DEPARTMENT OF MECHANICAL ENGINEERING
JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR
COLLEGE OF ENGINEERING (AUTONOMOUS), PULIVENDULA
YSR(KADAPA) Dist 516 390, (A.P) INDIA.

M.TECH: CAD/CAM

COURSE STRUCTURE

Semester-I

S.No.	Course Code	Course Name	Category	Hours per			Credits
				L	T	P	
1.		Geometric Dimensioning and Tolerancing	PC	3	0	0	3
2.		Advanced Finite Element Methods	PC	3	0	0	3
3.		**Professional Elective Course - I** a. Computer Integrated Manufacturing b. Geometric Modeling c. Design of Hydraulic & Pneumatic systems	PE	3	0	0	3
4.		**Professional Elective Course - II** a. Advances in Manufacturing Technology b. Total Quality Management c. Computer Aided process planning	PE	3	0	0	3
5.		Geometric Modelling Laboratory	PC	0	0	4	2
6.		Finite Element Analysis Laboratory	PC	0	0	4	2
7.		Research Methodology and IPR	MC	2	0	0	2
8.		**Audit Course - I**	AC	2	0	0	0
						Total	**18**

Semester-II

S.No.	Course Code	Course Name	Category	Hours per week			Credits
				L	T	P	
1.		Advanced Optimization Techniques	PC	3	0	0	3
2.		Industrial Robotics and Expert Systems	PC	3	0	0	3
3.		**Professional Elective Course – III** a. CNC Technology & Programming b. Advanced Composite Materials c. Advanced Mechanism design	PE	3	0	0	3
4.		**Professional Elective Course - IV** a. Mechatronics and MEMS b. Additive Manufacturing c. Design & Analysis of Experiments	PE	3	0	0	3
5.		Process Automation Laboratory	PC	0	0	4	2
6.		CAM Laboratory	PC	0	0	4	2
7.		Technical Seminar	PR	0	0	4	2
8.		**Audit Course - II**	AC	2	0	0	0
						Total	**18**

Semester-III							
S.No.	Course Code	Course Name	Category	Hours per week			Credits
				L	T	P	
1.		**Professional Elective Course** - V a. Advanced Tool Design b. Design for Manufacturing c. Automation in Manufacturing	PE	3	0	0	3
2.		Open Elective	OE	3	0	0	3
3.		Co-Curricular Activities		0	0	4	2
4.		Dissertation Phase – I	PR	0	0	20	10
						Total	**18**

Semester-IV							
S.No.	Course Code	Course Name	Category	Hours per week			Credits
				L	T	P	
1.		Dissertation Phase – II	PR	0	0	32	16
						Total	**16**

Open Elective

1. Business Analytics.
2. Industrial Safety.
3. Operations Research.
4. Supply Chain Management.
5. Composite Materials.
6. Waste to Energy.
7.Mechatronics.
8.Optimization through Matlab.
9.Automotive Electronics.
10. Rapid Manufacturing.
11. Programming Of Robot And Its Control
12. Industry 4.0.

Audit course 1 & 2

1. Disaster Management.
2. Sanskrit for Technical Knowledge.
3. Value Education.
4. Constitution of India.
5. Pedagogy Studies.
6. Stress Management by Yoga.
7. Personality Development through Life Enlightenment Skills.

Course Code		GEOMETRIC DIMENSIONING AND TOLERANCING	L	T	P	C
Semester	I		3	0	0	3

Course Objectives:

- Teach the basics of the geometric dimensioning and tolerances.
- Familiar with five groups of GD&T tolerances, form, orientation, location, runout and profile tolerances.
- Introduce tolerances of profiles of lines and surfaces with or without datums.
- Expose the students to various surface roughness parameters and their measurements in two dimensions.
- Understand the concepts of dimensional chains and inspection techniques.

Course Outcomes (CO): Student will be able to

- This course systematically introduces the essentials of the language of geometric dimensioning and tolerancing (GD&T) based on ASME standards, as well as the essentials of surface roughness measurements in both 2D and 3D including filtering techniques.
- This course also introduces the related concepts of Vectorial dimensioning and tolerancing, dimensional chains, measurement uncertainty, etc.
- The knowledge gained by the students by learning the above topics will help them to perform very well in their profession as metrologists as well as product designers.

UNIT - I	**Basic Concepts**	Lecture Hrs: 8

General terms and definitions of geometrical features - General principle of sizes - System of limits and fits - Inspection of dimensional and geometrical deviations - Datums, datum systems, and selection of datums. Restraining degrees of freedom, DOF, Simulators. Rule #1(Boundary principle) and Rule #2.

UNIT - II	**Form and Orientation Tolerances**	Lecture Hrs: 10

Principles of dimensioning - Introduction to geometric dimensioning and tolerancing (GD&T); Form tolerances: types, specifications and interpretations - measurement and evaluation of straightness, flatness and roundness - Orientation tolerances: types, specifications and interpretations, and verification of orientation tolerances. Exercises on each group. RFS, MMC and LMC concepts.

UNIT - III	**Location, Runout and Profile Tolerances**	Lecture Hrs: 10

Tolerances of location: types, specifications and interpretations - verification techniques - Tolerances of profiles of lines and surfaces with or without datums - Tolerances of runout - Tolerancing of angles and cones. Exercises on each group. RFS, MMC and LMC concepts.

UNIT - IV	**Surface Roughness**	Lecture Hrs: 8

Various parameters and their measurements in two dimensions - filtering and filtering techniques - areal parameters. symbology

UNIT - V	**Inspection of GD&T call-outs**	Lecture Hrs: 9

Vectorial dimensioning and tolerancing - Statistical tolerancing of mechanical assemblies - Dimensional chains - Measurement uncertainty - Computer-aided tolerancing and verification. Inspection techniques- conventional and CMM.

Textbooks:

1. Drake, P. J., Dimensioning and Tolerance Handbook, McGraw-Hill, Inc., New York. 1999.
2. Meadows, J. D., Geometric Dimensioning and Tolerancing: Applications and Techniques for use in Design, Manufacturing and Inspection, Marcel Dekker, Inc., New York. 1995.
3. Gill, P. S., Geometric Dimensioning and Tolerancing, S. K. Kataria & Sons, New

Delhi.
4. ASME 14.5 - 2009 standards
5. Alex Krulikowski, Fundamentals of geometric dimensionining and tolerancing.
6. James D Meadows, ―Measurement of Geometric Tolerances in Manufacturing.

Reference Books:

1. Gupta, I. C., A Textbook of Engineering Metrology, Dhanpat Rai Publications, New Delhi.
2. Galyer, J. F. W. and C. R. Shotbolt, Metrology for Engineers, Cassell Publishers, London.
3. Henzold, G., Handbook of Geometrical Tolerancing: Design, Manufacturing and Inspection, John Wiley & Sons, Chichester.
4. Muralikrishnan, B. and J. Raja, Computational Surface and Roundness Metrology, Springer, USA.
5. Relevant Indian and International Standards.
6. Whitehouse, D. J., Surfaces and their Measurement, Hermes Penton Science, London.

Online Learning Resources:

- https://nptel.ac.in/courses/112/106/112106179/
- https://www.youtube.com/watch?v=X_VepJhq_vk
- https://www.youtube.com/watch?v=cjzSXPDBA_Q&t=1s
- https://www.youtube.com/watch?v=-tLq1wXio0U
- https://digitaldefynd.com/best-gdt-courses/

Course Code		ADVANCED FINITE ELEMENT METHODS	L	T	P	C
Semester	I		3	0	0	3

Course Objectives:

- To provide the mathematical foundations of the finite element formulation for engineering applications (solids, heat, fluids).
- To expose students to some of the recent trends and research areas in finite elements.

