (9 Hrs)

Two and three factor full factorial experiments, 2K factorial Experiments Confounding and Blocking designs.

UNIT IV SPECIAL EXPERIMENTAL DESIGNS (9 Hrs)

Fractional factorial design, nested designs, Split plot design, Introduction to Response Surface Methodology, Experiments with random factors, rules for expected mean squares, approximate F- tests.

UNIT V CASE STUDIES (9 Hrs)

Steps in experimentation, design using Orthogonal Arrays, data analysis, robust design- control and noise factors, S/N ratios, parameter design, case studies.

Text Books

1. Douglas C. Montgomery, Design and Analysis of Experiments, 2010
2. Montgomery, D.C., Design and Analysis of experiments, John Wiley and Sons, 2009.
3. Angela Dean, Daniel Voss, Danel Draguljić, Design and Analysis of Experiments, Springer International Publishing AG, 2017.

Reference Books

1. Robert L. Mason, Richard F. Gunst, James L. Hess, Statistical Design and Analysis of Experiments, 2014.
2. Phillip J.Rose, Taguchi techniques for quality engineering, McGraw Hill, 2014
3. Nicolo Belavendram, Quality by Design; Taguchi techniques for industrial experimentation, Prentice Hall, 2015.
4. Klaus Hinkelmann, Oscar Kempthorne, Design and Analysis of Experiments, 2013
5. Peter W. M. John, Statistical Design and Analysis of Experiments, 2011

Web References

1. http://users.stat.umn.edu/~gary/book/fcdae.pdf
2. https://nptel.ac.in/courses/106/106/106106131/
3. https://www.coursera.org/specializations/design-experiments
4. https://www.udemy.com/course/design-of-experiments-i/
5. https://nptel.ac.in/courses/110/105/110105087/

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)						Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
1	2	1	2	1	2	1	1	2	2
2	2	1	2	1	2	1	1	2	2
3	2	1	2	1	2	1	1	2	2
4	2	1	2	1	2	1	1	2	2
5	2	1	2	1	2	1	1	2	2

Correlation Level: 1- Low, 2 - Medium, 3 - High

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P20MEE403 **ADVANCED OPTIMIZATION TECHNIQUES AND APLLICATIONS**

L	T	P	C	Hrs
3	0	0	3	45

Course Objectives

- To solve single-variable optimization problems using elimination and interpolation methods.
- To solve multivariable problems using direct search and gradient methods.
- To learn linear programming concepts.
- To learn integer programming concepts.
- To know the different traditional and non-traditional optimization algorithms.

Course Outcomes

After completion of the course, the students will be able to

CO1 - Solve single-variable optimization problems using elimination and interpolation methods. **(K3)**
CO2 - Solve multi-variable optimization problems using direct search and gradient methods. **(K3)**
CO3 - Express linear programming problems. **(K3)**
CO4 - Formulate and solve integer programming problems. **(K3)**
CO5 - Compare and contrast the different non-traditional optimization algorithms. **(K2)**

UNIT I SINGLE VARIABLE NON-LINEAR UNCONSTRAINED OPTIMIZATION **(9 Hrs)**

Elimination methods: Uni-Model function-its importance, Fibonacci method & Golden section method. Interpolation methods: Quadratic & Cubic interpolation methods.

UNIT II MULTI VARIABLE NON-LINEAR UNCONSTRAINED OPTIMIZATION **(9 Hrs)**

Direct search methods – Univariant method, Pattern search methods – Powell's, Hook -Jeeves, Rosenbrock search methods. Gradient methods: Gradient of function& its importance, Steepest descent method, Conjugate direction methods: Fletcher- Reeves method & variable metric method.

UNIT III LINEAR PROGRAMMING **(9 Hrs)**

Formulation, Simplex method & Artificial variable optimization techniques: Big M & Two-phase methods. Sensitivity analysis: Changes in the objective coefficients, constants& coefficients of the constraints. Addition of variables, constraints. Simulation – Introduction – Types- steps – applications: inventory & queuing – Advantages and disadvantages.

UNIT IV INTEGER PROGRAMMING **(9 Hrs)**

Introduction – formulation – Geometry cutting plane algorithm – Zero or one algorithm, branch and bound method Basic concepts of probability theory, random variables- distributions mean, variance, correlation, co variance, joint probability distribution. Stochastic linear programming: Chance constrained algorithm.

UNIT V OPTIMIZATION ALGORITHMS **(9 Hrs)**

Polynomials – Arithmetic - Geometric inequality – unconstrained G.P, constrained G.P (≤ type only),Non-Traditional Optimization Algorithms: Genetics Algorithm-Working Principles, Similarities and Differences between Genetic Algorithm & Traditional Methods. Simulated Annealing-Working Principle-Simple Problems. Introduction to Particle Swarm Optimization (PSO)

Text Books

1. S. S. Rao, Optimization theory & Applications, New Age International.2000.
2. Kalyanmoy Deb, Optimization for Engineering Design, PHI, 2012.
3. R. Venkata Rao, Vimal J. Savsani, Mechanical Design Optimization Using Advanced Optimization Techniques, (Springer Series in Advanced Manufacturing), 2012

Reference Books

1. R. L Rardin Optimization in operations research Pearson, 1997
2. S. D. Sharma, Operations Research, Kedar Nath Ram Nath, 2010.
3. Operations Research: An Introduction, 9th Edition, Hamdy A. Taha, Pearson Education, 2013.

4. Anindya Ghosh, Advanced Optimization and Decision-Making Techniques in Textile Manufacturing, CRC Press; 1st Edition , 2019.
5. Linear Programming and Extensions, George Dantzig, Princeton University Press, 2016.

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1. https://www.youtube.com/watch?v=Slmj1F4xxZM
2. https://www.youtube.com/watch?v=LL20TZGXp3Q
3. https://www.youtube.com/watch?v=7KxlpQIbKUw
4. https://www.youtube.com/watch?v=SHbb9dV-we8
5. https://arxiv.org/abs/2007.13545

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)						Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
1	3	1	2	1	2	1	1	2	3
2	3	1	2	1	2	1	1	2	3
3	3	1	2	1	2	1	1	2	3
4	3	1	2	1	2	1	1	2	3
5	3	1	2	1	2	1	1	2	3

Correlation Level: 1- Low, 2 - Medium, 3 - High

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P20MEE404 **INDUSTRIAL DESIGN AND ERGONOMICS**

L	T	P	C	Hrs
3	0	0	3	45

Course Objectives

- To study about the concept of industrial design and ergonomics.
- To learn about control and displaying.
- To study about visual effects of line and form.
- To understand the aesthetic concepts.
- To understand the industrial design process.

Course Outcomes

After completion of the course, the students will be able to

CO1 - Understand the basics of industrial design and ergonomics. **(K2)**
CO2 - Explain the various types of controls and displays. **(K1)**
CO3 - Describe the effects of line and form in engineering designs. **(K1)**
CO4 - Explain the aesthetic concepts in engineering design. **(K1)**
CO5 - Understand the importance of industrial design process. **(K2)**

UNIT I INTRODUCTION TO ERGONOMICS AND INDUSTRIAL DESIGN **(9 Hrs)**

An approach to industrial design -elements of design structure for industrial design in engineering application in modern manufacturing systems. General approach to the man- machine relationship- workstation design-working position.

UNIT II CONTROL AND DISPLAYING **(9 Hrs)**

Shapes and sizes of various controls and displays-multiple, displays and control situations - design of major controls in automobiles, machine tools etc.

Ergonomics and Production: ergonomics and product design -ergonomics in automated systems- expert systems for ergonomic design. Anthropometric data and its applications in ergonomic, design- limitations of anthropometric data use of computerized database.

UNIT III VISUAL EFFECTS OF LINE AND FORM **(9 Hrs)**

The mechanics of seeing- psychology of seeing general influences of line and form.

Colour: Colour and light -colour and objects- colour and the eye -colour consistency- colour terms- reactions to colour and colour continuation -colour on engineering equipments.

UNIT IV AESTHETIC CONCEPTS **(9 Hrs)**

Concept of unity- concept of order with variety -concept of purpose style and environment Aesthetic expressions. Style-components of style- house style, observation style in capital goods, case study.

UNIT V DESIGN PROCESS **(9 Hrs)**

General design -specifying design equipments- rating the importance of industrial design -industrial design in the design process.

Text Books

1. Industrial Design for Engineers - Mayall W.H. - London Hiffee books Ltd.2011.
2. Applied Ergonomics Hand Book - Brain Shakel (Edited) - Butterworth scientific. London 2011.
3. Pamela McCauley-Bush, Ergonomics: Foundational Principles, Applications, and Technologies, CRC press, 2012

Reference Books

1. Introduction to Ergonomics - R. C. Bridger - McGraw Hill Publications 2012.
2. Human Factor Engineering - Sanders & McCormick - McGraw Hill Publications 6th edition, 2012.
3. Waldemar Karwowski, Marcelo M. Soares, Neville A. Stanton, Human Factors and Ergonomics in Consumer Product Design, Publisher: CRC Press, January 2011.
4. Toni Ivergård, Brian Hunt, Handbook of Control Room Design and Ergonomics, CRC press, 2008 .

5. Barry Tillman , Peggy Tillman .,Human Factors and Ergonomics Design Handbook, Third Edition MC Graw Hill Eduction Publication, 2016

Web References

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2. http://www.nptelvideos.in/search?q=INDUSTRIAL+DESIGN+AND+ERGONOMICS
3. https://spocathon.page/video/ergonomics-product-design
4. https://nptel.ac.in/courses/107/103/107103085/
5. https://nptel.ac.in/courses/107/103/107103084/

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)						Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
1	3	1	2	1	2	1	1	2	3
2	3	1	2	1	2	1	1	2	3
3	3	1	2	1	2	1	1	2	3
4	3	1	2	1	2	1	1	2	3
5	3	1	2	1	2	1	1	2	3

Correlation Level: 1- Low, 2 - Medium, 3 - High

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P20MEE405 **MANUFACTURING SYSTEM SIMULATION**

L	T	P	C	Hrs
3	0	0	3	45

Course Objectives

- To study in detail about the concept of manufacturing system simulation.
- To understand the probability and statistical concepts of simulation.
- To learn about design of simulation experiments.
- To understand about simulation language.
- To understand the development of simulation models using GPSS.

Course Outcomes

After completion of the course, the students will be able to

CO1 - Understand the basics of manufacturing system simulation. **(K2)**
CO2 - Familiar with random numbers. **(K2)**
CO3 - Apply the design of simulation experiments for validation. **(K3)**
CO4 - Apply the simulation in engineering industry. **(K3)**
CO5 - Perform the case studies. **(K2)**

UNIT I INTRODUCTION **(9 Hrs)**

Basic concepts of system – elements of manufacturing system - concept of simulation – simulation as a decision making tool – types of simulation – Monte-Carlo simulation - system modeling – types of modeling – Limitations and Areas of application of simulation.

UNIT II RANDOM NUMBERS **(9 Hrs)**

Probability and statistical concepts of simulation – Pseudo random numbers – methods of generating random numbers – discrete and continuous distribution – testing of random numbers – Kolmogorov-Smirnov test, the Chi-Square test - sampling - simple, random and simulated.

UNIT III DESIGN OF SIMULATION EXPERIMENTS **(9 Hrs)**

Problem formulation – data collection and reduction – time flow mechanical – key variables - logic flow chart starting condition – run size – experimental design consideration – output analysis, interpretation and validation – application of simulation in engineering industry.

UNIT IV SIMULATION LANGUAGE **(9 Hrs)**

Comparison and selection of simulation languages - Study of GPSS (Basic blocks only) Generate, Queue, Depart, Size, Release, Advance, Terminate, Transfer, Enter and Leave.

UNIT V SIMULATION MODELS **(9 Hrs)**

Development of simulation models using GPSS for queuing, production, inventory, maintenance and replacement systems – case studies.

Text Books

1. Adelinde M. Uhrmacher, AdelindeUhrmacher, Danny Weyns"Multi-Agent Systems: Simulation and Applications "- 0212
2. Jeffrey L.Written, Lonnie D, Bentley and V.M. Barice, "System analysis and Design Methods", Galgotia publication, 2011.
3. Curry, Guy L., Feldman, Richard M. Manufacturing Systems Modeling and Analysis, Springer, 2011

Reference Books

1. Geoffrey Gordon "System simulation" – Prentice Hall of India, 2016.
2. Shannon R.E., "System simulation", Prentice Hall 2015.
3. Jerry Banks and John S.Carson, "Discrete event system simulation", Prentice Hall 2014.
4. Averill M.Law and W.DavidKelton, "Simulation Modeling and analysis", McGraw Hill International Editions, 2014.
5. John H.Mize and J.Grady Cox, "Essentials of simulation" – Prentice hall 2013.

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1. https://link.springer.com/chapter/10.1007%2F978-1-4419-9218-5_15
2. https://nptel.ac.in/courses/112/104/112104225/
3. http://www.digimat.in/nptel/courses/video/112107214/L05.html
4. https://www.youtube.com/watch?v=wbLItIE-78E
5. http://www.digimat.in/nptel/courses/video/112107220/L34.html

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)						Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
1	2	1	2	1	1	1	1	2	2
2	2	1	2	1	1	1	1	2	2
3	2	1	2	1	1	1	1	2	2
4	2	1	2	1	1	1	1	2	2
5	2	1	2	1	1	1	1	2	2

Correlation Level: 1- Low, 2 - Medium, 3 - High

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PROFESSIONAL ELECTIVES – V

P20MEE501 **PRODUCTION AND OPERATIONS MANAGEMENT**

L	T	P	C	Hrs
3	0	0	3	45

Course Objectives

- To study in detail about the concept of production and operations management.
- To understand about location and line balancing.
- To acquire knowledge of various planning strategies.
- To utilize about work study and quality control.
- To apply about maintenance planning.

Course Outcomes

After completion of the course, the students will be able to

CO1 - Recognize the selection of planning and forecasting.**(K1)**

CO2 - Understand plant and material handling layout procedure. **(K2)**

CO3 - Understand the Bill of Materials and MRP concept. **(K2)**

CO4 - Apply quality control tool for validation of samples.**(K3)**

CO5 - Analyze various types of maintenances and reliability calculations.**(K4)**

UNIT I INTRODUCTION (9 Hrs)

Systems Concept of Production, Types of Production System, Productivity, World Class Manufacturing, Process Planning & Design, Selection of Process, Value Analysis/Value Engineering, Make or Buy Decision. Capacity Planning, forecasting: Nature and use of Forecast, Sources of data, Demand Patterns, Forecasting Models, selection of a Forecasting Technique, Simple Moving Average Method, Weighted Moving Average, Simple(single) Exponential Smoothing, Linear Regression, Delphi Method.

UNIT II LOCATION AND LINE BALANCING (9 Hrs)

Facility Location: Factors influencing Plant Location, Break Even Analysis, Plant Layout & Materials Handling: Classification of Layout, Advantages and Limitations of Process Layout, Advantages and Limitations of Product Layout, Advantages and Limitations of Group Technology Layout. Layout Design Procedures: Systematic Layout Design Procedure, Introduction to CRAFT, ALDEP & CORELAP, Material Handling System, Unit Load Concept, Material Handling Principles, Classification of Materials Handling Equipments.
Line Balancing: Concept of Mass Production system, Objective of Assembly Line Balancing. Rank Positional Weight Method. Inventory Control: Review of basic models of Inventory, Quality Discount Model, Implementation of Inventory system, P and Q system of Inventory.

UNIT III PLANNING (9 Hrs)

Nature of Aggregate Planning Decisions, Aggregate Planning Strategies, Aggregate Planning Methods: Heuristic Method, Transportation Model for Aggregate Planning. Material Requirement Planning: Product Structure/Bill of Materials (BOM), MRP concept. Sing Machine Scheduling: Types of Scheduling, Concept of Single Machine Scheduling, SPT Rule to Minimize Mean Flow Time, Minimizing Weighted Mean Flow Time, EDD Rule to Minimize Maximum Lateness, Flow Shop Scheduling: Introduction, Johnson's Problem, and Extension of Johnson's Rule.

UNIT IV WORK STUDY AND QUALITY CONTROL (9 Hrs)

Work Study, Method Study – Steps in Method Study, Recording Examine Step, Principles of Motion Economy, Time Study. Quality Control: Introduction, Need for controlling Quality, Definition of a Quality System, Classification of Quality Control Techniques, Control Charts, Control Charts for Variable, Control Charts for Attributes, C-Chart, Acceptance Sampling: Operating Characteristic Curt (O.C. Curve), Single Sampling Plan.

UNIT V MODERN PRODUCTION MANAGEMENT (9 Hrs)

Maintenance Planning and Control: Maintenance Objectives, Types of Maintenance, Basic Reasons for Replacement (Need for Replacement), Group Replacement Vs Individual Replacement – Trade off. Reliability:

Reliability Improvement, Reliability calculations. Modern Production Management Tools: Just-in-time Manufacturing: Introduction-Overview of JIT, Kanban Systems

Text Books

1. Panneerselvam R, Production and Operations Management, Prentice Hall, New Delhi, 2015
2. K.C. Arora, Production and Operations Management, Laxmi Publications, 2014,
3. Russell & Taylor - Operations Management, PHI Publication, 2019.