Course Outcomes (CO):

Students can able to solve below following problems.

- Students will learn the mathematical formulation of the finite element method and how to apply it to basic (linear) ordinary and partial differential equations.
- Solve 1- D problems. & 2- D Structural & Heat Transfer Problems using FEA
- Solve Trusses & Beams Problems using FEA.
- Formulate & solve structural & dynamics problems.

UNIT - I	**Formulation Techniques**	Lecture Hrs: 8

Methodology, Engineering problems and governing differential equations, finite elements, Variational methods-potential energy method, Raleigh Ritz method, strong and weak forms, Galerkin and weighted residual methods, calculus of variations, Essential and natural boundary conditions.

UNIT - II	**One-dimensional Finite Element Methods**	Lecture Hrs: 10

Bar elements, temperature effects. Element matrices, assembling of global stiffness matrix, Application of boundary conditions, Elimination and penalty approaches, solution for displacements, reaction, stresses, temperature effects, Quadratic Element, Heat transfer problems: One – dimensional, conduction and convection problems. Examples:- One dimensional fin.

UNIT - III	**Trusses, Beams and frames - 1D**	Lecture Hrs: 8

Element matrices, assembling of global stiffness matrix, solution for displacements, reaction, stresses, temperature effects.

Beams and Frames: Element matrices, assembling of global stiffness matrix, solution for displacements, reaction, stresses.

UNIT - IV	**Two dimensional problems**	Lecture Hrs: 8

CST, LST, four noded and eight nodded rectangular elements, Lagrange basis for triangles and rectangles, serendipity interpolation functions. Axisymmetric Problems: Axisymmetric formulations, Element matrices, boundary conditions. Heat Transfer problems: Conduction and convection, examples: - two – dimensional fin.

Isoparametric formulation: Concepts, sub parametric, super parametric elements, numerical integration.

UNIT - V	**Finite elements in Structural Dynamics**	Lecture Hrs: 9

Dynamic equations, eigen value problems, and their solution methods, simple problems.

Convergence: Requirements for convergence, h-refinement and p-refinement, complete and incomplete interpolation functions, pascal's triangle.

Fracture Mechanics: Formulation of J Integral.

Textbooks:

1. T.R.Chandraputla & A.D.Belegundu, Introduction to Finite Elements in Engineering, Pearson Education India; 4th edition - 1st January 2015.
2. J. N. Reddy, D.K. Gartling,The Finite Element Method in Heat Transfer and Fluid Dynamics, Taylor & Francis, 6 April 2010.

Reference Books:

1. Zienckiwicz O.C. & R. L. Taylor, Finite Element Method, McGraw-Hill,1983.
2. J. N. Oden, Finite Element of Nonlinear continua, McGraw-Hill, New York, 1971.
3. K. J. Bathe, Finite element procedures, . Prentice-Hall, 1996.
4. Prashant Kumar, Elements of Fracture Mechanics, McGraw Hill Education (India) Private Limited, 2009.
5. Meinhard Kuna, Finite Elements in Fracture Mechanics: Theory - Numerics - Applications, Springer Publications, 2013.

Online Learning Resources:

- https://nptel.ac.in/courses/112/104/112104193/
- https://nptel.ac.in/courses/112/104/112104205/
- https://nptel.ac.in/courses/105/105/105105041/
- https://nptel.ac.in/courses/112/106/112106130/
- https://nptel.ac.in/courses/112/103/112103295/

Course Code		COMPUTER INTEGRATED MANUFACTURING Professional Elective Course - I	L	T	P	C
Semester	I		3	0	0	3

Course Objectives:

- This course will enable the student
- To gain knowledge about the basic fundamental of CAD.
- To gain knowledge on how computers are integrated at various levels of planning and manufacturing understand computer aided planning and control and computer monitoring.

Course Outcomes (CO): Student will be able to

- Understand the importance of product development through CIM. Get knowledge of shop floor control , Computer Integrated Manufacturing and Automation.
- Adopt appropriate material handling and storage in an automated manufacturing environment.
- Incorporate methods of utilization of appropriate features in CAD application enhancing productivity in design

UNIT - I	**Introduction and NC Machines**	Lecture Hrs:10

Fundamental concepts in Manufacturing and Automation, Automation Strategies, Economic analysis in production, fundamentals of CAD / CAM, product cycle and CAD/CAM, Automation and CAD/CAM, Scope of CIM, Automated flow lines, Transfer mechanisms, methods of Line balancing.

Numerical control machines: Introduction- basic components of an NC system-the NC procedure- NC coordinate system, NC motion control system- application of numerical control- Economics of Numerical control.

UNIT - II	**NC part programming:**	Lecture Hrs: 8

Introduction - The Bunch tape in NC - Tape code format - manual part programming. NC programming with manual data input.

UNIT - III	**Computer controls in NC and Group Technology**	Lecture Hrs: 8

Computer controls in NC: NC controllers' technology - Computer Numerical Control (CNC), Direct Numerical control (DNC).

Adaptive control machining systems. adaptive control optimization system, adaptive control constraint system, applications to machining processes, computer process monitoring, hierarchical structure of computers in manufacturing, and computer process control.

Group Technology: Part families, parts classification and coding, production flow analysis, Composite part concept, Machine cell design, benefits of GT.

UNIT - IV	**CAPP & FMS**	Lecture Hrs: 9

Computer aided planning systems: Approaches to Computer aided Process Planning (CAPP) - Generative and Retrieval CAPP systems, benefits of CAPP, Material Requirement Planning (MRP), mechanism of MRP, benefits, and Capacity Planning.

Flexible Manufacturing Systems: Components of FMS, FMS Work stations, Material Handling Systems, and Computer Control system, FMS layout configurations and benefits of FMS.

UNIT - V	**CAQC**	Lecture Hrs: 8

Computer Aided Quality Control.

Introduction, Total Quality Management (TQM), QC and CIM, Inspection and Testing, Statistical Process Control (SPC), Objectives of CAQC, Role of Computer in QC, Coordinate Measuring Machine, Non-Contact Inspection Methods, Post Process Metrology, Computer Aided Inspection Using Robots, Integrated Computer Aided Inspection Systems, Flexible Inspection System (FIS).

Textbooks:

1. Mikel P.Groover, Automation, Production systems and Computer Integrated Manufacturing Systems – Pearson Education; Fourth edition 2016.
2. Radhakrishnan and Subramanian, CAD/CAM/CIM, New Age Publishers, 2007.

Reference Books:

1. Mikell P.Groover, and Emory W.Zimmers.Jr., CAD/CAM - PHI Publishers, 1984.
2. K.Lalit Narayan, K.Mallikarjuna Rao, MMM Sarcar, Computer Aided Design and Manufacturing, PHI Publishers, 2008.

Online Learning Resources:

- https://en.wikipedia.org/wiki/Computer-integrated_manufacturing
- https://www.techopedia.com/definition/30965/computer-integrated-manufacturing-cim
- https://www.youtube.com/watch?v=_OaBMsUgqgQ
- https://www.youtube.com/watch?v=edplvB_Xvso
- https://nptel.ac.in/courses/112/104/112104289/
- https://www.youtube.com/watch?v=9fqygvj-O2s.

Course Code		GEOMETRIC MODELING	L	T	P	C
Semester	I	Professional Elective Course - I	3	0	0	3

Course Objectives:

- To Learn advanced concepts of feature based modeling and parametric modeling
- To understand the mathematical basis for geometric modeling of curves and surfaces and their relationship with computer graphics.
- To understand the methods of representation of wireframe, surface, and solid modeling systems.
- To Consider data associativity concepts of CAD/CAE integration; Be familiar with interoperability and data transfer techniques between design and analysis software systems.

Course Outcomes (CO): Student will be able to

Upon completing this course, the students will be able to:

- Represent curves and surfaces using parametric equations
- Define and relate the basic concepts, tools, and algorithms in geometric modeling and digital surface processing
- Critically analyze and assess current research on surface representations and geometric modeling with the intent to apply the proposed methods in your own work
- Define the methods of representation of wireframe, surface, and solid modeling systems.

UNIT - I	**Introduction:**	Lecture Hrs:8

Introduction: Definition, Explicit and implicit equations, parametric equations.

UNIT - II	**Cubic Splines:**	Lecture Hrs: 8

Cubic Splines: Algebraic and geometric form of cubic spline, tangent vectors, parametric space of a curve, blending functions, four point form, reparametrization, truncating and subdividing of curves, Graphic construction and interpretation, composite pc curves.

UNIT - III	**Bezier & B-Spline Curves**	Lecture Hrs: 8

Bezier Curves: Bernstein basis, equations of Bezier curves, properties, derivatives and related problems.

B-Spline Curves: B-Spline basis, equations, knot vectors, properties, derivatives and related problems.

UNIT - IV	**Surfaces:**	Lecture Hrs: 9

Surfaces: Bicubic surfaces, Coon's surfaces, Bezier surfaces, B-Spline surfaces, surfaces of revolutions, Sweep surfaces, ruled surfaces, tabulated cylinder, bilinear surfaces, triangular patches, sculptured surface and rational parametric surface.

UNIT - V	**Solids and Solid modeling concepts:**	Lecture Hrs: 8

Solids: Tricubic solid, Algebraic and geometric form.

Solid modeling concepts: Wire frames, Boundary representation, Half space modeling, spatial cell, Constructive Solid Geometry (CSG), Analytical Solid Modelling (ASM).

Textbooks:

1. Micheal E. Mortenson, Geometric Modeling, McGraw Hill Publishers, 2013.
2. Ibrahim Zeid, CAD/CAM: Theory and Practice, Tata McGraw Hill, 2010.
3. P. N. Rao, CAD/CAM principles and applications, 3-e, McGraw Hill Publishers, 2017.

Reference Books:

1. Rogoer's Adams, Elements of Computer Graphics, Tata McGraw Hill, 1990.
2. K.Lalit Narayan, K.Mallikarjuna Rao, MMM Sarcar, Computer Aided Design and Manufacturing, PHI Publishers, 2008.

Online Learning Resources:

- https://www.coursera.org/lecture/interactive-computer-graphics/3-4-flower-modeling-MrexG
- https://www.youtube.com/watch?v=0IgOapAtauM
- https://www.youtube.com/watch?v=tgbXCwjlcaE
- https://www.youtube.com/watch?v=CeOV_tVo970
- https://www.youtube.com/watch?v=hBJ4CLE8k1k
- https://nptel.ac.in/courses/112/102/112102101/

Course Code		DESIGN OF HYDRAULIC AND PNEUMATIC SYSTEMS Professional Elective Course – I	L	T	P	C
Semester	I		3	0	0	3

Course Objectives:

- To impart students on the science, use and application of hydraulics and pneumatics as fluid power in Industry.
- Also to impart knowledge on the methodology of basic and advanced design of pneumatics and hydraulics systems.

Course Outcomes (CO):

- It helps students to get knowledge on the need, use and application of fluid power and make them familiar to industrial design that lead to automation.

UNIT - I	**HYDRAULIC POWER GENERATORS & ACTUATORS**	Lecture Hrs: 8

Hydraulic Power Generators – Types, Selection and specification of pumps, pump characteristics. Actuators - Types, selection and specifications of actuators, characteristics of actuators.

UNIT - II	**CONTROL AND REGULATION ELEMENTS**	Lecture Hrs: 8

Pressure - direction and flow control valves - relief valves, non-return and safety valves - valve actuation systems.

UNIT - III	**HYDRAULIC CIRCUITS**	Lecture Hrs: 10

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**	Lecture Hrs: 10

Pneumatic fundamentals - control elements, position and pressure sensing - logic circuits - switching circuits - fringe conditions modules and these integration - sequential circuits - Design Methods: cascade method - mapping method - step counter method.

UNIT - V	**INSTALLATION, MAINTENANCE AND SPECIAL CIRCUITS**	Lecture Hrs: 8

Pneumatic equipments- selection of components - application - fault finding in fluid power systems - hydro pneumatic circuits - use of microprocessors for sequencing - PLC, Low cost automation - Robotic circuits.

Text Books:

1. Antony Espossito, “Fluid Power with Applications”, Prentice Hall, 1980.
2. Andrew Parr, “Hydraulic and Pneumatics” (HB), Jaico Publishing House, 1999.

Reference Books:

1. Dudleyt, A. Pease and John J. Pippenger, “Basic fluid power”, Prentice Hall, 1987.
2. Bolton. W., “Pneumatic and Hydraulic Systems “, Butterworth –Heinemann, 1997.
3. K.Shanmuga Sundaram, “Hydraulic and Pneumatic Controls: Understanding made Easy" S.Chand & Co Book publishers, New Delhi, 2006 (Reprint 2009).

Online Learning Resources:

- Chrome-extension://efaidnbmnnibpcaglefindmkaj/viewer.htms?pdfhrl https%3A%2%2Fwww.iare.ac.in%2Fsites%2Fdefault%2Ffiles%2FDHPS%2520LECTURER%2520NOTES%2520FINAL.pdf&chunk=true.
- chromeextension://efaidnbmnnnibpcajpcglclefindmkaj/viewer.html?pdfurl=https%3A%2F%2Fwww.iare.ac.in%2Fsites%2Fdefault%2Ffiles%2FDHPS%2520PPT%2520%2520FINAL.pdf&chunk=true.
- https://nptel.ac.in/courses/112/105/112105047/
-

Course Code		ADVANCES IN MANUFACTURING TECHNOLOGY Professional Elective Course - II	L	T	P	C
Semester	I		3	0	0	3

Course Objectives:

- Provide an integrated, effective and practical platform for create facilities for teaching, training and research & development work for post-graduate studies in various fields of manufacturing technology.
- Link up with national and international colleges/ universities of excellence to impart the education, maintain quality & content of curriculum and award degree certificates in post-Graduation / Doctorates.
- Provide facilities for international and national subject experts to stay, teach and conduct research projects / programmes on mutual exchange and recognition basis.

Course Outcomes (CO):

- Analyze technical problems, propose solutions and document with written and oral reports.
- Employ technology for communications, data collection, analysis, simulation and control.
- Use Basic Project management skills, project team work and ethical behavior.
- Machine variety materials using a conversational and CNC lathe, milling machine and grinder.
- Use the basic manufacturing methods, measurements, automation and quality control.

UNIT - I	**Surface Processing Operations**	Lecture Hrs: 10

Plating and Related Processes, Conversion Coatings, Physical Vapor Deposition, Chemical Vapor Deposition, Organic Coatings, Porcelain Enameling and other Ceramic coatings, Thermal and Mechanical Coating Processes.

UNIT - II	**Mechanical Energy Based NTM Process**	Lecture Hrs: 10

Elements of the process, mechanics of metal removal, process parameters, effect of process parameters on surface finish and metal removal rate, economic considerations, applications and limitations, recent developments in Abrasive Jet Machining, Water Jet Machining, Abrasive Water Jet Machining and Ultrasonic Machining.

UNIT - III	**Electro – Chemical Energy Based NTM Process**	Lecture Hrs: 8

Electro - Chemical Machining: Fundamentals of electro chemical machining, metal removal rate in ECM, Tool design, Surface finish and accuracy economics aspects of ECM.