Reference Books

1. William J. Stevenson: Production/ Operations Management, Richard Irwin.2015
2. S.N. Chary, Production and Operations Management, Tata McGraw Hill.2014
3. Singh, Mahadevan, Production & Operations Management, Vikas Publishing 2014
4. Jay Heizer& Barry Render: Operations Management, Prentice Hall International, Inc 2014.
5. Everett E. Adam & Ronald J. Ebert: Production and Operations Management, Prentice Hall, 2014.

Web References

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3. https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-mg06/
4. https://nptel.ac.in/courses/110/106/110106045/
5. https://onlinecourses.swayam2.ac.in/nou20_cs07/preview

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)						Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
1	3	1	3	3	1	2	3	2	2
2	3	1	3	2	2	2	3	2	2
3	3	1	3	3	2	2	3	2	2
4	3	1	3	3	2	2	2	3	2
5	3	1	3	3	2	2	2	3	2

Correlation Level: 1- Low, 2 - Medium, 3 - High

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P20MEE502 **ENTERPRISE RESOURCE PLANNING**

L	T	P	C	Hrs
3	0	0	3	45

Course Objectives

- To understand the detail about the concept of enterprise resource planning.
- To study about client / server architecture.
- To learn about software platforms.
- To apply about application of software platforms.
- To identified the market trends.

Course Outcomes

After completion of the course, the students will be able to

CO1 - Understand the basics of enterprise resource planning. **(K2)**
CO2 - Familiar with technology Choices and evaluation frame work. **(K2)**
CO3 - Understand the Integration of ERP and Internet.. **(K2)**
CO4 - Realize the importance of application of software platforms. **(K2)**
CO5 - Analyze current market trends and case studies. **(K4)**

UNIT I INTRODUCTION **(9 Hrs)**

Principle – ERP framework – Business Blue Print – Business Engineering vs. Business process Re-Engineering – Tools – Languages – Value chain – Supply and Demand chain – Extended supply chain management – Dynamic Models –Process Models.

UNIT II CLIENT / SERVER ARCHITECTURE **(9 Hrs)**

Technology choices – Internet direction – Evaluation framework– CRM – CRM pricing – chain safety – Evaluation framework.

UNIT III SOFTWARE PLATFORMS **(9 Hrs)**

SAP – People soft, Baan and Oracle – Comparison – Integration of different ERP applications– ERP as sales force automation – Integration of ERP and Internet – ERP Implementation strategies – Organizational and social issues.

UNIT IV APPLICATION OF SOFTWARE PLATFORMS **(9 Hrs)**

Overview – Architecture – AIM – applications – Oracle SCM – SAP: Overview – Architecture– applications – Before and after Y2K – critical issues – Training on various modules of IBCSERP Package – Oracle ERP and MAXIMO, including ERP on the NET.

UNIT V MARKET TRENDS AND CASE STUDIES **(9 Hrs)**

Market Trends – Outsourcing ERP – Economics – Hidden Cost Issues – ROI – Analysis of cases from five Indian Companies.

Text Books

1. Alexis Leon, Enterprise Resource Planning, McGraw-Hill Education 2014.
2. Vinod Kumar Garg, N. K. Venkitakrishnan, Enterprise Resource Planning, PHI Pvt.Ltd , 2013.
3. Veena Bansal, Enterprise Resource Planning, Dorling Kindersley (India) Pvt, Ltd - 2013

Reference Books

1. Sadagopan. S, "ERP – A Managerial Perspective", Tata McGraw Hill, 2016. 2. Jose Antonio Fernandez, "The SAP R/3 Handbook", Tata McGraw Hill, 2015.
3. Vinod Kumar Crag and N.K.Venkitakrishnan, "Enterprise Resource Planning – Concepts and Practice", Prentice Hall of India, 2010.
4. Thomas E Vollmann and BeryWhybark, "Manufacturing and Control Systems', Galgothia Publications, 2009.
5. Garg & Venkitakrishnan, "ERPWARE, ERP Implementation Framework", Prentice Hall, 2008.

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2. https://nptel.ac.in/courses/110/105/110105083/
3. https://www.investopedia.com/terms/e/erp.asp
4. https://www.coursera.org/lecture/enterprise-systems/1-1b-introduction-to-enterprise- resource-planning-erp
5. https://onlinecourses.nptel.ac.in/noc19_mg54/preview

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)						Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
1	3	2	3	3	3	3	2	2	1
2	3	2	3	2	3	3	3	1	2
3	3	2	3	1	3	3	3	3	2
4	3	2	3	2	3	3	3	3	1
5	3	2	1	1	3	3	3	1	3

Correlation Level: 1- Low, 2 - Medium, 3 - High

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P20MEE503 **LEAN SIX SIGMA IN MANUACTURING**

L	T	P	C	Hrs
3	0	0	3	45

Course Objectives

- To study in detail about the concept of lean manufacturing system.
- To understand various measuring tools.
- To learn about lean wastes measuring system.
- To acquire the knowledge of waste elimination methods
- To learn the practices of six sigma in manufacturing industries.

Course Outcomes

After completion of the course, the students will be able to

CO1 - Understand the basics of lean manufacturing system. **(K2)**
CO2 - Familiar with Voice of customer and measurement system. **(K2)**
CO3 - Understand the statistical software and failure mode analysis methods. **(K2)**
CO4 - Realize the importance of application of Quality Function Deployment. **(K3)**
CO5 - Analyze the implementation of lean manufacturing. **(K2)**

UNIT I INTRODUCTION **(9 Hrs)**

Overview of six sigma concept: definition, origin, terms. Foundations of lean six sigma –four keys, five laws of lean six sigma, types of lean six sigma: DMAIC versus DMADV – lean six sigma project selections: selection of team members, six sigma roles and responsibilities. Team stages: characteristics of effective teams, six sigma training plan; Six sigma metrics: DPMO calculation, quality cost, cost of poor quality- roadmap for implementation; Common implementation issues and management strategies.

UNIT II DEFINE AND MEASURE PHASE **(9 Hrs)**

Customer identification, Voice of customer (VOC), VOC data collection, Critical To Quality (CTQ) – Value Stream Mapping - SIPOC – project charter, types of measures, types of data, applications of QC tools, measurement system analysis, Process capability calculations.

UNIT III ANALYSE PHASE **(9 Hrs)**

Inferential and Descriptive Statistics, Patterns of Variation, Normality Analysis, Multi-Vari Analysis; Hypothesis testing for Normal Data: Selection and application problems; Introduction to statistical software, failure mode and effects analysis, analysis of lean wastes.

UNIT IV IMPROVE AND CONTROL PHASE **(9 Hrs)**

Process redesign principles, Generating improvement alternatives, Quality Function Deployment (QFD), Theory of Inventive Problem Solving (TRIZ); Design of experiments; Waste elimination methods, Cycle time reduction, Cost/benefit analysis; Process scorecard – Control Plan.

UNIT V PRACTICE OF LEAN MANUFACTURING **(9 Hrs)**

Various case studies of implementation of lean six sigma in manufacturing industries.

Text Books

1. R. Black, Lean Production: Implementing a World Class System, Industrial Press Inc. 2017
2. Dennis P. Hobbs, Lean Manufacturing Implementation Guide,John 2016.
3. Michael L. George, Lean Six Sigma, Tata McGraw Hill Companies Inc 2011.

Reference Books

1. Jay Arthur, "Lean Six Sigma – Demystified", Tata McGraw Hill Companies Inc, 2011.
2. Joseph De Feo, William Barnard, "Juran Institute's Six Sigma Breakthrough and Beyond", McGraw-Hill, 2004.
3. Kai Yangand Basem El, Haik, "Design for Six Sigma", McGraw Hill, New York, 2004.
4. Donald W Benbow, Kubiak T M, "Certified Six Sigma Black Belt Handbook", Pearson Education, 2007.

5. J. Temple Black, Steve L. Hunter, Lean Manufacturing Systems and Cell Design, Society of Manufacturing Engineers, 2016.

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1. https://shodhganga.inflibnet.ac.in/bitstream/10603/34556/6/06_chapter1.pdf
2. https://nptel.ac.in/courses/110/105/110105039/
3. https://onlinecourses.nptel.ac.in/noc20_mg19/preview
4. https://iselglobal.com/lean-manufacturing/
5. https://www.simplilearn.com/six-sigma-role-manufacturing-industry-rar406-article

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)						Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
1	3	3	3	2	3	2	3	2	3
2	3	3	3	3	3	2	2	3	3
3	3	3	2	3	3	2	3	3	3
4	3	3	3	3	3	2	3	2	3
5	3	3	2	2	3	2	3	2	3

Correlation Level: 1- Low, 2 - Medium, 3 - High

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P20MEE504 **SUPPLY CHAIN MANAGEMENT**

L	T	P	C	Hrs
3	0	0	3	45

Course Objectives

- To provide a basic and a deeper understanding about supply chain management and the role of supply chain in an industry.
- To acquire a detailed knowledge on product and process management.
- To understand the inventory models and its applications.
- To get the knowledge about decision trees in evaluating network design.
- To impart the knowledge of ERP.