Electro Discharge Machining: General Principle and applications of EDM, Mechanics of metal removal, Process parameters, selection of tool electrode and dielectric fluids, methods surface finish and machining accuracy, Wire EDM.

UNIT - IV	**Thermo Electric Based NTM**	Lecture Hrs: 8

Electron Beam Machining: Generation and control of electron beam for machining, theory of electron beam machining, principle, advantages, and limitations, comparison of thermal and non-thermal processes.

Plasma Arc Machining: Principle, machining parameters, effect of machining parameters on surface finish and metal removal rate, applications, limitations.

Laser Beam Machining: Principle, effect of machining parameters on surface finish, applications and limitations.

UNIT - V	**Additive Manufacturing**	Lecture Hrs: 8

Additive Manufacturing: Definition, Classification of AM Processes, Steps in AM Process, Fused Deposition Method, Steriolithography, Selective Laser sintering, Laminated Object Manufacturing, and 3D Printing – Working principle, applications and limitations.

Text Books:

1. V.K.Jain, Advanced Machining Processes - Allied Publishers Private Limited.
2. Mikell P. Groover, Fundamentals of Modern Manufacturing- John Wiley & Sons Publishers.
3. Serope Kalpakjian and Steven R.Schmid, Manufacturing Engineering and Technology – Pearson.
4. P.C Pandey and H.S Shan, Modern Machining Process- Tata McGraw - Hill Education, 1980.
5. T.Jagadeesha, Unconventional Machining Processes - I.K Publishers, 2016.
6. Gibson, I., Rosen, D.W. and Stucker, B., "Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010.

Reference Books:

1. P.N.Rao, Manufacturing Technology - McGraw Hill Education Private Limited.
2. Amitabha Ghosh, Asok Kumar Mallik,Manufacturing Science - East West press.

Online Learning Resources:

- https://nptel.ac.in/courses/112/107/112107078/
- https://youtu.be/t3y_Ys3LgGM
- https://www.youtube.com/watch?v=E4VZ_rFqpG4&t=1s
- https://youtu.be/-tcaR7oSx_w
- https://youtu.be/Uybg6VDLoRQ
- https://youtu.be/Uybg6VDLoRQ
- https://youtu.be/aWQsEX1TrSI

Course Code		TOTAL QUALITY MANAGEMENT	L	T	P	C
Semester	I	Professional Elective Course - II	3	0	0	3

Course Objectives:

- Introduce the students, the basic concepts of Total Quality Management.
- Expose with various quality issues in Inspection.
- Gain Knowledge on quality control and its applications to real time.
- Know the extent of customer satisfaction by the application of various quality concepts.
- Understand the importance of Quality standards in Production.

Course Outcomes (CO):

At the end of this course, the student will be able to

- Develop an understanding on quality Management philosophies and frameworks
- Adopt TQM methodologies for continuous improvement of quality
- Measure the cost of poor quality, process effectiveness and efficiency to identify areas for improvement
- Apply benchmarking and business process reengineering to improve management processes.
- Determine the set of indications to evaluate performance excellence of an organization.

UNIT - I	**Introduction**	Lecture Hrs: 10

Introduction: Definition of Quality, Dimensions of Quality, Definition of Total quality management, Quality Planning, Quality costs – Analysis, Techniques for Quality costs, Basic concepts of Total Quality Management.

UNIT - II	**Historical Review:**	Lecture Hrs:

Historical Review: Quality council, Quality statements, Strategic Planning, Deming Philosophy, Barriers of TQM Implementation, Benefits of TQM, Characteristics of successful quality leader, Contributions of Gurus of TQM, Case studies.

UNIT - III	**TQM Principles:**	Lecture Hrs:

TQM Principles: Customer Satisfaction – Customer Perception of Quality, Customer Complaints, Service Quality, Customer Retention, Employee Involvement – Motivation, Empowerment teams, Continuous Process Improvement – Juran Trilogy, PDSA Cycle, Kaizen, Supplier Partnership – Partnering, sourcing, Supplier Selection, Supplier Rating, Relationship Development, Performance Measures – Basic Concepts, Strategy, Performance Measure Case studies.

UNIT - IV	**TQM Tools:**	Lecture Hrs:

TQM Tools: Benchmarking – Reasons to Benchmark, Benchmarking Process, Quality Function Deployment (QFD) – House of Quality, QFD Process, Benefits, Taguchi Quality Loss Function, Total Productive Maintenance (TPM) – Concept, Improvement Needs, FMEA – Stages of FMEA, The seven tools of quality, Process capability, Concept of Six Sigma, New Seven management tools, Case studies.

UNIT - V	**Quality Systems:**	Lecture Hrs:

Quality Systems: Need for ISO 9000 and Other Quality Systems, ISO 9000: 2000 Quality System – Elements, Implementation of Quality System, Documentation, Quality Auditing, QS 9000, ISO 14000 – Concept, Requirements and Benefits, Case Studies.

Text Books:

1. Dale H Besterfield, Total Quality Management, Fourth Edition, Pearson Education, 2015.
2. Subburaj Ramaswamy, Total Quality Management, Tata Mcgraw Hill Publishing Company Ltd., 2005.

3. Joel E.Ross , Total Quality Management, Third Eition, CRC Press, 2017.

Reference Books:

1. Narayana V and Sreenivasan N.S, Quality Management – Concepts and Tasks, New Age International, 1996.
2. Robert L.Flood, Beyond TQM, First Edition, John Wiley & Sons Ltd, 1993.
3. Richard S. Leavenworth & Eugene Lodewick Grant, Statistical Quality Control, Seventh Edition, Tata Mcgraw Hill, 2015
4. Samuel Ho , TQM – An Integrated Approach, Kogan Page Ltd, USA, 1995.

Online Learning Resources:

- https://www.youtube.com/watch?v=VD6tXadibk0
- https://www.investopedia.com/terms/t/total-quality-management-tqm.asp
- https://blog.capterra.com/what-is-total-quality-management/
- https://nptel.ac.in/courses/110/104/110104080/
- https://onlinecourses.nptel.ac.in/noc21_mg03/preview
- https://nptel.ac.in/courses/110/104/110104085/
- https://nptel.ac.in/noc/courses/noc18/SEM2/noc18-mg39/

Course Code		COMPUTER AIDED PROCESS PLANNING	L	T	P	C
Semester	I	Professional Elective Course - II	3	0	0	3

Course Objectives:

After studying this unit, you should be able to understand what is process planning and CAPP,

- To know the various steps involved in CAPP.
- To classify the various methods of CAPP.
- To understand the feature recognition in CAP.
- Notable requirements for process planning systems are consistency, accuracy, and ease of application and completeness.

Course Outcomes (CO):

At the end of the course, the student will be able to

- Generate the structure of automated process planning system and uses the principle of generative and retrieval CAPP systems for automation.
- Select the manufacturing sequence and explains the reduction of total set up cost for a particular sequence.
- Predict the effect of machining parameters on production rate, cost and surface quality and determines the manufacturing tolerances.
- Explain the generation of tool path and solve optimization models of machining processes.

UNIT - I	**Introduction to CAPP**	Lecture Hrs: 9

Information requirement for process planning system, Role of process planning, advantages of conventional process planning over CAPP, Structure of Automated process planning system, feature recognition, methods.

Generative CAPP system: Importance, principle of Generative CAPP system, automation of logical decisions, Knowledge based systems, Inference Engine, implementation, benefits.

UNIT - II	**Retrieval CAPP system**	Lecture Hrs: 8

Significance, group technology, structure, relative advantages, implementation, and applications

Selection of manufacturing sequence: Significance, alternative manufacturing processes, reduction of total set-up cost for a particular sequence, quantitative methods for optimal selection, examples.