Course Outcomes

After completion of the course, the students will be able to

CO1 - Understand the entire spectrum of activities in meeting end-user needs. **(K2)**
CO2 - Understand the Supply chain process optimization tools. **(K3)**
CO3 - Understand industrial inventory managements and various models **(K3)**
CO4 - Apply SCOR Model for designing framework of supply chain.**(K3)**
CO5 - Perform case studies of ERP implementations in manufacturing industry.**(K4)**

UNIT I INTRODUCTION **(9 Hrs)**

Supply Chain, Objectives & Stages, power of SCM – Process views of a supply chain– Strategic planning, Achieving a strategic fit in a supply chain and factors affecting the strategic fit – Value chain, supply chain flow lines - Product life cycle, Fishers classification of products – Effective and responsive supply chains

UNIT II SUPPLY CHAIN PROCESS **(9 Hrs)**

Forecasting in supply chain, characteristics, components, methods and approaches, collaborative forecasting – time series methods of forecasting- forecast error distribution order quantity and reorder point – Demand Management in MPC – MTS – ATO – MTO, customer order lead time – Postponement. Lean – elements of lean, lean techniques, agility, leagility. Mapping business processes using lean. Supply chain process optimization.

UNIT III PRODUCT PROCUREMENT & INVENTORY MANAGEMENT **(9 Hrs)**

Inter and Procurement process – Sourcing in a supply chain – deciding factors for in-house or outsourcing – 3PL – 4 PL – Supplier selection and assessment - Inventory, economies of scale to exploit fixed costs, Economies of scale to exploit quantity discounts, Managing multi-echelon cycle inventory – Bullwhip effect Safety inventory, Managing safety inventory practice – Product substitution. EOQ - Order Timing Decisions, safety stock, continuous distributions, probability of stocking out criterion, customer service criterion, time period correction factor. General inventory models, dynamic order quantity, deterministic and stochastic inventory models.

UNIT IV DESIGNING A SUPPLY CHAIN **(9 Hrs)**

Supply chain drivers - Supply chain performance measures - SCOR Model - Network design in a supply chain, factors influencing design, Framework for network design network, models for facility location and capacity allocation - Uncertainty in network design – Discounted cash flow analysis, Decision trees in evaluating network design. Distribution, factors influencing distribution, design options for a distribution network.

UNIT V ENTERPRISE RESOURCE PLANNING **(9 Hrs)**

Dynamic supply chain design, Impact of technology on SCM, Key trends in SCM, IT in supply chain coordination, IT in supply chain design – MRP, record processing, technical issues, using MRP and system dynamics – ERP – Performance metrics – Functional Silo approach – Integrated supply chain metrics – cash to cash time – CRM – ISCM - Discussion on supply chain adopted by primary industrial sectors and case studies.

Text Books

1. K Agrawal Textbook of Logistics and Supply Chain Management, Macmillan, 2003.
2. Sunil Chopra, Peter Meindl and Kalra, "Supply Chain Management, Strategy, Planning, and operation" –, Pearson Education, 2012.
3. Bowersox Donald J, Logistics Management – The Integrated Supply Chain Process, Tata McGraw Hill,3rd edition 2016

Reference Books

1. Ayers, J.,Hand Book of Supply Chain Management, The St Lencie Press/ APICS Series on Resource Management. 2000.
2. Burt, N.D., Dobler, W.D. and Starling, L.S. World Class Supply Chain Management, The Key to Supply Chain Management, Tata McGraw Hill Publishing Company Limited. 2005.
3. Altekar Rahul V, Supply Chain Management-Concept and Cases, PHI, 3rd edition, 2005.
4. Shapiro Jeremy F, Modeling the Supply Chain, Thomson Learning, Second Reprint , 2013.
5. Joel D. Wisner, G. Keong Leong, Keah-Choon Tan, Principles of Supply Chain Management A Balanced Approach, South-Western, Cengage Learning, 3rd edition, 2011.

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1. https://nptel.ac.in/courses/110/106/110106045/
2. https://nptel.ac.in/courses/110/107/110107074/
3. https://www.coursera.org/courses?query=supply%20chain
4. https://www.coursera.org/learn/supply-chain-logistics
5. https://www.investopedia.com/terms/s/scm.asp

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)						Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
1	3	1	3	2	3	2	2	2	2
2	3	1	3	3	3	2	2	3	2
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4	3	1	3	3	3	2	2	3	2
5	3	1	3	2	3	2	3	3	2

Correlation Level: 1- Low, 2 - Medium, 3 - High

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P20MEE505 **HUMAN FACTORS IN ENGINEERING**

L	T	P	C	Hrs
3	0	0	3	45

Course Objectives

- To study in detail about the concept of human factors in engineering.
- To understand about anthropometry.
- To learn about design of systems.
- To understand about environmental factors in design.
- To learn about work philosophy.

Course Outcomes

After completion of the course, the students will be able to

CO1 - Understand the Design philosophy in manufacturing industries. **(K2)**
CO2 - Understand the anthropometry design and measuring methods. **(K2)**
CO3 - Apply design tool for scheduling the shift work in manufacturing industry. **(K3)**
CO4 - Investigate various methods of measuring noise exposure. **(K4)**
CO5 - Relate energy tool for measuring pulse rate and blood pressure. **(K5)**

UNIT I INTRODUCTION **(9 Hrs)**

Concepts of human factors engineering and ergonomics-Man-Machine system and Design Philosophy-Physical work-Heat stress-manual lifting-work posture-repetitive motion – environmental factor.

UNIT II ANTHROPOMETRY **(9 Hrs)**

Physical dimensions of the human body as a working machine-Motion size relationships-Static and dynamic anthropometry-Anthropometric acids-Design principles-Using anthropometric measures for industrial design-Procedure for anthropometric design.

UNIT III DESIGN OF SYTEMS **(9 Hrs)**

Displays-Controls-Work place-Seating-Work process-Duration of rest periods-Hand tool design-Design of visual displays-Design for shift work.

UNIT IV ENVIRONMENTAL FACTORS IN DESIGN **(9 Hrs)**

Temperature-Humidity-Noise-Illumination and contrast-Use of Photometers-Recommended illumination levels- The ageing eye-Use of indirect (Reflected) lighting - Cost efficiency of illumination-Special purpose lighting for illumination and quality control-Measurement of sound-Noise exposure and hearing loss-Hearing protectors analysis and reduction of noise-Effects of noise performance-annoyance of noise and interface with communication-Sources of vibration discomfort it.

UNIT MEASUREMENT OF ENERGY **(9 Hrs)**

Provision of energy for muscular work-Role of oxygen physical exertion-Measurement of energy expenditure-Respiration-Pulse rate and blood pressure during physical work-Physical work capacity and its evaluation.

Text Books

1. Matthew Bret Weinger, Daryle Gardner-Bonneau, Michael E. Wiklund, Handbook of Human Factors in Medical Device Design, CRC Press ,2011
2. Karl H. E. Kroemer, Hiltrud J. Kroemer, Katrin E. Kroemer-Elbert, Engineering Physiology: Bases of HumanFactorsEngineering/Ergonomics,Springer,2010.
3. Stephen J Guastello, Human Factors Engineering and Ergonomics, Taylor & Francis Group - 2014

Reference Books

1. Christopher D.Wickens, Sallie E.Gordon, YiliLiu, An Intro to Human Factors Engineering, earson, 2003.
2. Martin Helander, "A guide to the Ergonomics of manufacturing ", East West Press, 2012.
3. B. Shackell,"Applied Ergonomics Hand Book ", I.P.C. Science and Technology Press.2010.
4. E.J.McCORMIC, "Human factors in engineering design ", McGraw Hill 2010.
5. P.V.Karpovich, W.E.Sinning, "Physiology of muscular activity ", W.E.Saunders Co.2009

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1. https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-400-human-factors-engineering-fall- 2011 /lecture-notes/MIT16_400F11_lec20.pdf
2. https://nptel.ac.in/courses/107/103/107103004/
3. https://nexus.engin.umich.edu/professional-programs/human-factors-engineering/index.htm
4. https://www.imse.iastate.edu/research/focus-areas/ergonomics-and-human-factors/
5. https://onlinecourses.nptel.ac.in/noc19_de02/preview

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)						Program Specific Outcomes (PSOs)		
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4	3	1	2	2	2	3	3	2	3
5	3	1	3	3	2	3	3	2	3

Correlation Level: 1- Low, 2 - Medium, 3 - High

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PROFESSIONAL ELECTIVE - VI

		L	T	P	C	Hrs
P20MEE601	ADVANCES IN CASTING AND WELDING PROCESSES	3	0	0	3	45

Course Objectives

- To impart knowledge on basic concepts and advances in casting and welding processes
- To study the metallurgical concepts and applications of casting and welding process
- To acquire knowledge in automation of welding process
- To attain knowledge on design of welding
- To get familiarize on recent advances in welding

Course Outcomes

After completion of the course, the students will be able to

CO1: Identify the key concepts and advances in casting and welding processes **(K1)**
CO2: Understand the metallurgical concepts and applications of casting and welding process **(K2)**
CO3: Acquire the knowledge in welding automation **(K3)**
CO4: Familiarity on Design of welding **(K3)**
CO5: Understand modern brazing and soldering techniques. **(K2)**

UNIT I CASTING DESIGN (9 Hrs)

Heat transfer between metal and mould — Design considerations in casting – Designing for directional solidification and minimum stresses - principles and design of gating and risering

UNIT II CASTING METALLURGY (9 Hrs)

Solidification of pure metal and alloys – shrinkage in cast metals - progressive and directional solidification - Degasification of the melt-casting defects - Cast ability of steel, Cast Iron, Al alloys, Babbitt alloy and Cu alloy

UNIT III RECENT TRENDS IN CASTING AND FOUNDRY LAYOUT (9 Hrs)

Shell moulding, precision investment casting, CO2moulding, centrifugal casting, Die casting, and Continuous casting, counter gravity low pressure casting, Squeeze casting and semisolid processes. Layout of mechanized foundry - sand reclamation - material handling pollution control in foundry

UNIT IV WELDING METALLURGY AND DESIGN (9 Hrs)

Heat affected Zone and its characteristics – Weld ability of steels, cast iron, stainless steel, aluminum, Mg, Cu, Zirconium and titanium alloys – Carbon Equivalent of Plain and alloy steels Hydrogen embrittlement – Lamellar tearing – Residual stress – Distortion and its control . Heat transfer and solidification - Analysis of stresses in welded structures – pre and post welding heat treatments – weld joint design – welding defects – Testing of weldment

UNIT V RECENT TRENDS IN WELDING (9 Hrs)

Friction welding, friction stir welding – explosive welding – diffusion bonding – high frequency induction welding – ultrasonic welding – electron beam welding – Laser beam welding –Plasma welding – Electro slag welding-narrow gap, hybrid twin wire active TIG – Tandem MIG- modern brazing and soldering techniques – induction, dip resistance, diffusion processes – Hot gas, wave and vapor phase soldering. Overview of automation of welding in aerospace, nuclear, surface transport vehicles and under water welding

Text Books

1. Jain P.L 'Principles of Foundry Technology', Tata McGraw-Hill Publishers, 2003
2. Parmer R.S. 'Welding Engineering and Technology', Khanna Publishers,2002
3. Srinivasan N.K. 'Welding Technology', Khanna Tech Publishers, 2002

Reference Books

1. ASM Handbook, Vol 15, 'Casting', 2004
2. ASM Handbook vol.6, 'welding Brazing & Soldering', 2003
3. Carrry B., 'Modern Welding Technology', Prentice Hall Pvt Ltd., 2002
4. Heineloper and Rosenthal, 'Principles of Metal Casting', Tata McGraw Hill, 2000.
5. Koen Faes, 'Advanced welding technologies for multi-material design', LAP LAMBERT Academic Publishing,2019

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2. https://www.classcentral.com/course/swayam-principles-of-casting-technology-7899
3. https://www.twi-global.com/technical-knowledge/published-papers/advanced-welding-processes-for-fusion-reactor-fabrication-september-1999
4. https://nptel.ac.in/courses/112/103/112103244/
5. https://nptel.ac.in/courses/112/107/112107083/

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)						Program Specific Outcomes (PSOs)		
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4	2	1	2	2	2	1	3	2	3
5	3	2	2	2	3	1	3	2	3

Correlation Level: 1- Low, 2 - Medium, 3 - High

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P20MEE602 **FLUID POWER AUTOMATION**

L	T	P	C	Hrs
3	0	0	3	45

Course Objectives

- To impart knowledge in the areas of hydraulics, pneumatic and fluid power components and its functions
- To make the students to learn the basic concepts of hydraulics and pneumatics
- To make the students understand the concepts of controlling elements of hydraulics and pneumatics in the area of manufacturing process.
- To train the students in designing the hydraulic and pneumatic circuits using ladder diagram
- To gain knowledge on electronic drive circuits

Course Outcomes

After completion of the course, the students will be able to

CO1 - Understand the key concepts on fluid power components and its functions **(K2)**
CO2 - Acquire the knowledge on basic concepts of hydraulics and pneumatics **(K2)**
CO3 - Familiarise on the concepts of controlling elements of hydraulics and pneumatics in the area of manufacturing process **(K3)**
CO4 - Understand the hydraulic and pneumatic circuits using ladder diagram **(K2)**
CO5 - Apply electronic drive circuits for various manufacturing applications. **(K3)**

UNIT I INTRODUCTION **(9 Hrs)**

Need for Automation, Hydraulic & Pneumatic Comparison – ISO symbols for fluid power elements, Hydraulic, pneumatic – Selection criteria.

UNIT II FLUID POWER GENERATING/UTILIZING ELEMENTS **(9 Hrs)**

Hydraulic pumps and motor gears, vane, piston pumps-motors-selection and specification-Drive characteristics – Linear actuator – Types, mounting details, cushioning – power packs – construction. Reservoir capacity, heat dissipation, accumulators – standard circuit symbols, circuit (flow) analysis.

UNIT III CONTROL AND REGULATION ELEMENTS **(9 Hrs)**

Direction flow and pressure control valves-Methods of actuation, types, sizing of ports-pressure and temperature compensation, overlapped and under lapped spool valves operating characteristics-electro hydraulic servo valves-Different types-characteristics and performance.

UNIT IV CIRCUIT DESIGN **(9 Hrs)**

Typical industrial hydraulic circuits-Design methodology – Ladder diagram-cascade, method-truth table-karnaugh map method-sequencing circuits-combinational and logic circuit.

UNIT V ELECTRO PNEUMATICS & ELECTRONIC CONTROL OF HYDRAULIC AND PNEUMATIC CIRCUITS **(9Hrs)**

Electrical control of pneumatic and hydraulic circuits-use of relays, timers, counters, Ladder diagram, Programmable logic control of Hydraulics Pneumatics circuits, PLC ladder diagram for various circuits, motion controllers, use of field busses in circuit. Electronic drive circuits for various Motors.

Text Books

1. W.Bolton, Mechatronics, Electronic control systems in Mechanical and Electrical Engineering Pearson Education, 2003.
2. Peter Rohner, Fluid Power Logic Circuit Design, McmelanPrem, 1994.
3. Antony Esposito, Fluid Power Systems and control Prentice-Hall, 1988

Reference Books

1. Peter Rohner, Fluid Power logic circuit design. The Macmillan Press Ltd.,London, 1979
2. E.C.Fitch and J.B.Suryaatmadyn. Introduction to fluid logic, McGraw Hill, 1978.
3. K.Hiraniya Singh, Pneumatic and Hydraulic Systems, IK International Publishing house,2016.

4. James R. Daines, Martha J. Daines, Fluid Power: Hydraulics and Pneumatics, Goodheart-Willcox Company, Incorporated, 2018.
5. Vyas, J. Jaidev, Gopalsamy, Balamurugan, Joshi, Harshavardhan, Electro-Hydraulic Actuation Systems, Springer,2019.