UNIT - III	**Determination of machining parameters**	Lecture Hrs: 10

reasons for optimal selection of machining parameters, effect of parameters on production rate, cost and surface quality, different approaches, advantages of mathematical approach over conventional approach, solving optimization models of machining processes.

Determination of manufacturing tolerances: design tolerances, manufacturing tolerances, methods of tolerance allocation, sequential approach**,** integration of design and manufacturing tolerances, advantages of integrated approach over sequential approach

UNIT - IV	**Generation of tool path**	Lecture Hrs: 8

Simulation of machining processes, NC tool path generation, graphical implementation, determination of optimal index positions for executing fixed sequence, quantitative methods.

UNIT - V	**Implementation techniques for CAPP**	Lecture Hrs: 8

MIPLAN system, Computer programming languages for CAPP, criteria for selecting a CAPP system and benefits of CAPP. Computer integrated planning systems, and Capacity planning system.

Text Books:

1. Mikel P.Groover, Automation, Production systems and Computer Integrated Manufacturing Systems – Pearson Education; Fourth edition 2016.
2. Dr.Sadhu Singh, Computer Aided Design and Manufacturing – Khanna Publishers, 1998.

Reference Books:

1. David Bedworth, "Computer integrated design and manufacturing" TMH.

2. K.Lalit Narayan, K.Mallikarjuna Rao, MMM Sarcar, Computer Aided Design and Manufacturing, PHI Publishers, 2008.
3. Radhakrishnan and Subramanian, CAD/CAM/CIM, New Age Publishers, 2007.

Online Learning Resources:

- https://nptel.ac.in/courses/112/104/112104188/
- https://www.youtube.com/watch?v=20_K7c65Swg
- https://www.youtube.com/watch?v=y24meNZbUoU
- https://youtu.be/PRjExZxWsNc
- https://nptel.ac.in/courses/103/103/103103164/

Course Code		GEOMETRIC MODELING LABORATORY	L	T	P	C
Semester	I		0	0	4	2

Course Objectives:

- To train the students with CAD packages.
- To impart the 2D and 3D modeling skills to the students.
- To import and export different IGES files from one software to another

Course Outcomes (CO):

- Students will be able to design different parts of mechanical equipments
- Students will be able to apply their skills in various designing and Manufacturing Industries.

List of Experiments:

1. Generation of the following curves using "C" language
   a) Cubic Splines
   b) Bezier curves
   c) B-Splines.
2. Generation of the following surfaces using "C" language
   a) Bezier surfaces
   b) B-Spline surfaces
3. Typical tasks of Modeling using PRO/E, IDEAS, CATIA solid modeling packages
   a) Sketcher Module
   b) Part Module
   c) Assembly Module
   d) Drafting Module
   e) Surface Modelling.

Course Code		FINITE ELEMENT ANALYSIS LABORATORY	L	T	P	C
Semester	I		0	0	4	2

Course Objectives:

- To use the commercial Finite Element packages to build Finite Element models and solve a selected range of engineering problems.
- To validate a Finite Element model using a range of techniques.
- To communicate effectively in writing to report (both textually and graphically) the method used, the implementation and the numerical results obtained.
- To discuss the accuracy of the Finite Element solutions.

Course Outcomes (CO):

- Ability to solve engineering problems using the commercial software's like ANSYS, SIMUFACT, ABAQUS, SIMULIA, MAT LAB.

List of Experiments:

Finite Element Analysis using ANSYS 14.5 Package for different structures the discretization can be done with 1-D, 2-D & 3-D elements to perform the following analysis:

1. **Static Analysis**
   - **a.** Stress analysis of 2D truss.
   - **b.** Stress analysis of a plate with a circular hole and L-Bracket – 2D and 3D
   - **c.** Stress analysis of beams (cantilever, simply supported & fixed ends)
   - **d.** Stress analysis of an axi-symmetric component
2. **Thermal and Fluid flow Analysis**
   - **a.** Conductive heat transfer analysis of a 2D and 3D components
   - **b.** Convective heat transfer analysis of a 2D component
   - **c.** Coupled field analysis of a component
   - **d.** Determination of velocity of a fluid and volumetric flow rates for 1-D Fluid flow
   - **e.** Determination of velocity of a fluid and volumetric flow rates for 2-D Fluid flow
3. **Modal Analysis**
   - **a.** mode frequency analysis of a 2D component
   - **b.** mode frequency analysis of beams (cantilever, simply supported, fixed ends)
4. **Transient analysis**
   - a. Transient analysis of a cantilever beam
5. **FEM through MAT LAB**
   - **a.** Introduction to MAT LAB
   - **b.** Analysis of 1-dimesional & 2D dimensional truss.
   - **c.** Analysis of 1-dimesional & 2D dimensional beam.
   - **d.** Analysis of 1-dimesional & 2D dimensional heat conduction.

Course Code		RESEARCH METHODOLOGY AND IPR (Mandatory Course)	L	T	P	C
Semester	I		2	0	0	2

Course Objectives:

- To give an overview of the research methodology and explain the technique of defining a research problem
- To explain the functions of the literature review in research.
- To explain carrying out a literature search, its review, developing theoretical and conceptual frameworks and writing a review.
- To explain the art of interpretation and the art of writing research reports.
- To explain various forms of the intellectual property, its relevance and business impact in the changing global business environment.

Course Outcomes (CO):

At the end of the course, the student will be able to

- Understand the meaning of research and various methods of research.
- Select the area of research by studying the literature.
- Understand the concepts of Testing of Hypotheses and Interpretation and Report Writing.

UNIT - I	**RESEARCH FORMULATION AND DESIGN**	Lecture Hrs: 11

Motivation and objectives – Research methods vs. Methodology. Types of research – Descriptive Vs Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical, concept of applied and basic research process, criteria of good research. Defining and formulating the research problem, selecting the problem, necessity of defining the problem, importance of literature review in defining a problem, literature review-primary and secondary sources, reviews, monograph, patents, research databases, web as a source, searching the web, critical literature review, identifying gap areas from literature and research database, development of working hypothesis.

UNIT - II	**DATA COLLECTION AND ANALYSIS**	Lecture Hrs: 10

Accepts of method validation, observation and collection of data, methods of data collection, sampling methods, data processing and analysis strategies and tools, data analysis with statically Package (Sigma STAT,SPSS for student t-test, ANOVA, etc.), hypothesis testing.

UNIT - III	**INTERPRETATION AND REPORT WRITING**	Lecture Hrs: 8

Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports, Conclusions.

UNIT - IV	**RESEARCH ETHICS, IPR AND SCHOLARY PUBLISHING**	Lecture Hrs: 8

Ethics-ethical issues, ethical committees (human & animal); IPR- intellectual property rights and patent law, commercialization, copy right, royalty, trade related aspects of intellectual property rights (TRIPS); scholarly publishing- IMRAD concept and design of research paper, Citation and acknowledgement, plagiarism, reproducibility and accountability.

UNIT - V	**PATENTS RIGHTS & NEW DEVELOPMENTS IN IPR**	Lecture Hrs: 8

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. 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. C.R. Kothari, Gaurav Garg, Research Methodology: Methods and Techniques New Age International 4th Edition, 2018.
2. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science

& engineering student.
3. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology Publications. 2 volumes.

Reference Books:

1. Research Methods: the concise knowledge base Trochim Atomic Dog Publishing 2005.
2. Conducting Research Literature Reviews: From the Internet to Paper Fink A Sage Publications 2009.