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2. https://bin95.com/vocational-training/mechanical/hydraulic-engineering.htm
3. https://www.ifps.org/online-training-pass
4. https://www.coursera.org/lecture/fluid-power/hydraulics-and-pneumatics-SD8dv
5. http://ocw.ump.edu.my/course/view.php?id=95

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)						Program Specific Outcomes (PSOs)		
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4	3	1	2	3	2	1	3	2	3
5	3	2	2	3	2	1	3	3	3

Correlation Level: 1- Low, 2 - Medium, 3 - High

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P20MEE603 **TECHNOLOGY MANAGEMENT**

L	T	P	C	Hrs
3	0	0	3	45

Course Objectives

- To create awareness in the field of implementation technology transfer and management in engineering
- To understand methods of technology management boosted with information technology in the global context
- To gain exposure in the functional areas of technology management stream
- To Understand the technology transfer and acquisition
- To gain knowledge on technology absorption and innovation

Course Outcomes

After completion of the course, the students will be able to

CO1 - Implement the technology transfer and management in engineering. **(K3)**
CO2 - Understand the technology forecasting and mathematical models. **(K2)**
CO3 - Adapt the functional areas of technology management stream. **(K3)**
CO4 - Understand and apply the technology transfer and acquisition concepts. **(K2)**
CO5 - Implement the technology absorption and innovation in the real time applications. **(K3)**

UNIT I INTRODUCTION **(9 Hrs)**

Technology Management-Scope, Components, and Overview, Technology and Environment, Technology And Society, Technology Impact Analysis, Environment, Social Legan, Political Aspects, Techniques For Analysis-Steps Involved. Technology Policy Strategy: Science and Technology Policy of India Implications STO Industry, the Dynamics of Technology Change.

UNIT II TECHNOLOGY FORECASTING **(9 Hrs)**

Need, Methodology And Methods-Trend Analysis, Analogy, Delphi, Soft System Methodology, Mathematical Models, Simulation, And System Dynamics.

UNIT III TECHNOLOGY CHOICE AND EVALUTATION **(9 Hrs)**

Issues In The Development New High Tech Products, Methods Of Analyzing Alternate Technologies, Techno-Economic Feasibility Studies. Need For Multi-Criteria Consideration Such As, Social-Environment, And Political, Analytic Hierarchy Method, Fuzzy Multi-Criteria Decision Making, and Other Methods.

UNIT IV TECHNOLOGY TRANSFER AND ACQUISTION **(9 Hrs)**

Import Regulations, Implications of Agreements Like Uruguay Round And WTO, Bargaining Process, Transfer Option, MOU-Technology Adoption And Productivity –Adopting Technology – Human Interactions, Organizational Redesign And Re-Engineering, Technology Productivity.

UNIT V TECHNOLOGY ABSORPTION AND INNOVATION **(9 Hrs)**

Present Status In India, Need For New Outlook, Absorption Strategies For Acquired Technology, Creating New/Improved Technologies. Innovations, Technology Measurements-Technology Audit, Risk and Exposure, R &D Portfolio Management

Text Books

1. U. Ravi Kiran, A Textbook on Technology Management, Laxmi Publication,2008
2. Richard C. Dorf, Technology Management Handbook, CRC,1999
3. Joseph M. Putti Management-A Functional Approach, McGraw Hill, 1997

Reference Books

1. Kenneth C. Lauden, MIS: Organization and Technology, Prentice Hall, 1995
2. James A. Senn, Information technology in Business, Prentice Hall, 1995
3. Narayanan V.K, Managing Technology and innovation for competitive advantages, Prentice Hall longman, 2001.

4. Kim, H, Advance in Technology Management, Springer, 2012.
5. Akhilesh, K. B, Emerging Dimension of Technology Management, Springer, 2013

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2. https://www.coursera.org/courses?query=information%20technology%20management
3. https://www. study-options-c/short/269779192/technology-management-united-states.html
4. https://www.shortcoursesportal.com/disciplines/248/technology-management.html
5. https://www.coursera.technolog management.com

COs/POs/PSOs Mapping

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3	3	1	2	3	1	2	3	2	2
4	3	1	3	3	1	2	3	2	2
5	3	2	3	3	2	2	3	2	2

Correlation Level: 1- Low, 2 - Medium, 3 - High

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P20MEE604 **ENGINE MANAGEMENT SYSTEM**

L	T	P	C	Hrs
3	0	0	3	45

Course Objectives

- To create knowledge in the field of vehicle electronic management systems
- To study the fundamentals of automotive electronics and the use of sensors and actuators in engine management
- To understand the concept of SI engines and its management system
- To understand the concept of CI engines and its management system
- To gain knowledge on digital engine control system

Course Outcomes

After completion of the course, the students will be able to

CO1 - Understand the vehicle electronic management systems and control parameters. **(K2)**
CO2 - Familiarity on sensors and actuators **(K2)**
CO3 - Understand the solid-state ignitions system and its applications. **(K2)**
CO4 - Understand the fuel injection system parameters in CI engines and its management system. **(K2)**
CO5 - Understand the principle and applications of digital engine control system. **(K2)**

UNIT I FUNDAMENTALS OF AUTOMOTIVE ELECTRONICS **(9 Hrs)**

Components for electronic engine management system, open and closed loop control strategies, PID control, Look up tables, introduction to modern control strategies like Fuzzy logic and adaptive control. Parameters to be controlled in SI and CI engines

UNIT II SENSORS AND ACTUATORS **(9 Hrs)**

Inductive, Hall Effect, hot wire, thermistor, piezo electric, piezoresistive based sensors. Throttle position, mass air flow, crank shaft position, cam position, engine and wheel speed, steering position, tire pressure, brake pressure, steering torque, fuel level, IC Engine and vehicle design data rash, exhaust oxygen level (two step and linear lambda), knock, engine temperature, manifold temperature and pressure sensors.

UNIT III SI ENGINE MANAGEMENT **(9 Hrs)**

Three way catalytic converter, conversion efficiency versus lambda. Layout and working of SI engine management systems like Bosch Monojetronic, L-Jetronic and LH-Jetronic. Group and sequential injection techniques. Working of the fuel system components.Advantages of electronic ignition systems.Types of solid state ignition systems and their principle of operation, Contactless electronic ignition system, Electronic spark timing control.

UNIT IV CI ENGINE MANAGEMENT **(9 Hrs)**

Fuel injection system parameters affecting combustion, noise and emissions in CI engines. Pilot, main, advanced post injection and retarded post injection. Electronically controlled Unit Injection system. Layout of the common rail fuel injection system.Working of components like fuel injector, fuel pump, rail pressure limiter, flow limiter, EGR valve

UNIT V DIGITAL ENGINE CONTROL SYSTEM **(9 Hrs)**

Cold start and warm up phases, idle speed control, acceleration and full load enrichment, deceleration fuel cut-off. Fuel control maps, open loop control of fuel injection and closed loop lambda control - Integrated engine control system, Exhaust emission control engineering, and Electromagnetic compatibility - EMI Suppression techniques - Electronic dash board instruments - Onboard diagnosis system.

Text Books

1. Steve V. Hatch, Computerized Engine Controls - 2011
2. Gamesman, Internal Combustion Engines – 2008
3. Robert Bosch, Diesel Engine Management, SAE, Publications 3rd Edition, 2004

Reference Books

1. Robert Bosch,Gasoline Engine Management by, SAE Publications, 2nd Edition, 2004
2. V. A. W. Hillier, Peter Coombes, Fundamentals of Motor Vehicle Technology- 2004
3. Eric Chowanietz, Automobile Electronics, SAE 2001
4. William B Ribbens, Understanding Automotive Electronics SAE 1998
5. Konrad Reif, Gasoline Engine Management, Springer, 2018

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2. https://alison.com/courses/nsdc-course-auto-service-technician/content/scorm/10510/engine-management-system-ems
3. https://alison.com/topic/learn/59658/ems-components-diesel-engine
4. https://onlinelibrary.wiley.com/doi/abs/10.1002/9781118536186.ch9
5. https://www.scribd.com/doc/140942498/AT2401-engine-and-vehicle-management-system-pdf

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)						Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
1	3	1	3	3	2	1	3	2	3
2	3	1	3	3	2	1	3	2	3
3	3	1	2	3	2	1	3	2	3
4	3	1	3	3	2	1	3	2	3
5	3	2	3	3	2	1	3	2	3

Correlation Level: 1- Low, 2 - Medium, 3 - High

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P20MEE605 MAINTENANCE AND RELIABILITY ENGINEERING

L	T	P	C	Hrs
3	0	0	3	45

Course Objectives

- To understand the key principles and objectives of Maintenance Management.
- To learn various types of maintenance functions and its limitation.
- To expose the necessary engineering techniques used for analysing, planning and controlling maintenance systems.
- To provide the basic skills related to systems reliability and systems maintenance function.
- To learn various techniques for estimating reliability and related characteristics of components/ systems.

Course Outcomes

After completion of the course, the students will be able to

CO1 – Understand the maintenance function and its objectives and know how to prepare report about the maintenance function **(K2)**

CO2 – Illustrate the types of maintenance and know how to use them when design maintenance systems. **(K2)**

CO3 – Understand Diagnostic maintenance and applications. **(K2)**

CO4 – Gain the necessary knowledge about failure distributions and apply failure analysis techniques. **(K3)**

CO5 – Estimate components reliability both for the independent & dependent cases as well as related characteristics. **(K3)**

UNIT I MAINTENANCE MANAGAMENT **(9 Hrs)**

Need for maintenance-Objective- Concepts-Types of maintenance-Organization-Trade force mix, type and location-Maintenance costs-Benefits-Computer Aided Maintenance management-Total productive maintenance concepts.