Online Learning Resources:

- https://nptel.ac.in/courses/121/106/121106007/
- https://www.youtube.com/watch?v=sI3pUyDUQVg
- https://www.youtube.com/watch?v=GSeeyJVD0JU
- https://www.youtube.com/watch?v=EVcPmmfK1Do

Course Code		ADVANCED OPTIMIZATION TECHNIQUES	L	T	P	C
Semester	II		3	0	0	3

Course Objectives:

- To understand the theory of optimization methods and algorithms developed for solving various types of optimization problems.
- To develop and promote research interest in applying optimization techniques in problems of Engineering and Technology.
- To apply the mathematical results and numerical techniques of optimization theory to concrete Engineering problems.

Course Outcomes (CO):

Student will be able to

- Understand importance of optimization of industrial process management.
- Apply basic concepts of mathematics to formulate an optimization problem.
- Analyse and appreciate variety of performance measures for various optimization problems.

UNIT - I	**Linear programming & Assignment problem**	Lecture Hrs: 8

Linear programming : Two-phase simplex method, Big-M method, duality, interpretation, applications.

Assignment problem: Hungarian's algorithm, Degeneracy, applications, unbalanced problems, traveling salesman problem.

UNIT - II	**Classical optimization techniques**	Lecture Hrs: 10

Single variable optimization with and without constraints, multi – variable optimization without constraints, multi – variable optimization with constraints – method of Lagrange multipliers, Kuhn-Tucker conditions.

UNIT - III	**Numerical methods for optimization**	Lecture Hrs: 10

Nelder Mead's Simplex search method, Gradient of a function, Steepest descent method, Newton's method, types of penalty methods for handling constraints.

UNIT - IV	**Genetic algorithm (GA)**	Lecture Hrs: 8

Differences and similarities between conventional and evolutionary algorithms, working principle, reproduction, crossover, mutation, termination criteria, different reproduction and crossover operators, GA for constrained optimization, draw backs of GA,

Genetic Programming (GP): Principles of genetic programming, terminal sets, functional sets, differences between GA & GP, random population generation, solving differential equations using GP.

UNIT - V	**Multi-Objective GA:**	Lecture Hrs: 10

Pareto's analysis, Non-dominated front, multi – objective GA, Non-dominated sorted GA, convergence criterion, applications of multi-objective problems .

Applications of Optimization in Design and Manufacturing systems: Some typical applications like optimization of path synthesis of a four-bar mechanism, minimization of weight of a cantilever beam, optimization of springs and gears, general optimization model of a machining process, optimization of arc welding parameters, and general procedure in optimizing machining operations sequence.

Text Books:

1. Jasbir Arora, Introduction to Optimal design – 4-e, Academic Press, 2011.
2. Kalyanmoy Deb, Optimization for Engineering Design: Algorithms and examples–PHI Publishers, 2012.
3. S.S.Rao, Engineering Optimization: Theory and practice –New Age Publishers, 2000.

Reference Books:

1. D.E.Goldberg, Addison, Genetic algorithms in Search, Optimization, and Machine

learning, Wesley Publishers, 1989.
2. John R Koza, Genetic Programming II – Automatic Discovery of Reusable Programs, MIT Press, 1994.
3. Multi objective Genetic algorithms - Kalyanmoy Deb, PHI Publishers.
4. S. Rajasekaran & GA Vijayalakshmi Pai "Neural Networks, Fuzzy Logic, and Genetic Algorithms synthesis and application", PHI

Online Learning Resources:

- https://www.youtube.com/watch?v=eo2tOPV3AoE
- https://www.youtube.com/watch?v=4t3z8y4CAcs
- https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-0002-introduction-to-computational-thinking-and-data-science-fall-2016/lecture-videos/lecture-1-introduction-and-optimization-problems/
- https://ocw.mit.edu/courses/sloan-school-of-management/15-093j-optimization-methods-fall-2009/lecture-notes/
- https://web.eng.fiu.edu/arleon/courses/Optimization/Lectures/Classical_Optimization.pdf
- https://nptel.ac.in/content/storage2/courses/105108127/pdf/Module_1/M1L4_LN.pdf
- https://www.iare.ac.in/sites/default/files/OT%20Complete%20Notes_1.pdf

Course Code		INDUSTRIAL ROBOTICS & EXPERT SYSTEMS	L	T	P	C
Semester	II		3	0	0	3

Course Objectives:

- To teach students the basics of robotics, construction features, sensor applications, robot cell design, robot programming and application of artificial intelligence and expert systems in robotics.

Course Outcomes (CO): Student will be able to

- Students are to the basics kinematics of robotics, and are able to understand the robot programming and also artificial intelligence and expert systems in robotics.

UNIT - I	**INTRODUCTION AND ROBOT KINEMATICS**	Lecture Hrs: 10

Definition need and scope of Industrial robots – Robot anatomy – Work volume – Precision movement – End effectors – Sensors. Robot Kinematics – Direct and inverse kinematics – Robot trajectories – Control of robot manipulators – Robot dynamics – Methods for orientation and location of objects.

UNIT - II	**ROBOT DRIVES AND CONTROL**	Lecture Hrs: 10

Controlling the Robot motion – Position and velocity sensing devices – Design of drive systems – Hydraulic and Pneumatic drives – Linear and rotary actuators and control valves – Electro hydraulic servo valves, electric drives – Motors – Designing of end effectors – Vacuum, magnetic and air operated grippers.

UNIT - III	Robotic vision	Lecture Hrs: 8

Robotic vision system – Image Representation - Image Grabbing –Image processing and analysis – Edge Enhancement – Contrast Stretching – Band Rationing - Image segmentation – Pattern recognition – Training of vision system.

UNIT - IV	**ROBOT CELL DESIGN AND Programming**	Lecture Hrs: 8

Robot work cell design and control – Safety in Robotics – Robot cell layouts – Multiple Robots and machine interference – Robot cycle time analysis. Methods of Robot Programming – Characteristics of task level languages lead through programming methods – Motion interpolation.

UNIT - V	**ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS**	Lecture Hrs: 8

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. K.S. Fu, R.C. Gonzalez and C.S.G. Lee, "Robotics Control, Sensing, Vision and Intelligence", Mc Graw Hill, 1987.
2. Yoram Koren," Robotics for Engineers' Mc Graw-Hill, 1987.

Reference Books:

1. Timothy Jordanides et al ,"Expert Systems and Robotics ", Springer –Verlag, New York,
2. Kozyrey, Yu. "Industrial Robots", MIR Publishers Moscow, 1985.
3. Richard. D, Klafter, Thomas, A, Chmielewski, Michael Negin, "Robotics Engineering – An Integrated Approach", Prentice-Hall of India Pvt. Ltd., 1984.
4. Deb, S.R." Robotics Technology and Flexible Automation", Tata Mc Graw-Hill, 1994.
5. Mikell, P. Groover, Mitchell Weis, Roger, N. Nagel, Nicholas G. Odrey," Industrial Robotics Technology, Programming and Applications", Mc Graw-Hill, Int. 1986.
6. May 1991.

Online Learning Resources:

- https://freevideolectures.com/course/4560/nptel-mechanism-robot-kinematics
- https://see.stanford.edu/course/cs223a
- https://cosmolearning.org/courses/introduction-to-robotics/video-lectures/

- https://www.youtube.com/watch?v=0yD3uBshJB0
- https://nptel.ac.in/courses/112/105/112105236/
- https://www.youtube.com/watch?v=xrwz9IxpMJg
- https://www.coursehero.com/file/59785981/Lecture-9-Robot-cell-designppt/
- https://www.plantautomation-technology.com/articles/different-types-of-robot-programming-languages

Course Code		CNC TECHNOLOGY & PROGRAMMING	L	T	P	C
Semester	II	Professional Elective Course - III	3	0	0	3

Course Objectives:

To study

- Safety in the CNC environment
- CNC Machine Tools compared to Manual Machine tools
- Repeatability and Speed is the Key to CNC C. Programming
- Manual Programming
- CAD/CAM Programming CNC Lathe 1. Uses 2. Setups 3. Tooling 4. CNC Lathe Project
- CNC Mill a. Uses b. Setups c. Tooling d. CNC Mill Project Course Topic

Course Outcomes (CO): Student will be able to

Upon completion of this course, the student will be able to:

- Understand the basic procedures and concepts of programming, set up and operation of a CNC Machining Center.
- Identify and understand the basic programming codes.
- Create geometry and toolpaths from the specifications on a blueprint for simple parts using Mastercam programming software.
- Identify and define the functions of the CNC machine control.
- Set up the CNC machining center for manufacturing simple parts.
- Manufacture simple parts on the CNC machining center.