UNIT II TYPES OF MAINTENANCE **(9 Hrs)**

Breakdown and Preventive maintenance-Advantages and Limitations-Maintenance prevention-Diagnostic maintenance-Design out maintenance-Opportunity maintenance

UNIT III DIAGNOSTIC MAINTENANCE **(9 Hrs)**

Leak detection-wear monitoring-Temperature monitoring-Vibration monitoring-Signature analysis-Shockmonitoring-Lubricant-Analysis-Methodology-Equipments-Applications

UNIT IV CONCEPTS OF RELIABILITY **(9 Hrs)**

Elements of Probability-Reliability Definition-Measures of Reliability-Failures-Classification of failures-Failure data Analysis-Availability-Criticality matrix-Event tree analysis-Utilization factor-Factors affecting reliability

UNIT V DESIGN FOR RELIABILITY **(9 Hrs)**

Analysis of reliability data-Weibull analysis-Design and manufacture for Reliability-Reliability of parts and components-Design for system reliability-Economics of standby or redundancy in production system-reliability testing-Types

Text Books

1. Higgins and Morrow,-" Maintenance Engineering Handbook ", Tata McGraw Hill, 1985.
2. O'connor, P.D.T', "Practical Reliability Engineering ", John Wiley-1994.
3. Alakesh Manna, 'Reliability and Maintenance Engineering, I K International Publishing House Pvt. Ltd,2020.

Reference Books

1. Carter, A.D.S. 'Mechanical Reliability',Macmillan, 1984.
2. Nakagawa, 'Maintenance Theory of reliability', Springer 2005.
3. Sushil Kumar Srivastava, Maintenance Engineering, S Chand & Company ,2010.
4. Lazzaroni, M, 'Reliability Engineering', Springer, 2011.
5. S Maheshwarkar, Reliability and Maintenance Engineering, S K Kataria & Sons,2014.

Web References

1. https://nptel.ac.in/courses/105/108/105108128/
2. https://nptel.ac.in/courses/112/107/112107241/

3. https://nptel.ac.in/courses/112/107/112107143/
4. https://ocw.mit.edu/courses/nuclear-engineering/22-38-probability-and-its-applications-to-reliability-quality-control-and-risk-assessment-fall-2005/lecture-notes/
5. https://www.coursehero.com/file/27769524/Week-1-Lecture-Material-NPTEL-CETpdf/

COs/POs/PSOs Mapping

COs	Program Outcomes (POs)						Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
1	3	-	2	3	-	1	2	2	1
2	3	-	2	3	1	1	2	2	2
3	3	2	2	3	2	2	3	2	3
4	3	2	2	3	1	2	3	3	3
5	3	1	2	3	1	2	3	2	2

Correlation Level: 1- Low, 2 - Medium, 3 - High

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ANNEXURE - III

AUDIT COURSES

P20ACT101 ENGLISH FOR RESEARCH PAPER WRITING

L	T	P	C	Hrs
2	0	0	0	30

Course Objectives

- Teach improve writing skills and level of readability.
- Tell about what to write in each section.
- Summarize the skills needed when writing a Title.
- Infer the skills needed when writing the Conclusion.
- Ensure the quality of paper at very first-time submission.

Course Outcomes

After completion of the course, the students will be able to

CO1 - Understand that how to improve your writing skills and level of readability.
CO2 - Learn about what to write in each section.
CO3 - Understand the skills needed when writing a Title.
CO4 - Understand the skills needed when writing the Conclusion.
CO5 - Ensure the good quality of paper at very first-time submission.

UNIT I INTRODUCTION TO RESEARCH PAPER WRITING (6 Hrs)

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness.

UNIT II PRESENTATION SKILLS (6 Hrs)

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction.

UNIT III TITLE WRITING SKILLS (6 Hrs)

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

UNIT IV RESULT WRITING SKILLS (6 Hrs)

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions.

UNIT V VERIFICATION SKILLS (6 Hrs)

Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first- time submission

Reference Books

1. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011.
2. Day R How to Write and Publish a Scientific Paper, Cambridge University Press, 2006.
3. Goldbort R Writing for Science, Yale University Press (available on Google Books), 2006.
4. Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book, 1998.

P20ACT102 **DISASTER MANAGEMENT**

L	T	P	C	Hrs
2	0	0	0	30

Course Objectives

- Summarize basics of disaster explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Develop the strengths and weaknesses of disaster management approaches.

Course Outcomes

After completion of the course, the students will be able to

CO1 - Ability to summarize basics of disaster.

CO2 - Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.

CO3 - Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.

CO4 - Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.

CO5 - Ability to develop the strengths and weaknesses of disaster management approaches.

UNIT I INTRODUCTION **(6 Hrs)**

Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT II REPERCUSSIONS OF DISASTERS AND HAZARDS **(6 Hrs)**

Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

UNIT III DISASTER PRONE AREAS IN INDIA **(6 Hrs)**

Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics.

UNIT IV DISASTER PREPAREDNESS AND MANAGEMENT **(6 Hrs)**

Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT V RISK ASSESSMENT **(6 Hrs)**

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival

Reference Books

1. Goel S. L., Disaster Administration And Management Text And Case Studies",Deep & Deep Publication Pvt. Ltd., New Delhi,2009.
2. NishithaRai, Singh AK, "Disaster Management in India: Perspectives, issues and strategies 'New Royal book Company,2007.
3. Sahni, Pardeep Et.Al. , "Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi,2001.

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P20ACT103 **SANSKRIT FOR TECNICAL KNOWLEDGE**

L	T	P	C	Hrs
2	0	0	0	30

Course Objectives

- Illustrate the basic Sanskrit language.
- Recognize Sanskrit, the scientific language in the world.
- Appraise learning of Sanskrit to improve brain functioning.
- Relate Sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power.
- Extract huge knowledge from ancient literature.

Course Outcomes

After completion of the course, the students will be able to

CO1 - Understanding basic Sanskrit language.
CO2 - Write sentences.
CO3 - Know the order and roots of Sanskrit.
CO4 - Know about technical information about Sanskrit literature.
CO5 - Understand the technical concepts of Engineering.

UNIT I ALPHABETS **(6 Hrs)**

Alphabets in Sanskrit.

UNIT II TENSES AND SENTENCES **(6 Hrs)**

Past/Present/Future Tense - Simple Sentences.

UNIT III ORDER AND ROOTS **(6 Hrs)**

Order - Introduction of roots of Engineering-Electrical, Mechanical, Architecture, Mathematics.

UNIT IV SANSKRIT LITERATURE **(6 Hrs)**

Technical information about Sanskrit Literature.

UNIT V TECHNICAL CONCEPTS OF ENGINEERING **(6 Hrs)**

Technical concepts.

References

1. "Abhyaspustakam" – Dr. Vishwas, Samskrita-Bharti Publication, New Delhi.
2. "Teach Yourself Sanskrit" Prathama Deeksha-Vempati Kutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication.
3. "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi, 2017.

P20ACT104 **VALUE EDUCATION**

L	T	P	C	Hrs
2	0	0	0	30

Course Objectives

- Understand value of education and self-development.
- Imbibe good values in students.
- Let the should know about the importance of character.

Course Outcomes

After completion of the course, the students will be able to

CO1 - Knowledge of self-development.
CO2 - Learn the importance of Human values.
CO3 - Developing the overall personality.

UNIT I

Values and self-development–Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non-moral valuation. Standards and principles. Value judgements of Women. All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively.

UNIT II

Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism. Love for nature, Discipline

UNIT III

Personality and Behavior Development-Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labour. Universal brother hood and religious tolerance. True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature.

UNIT IV

Character and Competence–Holy books vs Blind faith. Self-management and Good health. Science of reincarnation. Equality, Nonviolence, Humility, Role.

Reference Books

1. Chakroborty, S.K."Values and Ethics for organizations Theory and practice", Oxford University Press, New Delhi.

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P20ACT105 **CONSTITUTION OF INDIA**

L	T	P	C	Hrs
2	0	0	0	30

Course Objectives

- Understand the premises informing the twin themes of liberty and freedom from a civil rights Perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional.
- Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolutionin1917and its impact on the initial drafting of the Indian Constitution.

Course Outcomes

After completion of the course, the students will be able to

CO1 - Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.

CO2 - Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.

CO3 - Discuss the circumstances surrounding the foundation of the Congress Socialist Party[CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections.

CO4 - Discuss the passage of the Hindu Code Bill of 1956.