UNIT - I	**Introduction to CNC Machine tools**	Lecture Hrs: 10

Evolution of Computerized control in manufacturing, Components, Working principle of CNC, DNC and Machining centers.

Constructional features of CNC machine tools: Introduction, Spindle drives, Transmission belting, axes feed drives, Slide ways, Ball bearing screws.

Accessories: Work tables, Spindles, Spindle heads, Beds and Columns, Tooling – Automatic Tool changer (ATC).

UNIT - II	**Feedback devices**	Lecture Hrs: 10

Introduction, Digital incremental displacement measuring systems, encoders, Moire fringes, Digital absolute measuring system.

Electro-magnetic analogue position transducers: Principle, advantages, characteristics, Synchros, Synchro-Resolvers, Inductors, Laser interferometer.

UNIT - III	**Control Systems and interface**	Lecture Hrs: 8

Open and closed loop systems, Micro processor based CNC systems, block diagram of typical CNC system, description of hard ware and interpolation systems, Standard and optional features of CNC control systems.

UNIT - IV	**Manual and APT programming**	Lecture Hrs: 8

APT language structure, APT geometry, Definition of point, time, vector, circle, plane, patterns and matrices. APT motion commands: setup commands, point-to point motion commands, continuous path motion commands, post processor commands, control commands, Macro subroutines, Part programming preparation for typical examples.

UNIT - V	**Economics and Maintenance of CNC machine tools**	Lecture Hrs: 8

Introduction, factors influencing selection of CNC machines, Cost of operation of CNC machines, Maintenance features of CNC machines, Preventive maintenance, Documentation, Spare parts, Training in Maintenance.

Text Books:

1. Dr.Radha Krishnanan, Computer Numerical Control Machines – New Age International Pvt Ltd; 1-e, 2018.

2. Hans B. Kief and Frederick Waters, T., Computer Numerical Control - A CNC Reference Guide, Macmillan / McGraw-Hill. New York. 1992.

Reference Books:

1. C.Elanchezhian and T.Sundar Selwyn, Computer Aided Manufacturing, University Science Press.
2. Y.Koren – Computer Control of Manufacturing systems - Khanna publications
3. Chao-HWA Chang Michel A Melkanoff, NC machine programming and software design - Prentice Hall.
4. B.S. Aditahn and Pabla, CNC Machines, New Age; 3-e, 2018.

Online Learning Resources:

- https://nptel.ac.in/courses/112/105/112105211/
- https://academy.titansofcnc.com/files/Fundamentals_of_CNC_Machining.pdf http://home.iitk.ac.in/~nsinha/CNC.pdf
- https://www.thomasnet.com/articles/custom-manufacturing-fabricating/understanding-cnc-machining/
- https://www.hubs.com/knowledge-base/cnc-machining-manufacturing-technology-explained/
- https://www.youtube.com/watch?v=P0BvBbQoiok
- https://www.youtube.com/watch?v=bfTQVixviAo
- https://en.wikipedia.org/wiki/APT_(programming_language)

Course Code		INTERACTIVE COMPUTER GRAPHICS	L	T	P	C
Semester	II	Professional Elective Course - III	3	0	0	3

Course Objectives:

- The students can understand the Basics of computer Graphics like drawing line, arc etc.,
- Drawing of spline curves ,Creation of surfaces, Algorithms for 3D viewing, Available drawing standards.

Course Outcomes (CO): Student will be able to

The students can understand the following

- Basics of computer Graphics like drawing line, arc etc.
- Drawing of spline curves
- Creation of surfaces
- Algorithms for 3D viewing
- Available drawing standards
- Basics of computer Graphics like drawing line, arc etc.

UNIT - I	**Introduction to computer graphics**	Lecture Hrs: 10

Color CRT raster scan monitors, plasma display & liquid crystal display monitors, computer input devices, hard copy devices.

Raster scan graphics: Line drawing algorithms – DDA & Bresenham algorithms, circle generation, general function rasterization, displaying lines, characters and polygons.

UNIT - II	**Filling algorithms**	Lecture Hrs: 8

polygon filling, edge fill algorithm, seed fill algorithm, fundamentals of antialiasing and half toning.

UNIT - III	**Line CLIPPING**	Lecture Hrs: 8

Simple visibility algorithm, Cohen-Sutherland subdivision line clipping algorithm, midpoint sub division algorithm.

Polygon clipping: polygon clipping, reentrant polygon clipping – Sutherland – Hodgeman algorithm, character clipping, 3D- clipping.

UNIT - IV	**Transformations**	Lecture Hrs: 8

Cartesian and homogeneous coordinate systems two dimensional and three dimensional transformations – scaling, rotation, Shearing, Zooming, viewing transformation, reflection, rotation about an axis, concatenation.

UNIT - V	**Rendering**	Lecture Hrs: 8

Hidden line removal algorithms, surface removal algorithms, painters, Warnock, Z-buffer algorithm.

Shading algorithms: Constant intensity algorithm, Phong's shading algorithm, gourand shading algorithm, Comparison of shading algorithms.

Text Books:

1. Donald Hearn & M.P. Bakers, Computer Graphics, Prentice-Hall; 2-e.1994.
2. D. F. Rogers, Procedural elements for computer graphics- Tata McGraw-Hill.

Reference Books:

1. William Newman & Robert Sproull, Interactive computer graphics, McGraw Hill Education, 2001.
2. Steven Harrington, Computer graphics-Harrington, McGraw-Hill Inc.,US;2-e,1983.
3. CAD/CAM theory and practice, Ibrahim Zeid, 2nd edition, Tata McGraw-Hill.

Online Learning Resources:

- https://lecturenotes.in/subject/59/computer-graphics-cg
- https://www.dgp.toronto.edu/~hertzman/418notes.pdf
- http://www2.cs.uidaho.edu/~jeffery/courses/324/lecture.html
- http://personal.ee.surrey.ac.uk/Personal/J.Collomosse/pubs/cm20219.pdf
- http://www.svecw.edu.in/Docs%5CCSECGLNotes2013.pdf

- https://www.youtube.com/watch?v=fwzYuhduME4
- https://nptel.ac.in/courses/106/103/106103224/
- https://nptel.ac.in/courses/106/102/106102065/

Course Code		ADVANCED COMPOSITE MATERIALS	L	T	P	C
Semester	II	Professional Elective Course - III	3	0	0	3

Course Objectives:

- Introduce modern composite materials and their applications to students.
- Build proper background for stress and strength analysis in the design of composite materials and structures.

Course Outcomes (CO): Student will be able to

After completion of the course student can be able to**:**

- Understanding of types, manufacturing processes, and applications of composite materials.
- Understanding the theory behind Biocomposites.