UNIT I HISTORY OF MAKING OF THE INDIAN CONSTITUTION **(5 Hrs)**

History, Drafting Committee, (Composition & Working).

UNIT II PHILOSOPHY OF THE INDIAN CONSTITUTION **(5 Hrs)**

Preamble, Salient Features.

UNIT III CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES **(5 Hrs)**

Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT IV ORGANS OF GOVERNANCE **(5 Hrs)**

Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

UNIT V LOCAL ADMINISTRATION **(5 Hrs)**

District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO, Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy(Different departments), Village level:Role of Elected and Appointed officials, Importance of grass root democracy.

UNIT VI ELECTION COMMISSION **(5 Hrs)**

Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.

Reference Books

1. "The Constitution of India,1950 (Bare Act),Government Publication.
2. Dr.S.N.Busi, Dr.B. R.Ambedkar framing of Indian Constitution,1st Edition, 2015.
3. M.P. Jain, Indian Constitution Law, 7th Edition, Lexis Nexis,2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015 "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi, 2017.

P20ACT106 **PEDAGOGY STUDIES**

L	T	P	C	Hrs
2	0	0	0	30

Course Objectives

- Review existing evidence on their view topic to inform programme design and policy.
- Making under taken by the DfID, other agencies and researchers.
- Identify critical evidence gaps to guide the development.

Course Outcomes

After completion of the course, the students will be able to

CO1 - What pedagogical practices are being used by teachers informal and informal classrooms in developing countries?

CO2 - What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?

CO3 - How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

UNIT I INTRODUCTION AND METHODOLOGY: **(6 Hrs)**

Aims and rationale, Policy background, Conceptual framework and terminology - Theories of learning, Curriculum, Teacher education - Conceptual framework, Research questions – Overview of methodology and Searching.

UNIT II THEMATIC OVERVIEW **(6 Hrs)**

Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries - Curriculum, Teacher education.

UNIT III EVIDENCE ON THE EFFECTIVENESS OF PEDAGOGICAL PRACTICES **(6 Hrs)**

Methodology for the in depth stage: quality assessment of included studies - How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? - Theory of change - Strength and nature of the body of evidence for effective pedagogical practices - Pedagogic theory and pedagogical approaches - Teachers' attitudes and beliefs and Pedagogic strategies.

UNIT IV PROFESSIONAL DEVELOPMENT **(6 Hrs)**

Professional development: alignment with classroom practices and follows up support – Peer support - Support from the head teacher and the community - Curriculum and assessment - Barriers to learning: limited resources and large class sizes.

UNIT V RESEARCH GAPS AND FUTURE DIRECTIONS **(6 Hrs)**

Research design – Contexts – Pedagogy - Teacher education - Curriculum and assessment - Dissemination and research impact.

Reference Books

1. Ackers J, HardmanF (2001) Classroom interaction in Kenyan primary schools, Compare, 31(2): 245- 261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36(3):361-379.
3. Akyeampong K (2003) Teacher training in Ghana-does it count? Multi-site teacher education research project (MUSTER) country report 1.London:DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33(3): 272–282.
5. Alexander RJ(2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
6. Chavan M(2003) Read India: Amass scale, rapid, 'learning to read' campaign.
7. www.pratham.org/images/resource%20working%20paper%202.pdf.

M.Tech. Manufacturing Engineering

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P20ACT107 **STRESS MANAGEMENT BY YOGA**

L	T	P	C	Hrs
2	0	0	0	30

Course Objectives

- To achieve overall health of body and mind.
- To overcome stress.

Course Outcomes

After completion of the course, the students will be able to

CO1 - Develop healthy mind in a healthy body thus improving social health also

CO2 - Improve efficiency.

UNIT I

Definitions of Eight parts of yoga.(Ashtanga).

UNIT II

Yam and Niyam - Do`s and Don't's in life - i) Ahinsa, satya, astheya, bramhacharya and aparigraha, ii) Ahinsa, satya, astheya, bramhacharya and aparigraha.

UNIT III

Asan and Pranayam - Various yog poses and their benefits for mind & body - Regularization of breathing techniques and its effects-Types of pranayam.

Reference Books

1. 'Yogic Asanas for Group Tarining-Part-I":Janardan Swami Yoga bhyasi Mandal, Nagpur.
2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata.

P20ACT108	PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS	L	T	P	C	Hrs
		2	0	0	0	30

Course Objectives

- To learn to achieve the highest goal happily.
- To become a person with stable mind, pleasing personality and determination.
- To awaken wisdom in students.

Course Outcomes

After completion of the course, the students will be able to

CO1 - Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life.

CO2 - The person who has studied Geeta will lead the nation and mankind to peace and prosperity.

CO3 - Study of Neet is hatakam will help in developing versatile personality of students.

UNIT I

Neetisatakam-holistic development of personality - Verses- 19,20,21,22 (wisdom) - Verses- 29,31,32 (pride & heroism) – Verses- 26,28,63,65 (virtue) - Verses- 52,53,59 (dont's) - Verses- 71,73,75,78 (do's) 4-Verses 18, 38,39 Chapter18 – Verses37,38,63.

UNIT II

Approach to day to day work and duties - Shrimad Bhagwad Geeta: Chapter 2-Verses 41, 47,48 - Chapter 3-Verses 13, 21, 27, 35 Chapter 6-Verses 5,13,17,23, 35 - Chapter 18-Verses 45, 46, 48.model – shrimad bhagwad geeta - Chapter2- Verses 17, Chapter 3-Verses 36,37,42 – Chapter.

UNIT III

Statements of basic knowledge – Shrimad Bhagwad Geeta: Chapter2 - Verses 56, 62, 68 Chapter12 - Verses 13, 14, 15, 16,17, 18 - Personality of role.

Reference Books

1. Gopinath, Rashtriya Sanskrit Sansthanam P, Bhartrihari's Three Satakam, Niti-sringar- vairagya, New Delhi,2010.
2. Swami Swarupananda ,Srimad Bhagavad Gita, Advaita Ashram, Publication Department, Kolkata, 2016.

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P20ACT109 **UNNAT BHARATH ABHIYAN**

L	T	P	C	Hrs
2	0	0	0	30

Course Objectives

- To develop an appreciation of rural culture, life-style and wisdom amongst students
- To learn about the status of various agricultural and rural development programmes
- To understand causes for rural distress and poverty and explore solutions for the same
- To apply classroom knowledge of courses to field realities and thereby improve quality of learning.

Course Outcomes

After completion of the course, the students will be able to

CO1 - Gain an understanding of rural life, culture and social realities
CO2 - Develop a sense of empathy and bonds of mutuality with local community
CO3 - Appreciate significant contributions of local communities to Indian society and economy
CO4 - Learn to value the local knowledge and wisdom of the community
CO5 - Identify opportunities for contributing to community's socio-economic improvements.

UNIT I APPRECIATION OF RURAL SOCIETY **(4 Hrs)**

Rural life style, rural society, caste and gender relations, rural values with respect to community, nature and resources, elaboration of "soul of India lies in villages' (Gandhi), rural infrastructure

UNIT II UNDERSTANDING RURAL ECONOMY & LIVELIHOOD **(4 Hrs)**

Agriculture, farming, landownership, water management, animal husbandry, non-farm livelihoods and artisans, rural entrepreneurs, rural markets

UNIT III RURAL INSTITUTIONS **(4 Hrs)**

Traditional rural organisations, Self-help Groups, Panchayati raj institutions (Gram Sabha, Gram Panchayat, Standing Committees), local civil society, local administration

UNIT IV RURAL DEVELOPMENT PROGRAMMES **(4 Hrs)**

History of rural development in India, current national programmes: Sarva Shiksha Abhiyan,Beti Bachao, Beti Padhao,Ayushman Bharat, Swatchh Bharat, PM AwaasYojana, Skill India,Gram Panchayat Decentralised Planning, NRLM, MNREGA, etc.

UNIT V FIELD BASED PRACTICL ACTIVITIES **(14 Hrs)**

Visit MGNREGS project sites. Swachh Bharat project sites, Conduct Mission Antyodaya surveys, Interactive community exercise with local leaders, panchayat functionaries, Visit Rural Schools / mid-day meal centres, study Academic and infrastructural resources and gaps, Participate in Gram Sabha meetings, Visit local Anganwadi Centre, Conduct soil health test, drinking water analysis

Reference Books

1. Singh, Katar, Rural Development: Principles, Policies and Management, Sage Publications, New Delhi, 2015.
2. A Hand book on Village Panchayat Administration, Rajiv Gandhi Chair for Panchayati Raj Studies, 2002.
3. United Nations, Sustainable Development Goals, 2015 un.org/sdgs/
4. M.P.Boraian, Best Practices in Rural Development, Shanlax Publishers, 2016.

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