UNIT - I	**INTRODUCTION TO COMPOSITES**	Lecture Hrs: 10

Fundamentals of composites – Definition – classification of composites materials – based on Matrix – based on structure – Advantages and applications of composites - Reinforcement – whiskers – glass fiber – carbon fiber - Aramid fiber – ceramic fiber – Properties and applications. Testing of composites

UNIT - II	**POLYMER MATRIX COMPOSITES**	Lecture Hrs: 8

Polymers - Polymer matrix materials – PMC processes - hand layup processes – spray up processes – resin transfer moulding – Pultrusion – Filament winding – Auto clave based methods - Injection moulding – sheet moulding compound – properties and applications of PMCs.

UNIT - III	**METAL MATRIX COMPOSITES**	Lecture Hrs: 8

Metals - types of metal matrix composites – Metallic Matrices. Processing of MMC – Liquid state processes – solid state processes – Insitu processes. Properties and applications of MMCs.

UNIT - IV	**CERAMIC MATRIX COMPOSITES**	Lecture Hrs: 8

Ceramic matrix materials – properties – processing of CMCs –Sintering - Hot pressing – Infiltration – Lanxide process – Insitu chemical reaction techniques – solgel polymer pyrolsis – SHS - Cold isostatic pressing (CIPing) – Hot isostatic pressing(HIPing). Properties and Applications of CCMs.

UNIT - V	**ADVANCES IN COMPOSITES**	Lecture Hrs: 8

Carbon /carbon composites: Advantages of carbon matrix – limitations of carbon matrix carbon fibre – chemical vapour deposition of carbon on carbon fibre perform. Properties and applications of Carbon-carbon composites. Composites for aerospace applications.

Biodegradable composites: Biodegradability, introduction of biocomposites, classification, processing of biocomposites, applications of biocomposites - Mechanical, Biomedical, automobile Engineering.

Text Books:

1. "Composite materials", Chawla K.K., Springer – Verlag, Second Edition, 1998.
2. "Composite Materials: Engineering and Science", Mathews F.L. and Rawlings R.D., Chapman and Hall, London, England, 1st edition, 1994.

Reference Books:

1. "Composite Materials"., H K Shivanand, B V Babu Kiran, ASIAN BOOKS, 2011
2. "Fundamentals of Composite Manufacturing", A.B. Strong, SME, 1989.
3. "Composite materials", S.C. Sharma, Narosa Publications, 2000.
4. "Hand Book of Bioplastics & Biocomposites for Engineering applications", Maureen Mitton, John Wiley publications.

Online Learning Resources:

- https://www.youtube.com/watch?v=0kB0G6WKhKE
- https://www.youtube.com/watch?v=3JpXWhHdsdM
- https://www.youtube.com/watch?v=NQfirJs4m1M
- https://nptel.ac.in/courses/101/104/101104010/
- https://nptel.ac.in/courses/112/104/112104168/

Course Code		ADVANCED MECHANISM DESIGN	L	T	P	C
Semester	II	Program Elective Course - III	3	0	0	3

Course Objectives:

- At the end of this course the students would have developed a thorough understanding of the principle methods, areas of usage, possibilities and limitations as well as environmental effects of the advanced mechanism design.

Course Outcomes (CO): Student will be able to

- Compute mobility and motion parameters
- Apply Hall and Ault‟s method, Goodman‟s indirect method and Chase solution, explain instant center of acceleration; apply Euler- Savory equation and Bobillier construction
- Design two- , and three- position synthesis; apply Chebychev spacing; describe cognate linkages
- Analyze forces on static and dynamic mechanisms
- Analyze RSSR mechanism; apply D–H notation; contrast forward and inverse kinematics

UNIT - I	**Introduction**	Lecture Hrs: 10

Introduction – review of fundamentals of kinematics - analysis and synthesis – terminology, definitions and assumptions – planar, spherical and spatial mechanisms‟ mobility – classification of mechanisms – kinematic Inversion – Grashoff`s law Position and displacement – complex algebra solutions of planar vector equations – coupler curve generation velocity – analytical methods - vector method – complex algebra methods – Freudenstein‟s theorem.

UNIT - II	Planar complex mechanisms	Lecture Hrs: 8

Planar complex mechanisms - kinematic analysis - low degree complexity and high degree complexity, Hall and Ault`s auxiliary point method – Goodman‟s indirect method for low degree of complexity Mechanisms Acceleration – analytical methods – Chase solution - Instant centre of acceleration. Euler-Savory equation - Bobillier construction

UNIT - III	Synthesis of mechanisms	Lecture Hrs: 8

Synthesis of mechanisms: Type, number and dimensional synthesis – function generation – two position synthesis of slider crank and crank rocker mechanisms with optimum transmission angle – three position synthesis – structural error – Chebychev spacing - Cognate linkages – Robert-Chebychev theorem – Block‟s method of synthesis, Freudenstein‟s equation.

UNIT - IV	Static force analysis of planar	Lecture Hrs: 8

Static force analysis of planar mechanism – static force analysis of planar mechanism with friction – method of virtual work Dynamic force analysis of planar mechanisms - Combined static and inertia force analysis.

UNIT - V	Kinematic analysis	Lecture Hrs: 8

Kinematic analysis of spatial revolute-Spherical-Spherical-Revolute mechanism – Denavit-Hartenberg parameters – forward and inverse kinematics of robotic manipulators.

Text Books:

1. Amitabh Ghosh and Ashok Kumar Mallik, “Theory of Mechanisms and Machines,”,3e,EWP, 1999.
2. Shighley Joseph Edwards and Uicker John Joseph, “Theory of Machines and Mechanism”, 2e, McGraw Hill,1985.

Reference Books:

1. Arthur G. Erdman and G.N. Sandor, “Advanced Mechanism Design: Analysis and Synthesis”, Vol. I, PHI, 1984.
2. Arthur G. Erdman and G.N. Sandor, “Advanced Mechanism Design: Analysis and Synthesis”, Vol. II, PHI, 1984.

Course Code		MECHATRONICS & MEMS	L	T	P	C
Semester	II	Program Elective Course - IV	3	0	0	3

Course Objectives:

The general objectives of the course are to enable the students to

- Familiarize the technologies behind modern mechatronic systems.
- Explain fundamentals for the development of fully automated system.
- Develop a robotic or automated systems focusing on the hardware and software integration.
- Demonstrate the development of mechatronic system and MEMS.

Course Outcomes (CO):

Upon successful completion of this unit, the student will be able to:

- Define the discipline of mechatronics.
- Identify examples of mechatronic systems that are encountered in real life.
- Identify the components of a typical mechatronic system.

UNIT - I	**INTRODUCTION**	Lecture Hrs: 10

Definition of Mechatronics, Need for Mechatronics in Industry, Objectives of mechatronics, mechatronics design process, Mechatronics key elements, mechatronics applications – Computer numerical control (CNC) machines, Tool monitoring systems, Flexible manufacturing system (FMS), Industrial Robots, Automatic packaging systems, Automatic inspection systems.

UNIT - II	**SENSORS**	Lecture Hrs: 8

Static characteristics of sensors, Selection criteria for sensors, Displacement, Position and Proximity Sensors, Force and torque sensors, Pressure sensors, Flow sensors, Temperature sensors, Acceleration sensors, Level sensors, Light sensors, Smart material sensors, Micro and Nano sensors.

UNIT - III	**Actuators**	Lecture Hrs: 8

Mechanical, Electrical, Hydraulic and Pneumatic Actuation systems, Characteristics and their limitations, Selection criteria for actuators, Design of Hydraulic and Pneumatic circuits, Piezoelectric actuators, Shape memory alloys,

UNIT - IV	**Microprocessors, Microcontrollers and Programmable Logic Controllers:**	Lecture Hrs: 8

Architecture of Microprocessor, Microcontroller and Programmable Logic Controller, PLC Programming using ladder diagrams, logics, latching, sequencing, timers relays and counters, data handling, Analog input/output, selection of controllers.

UNIT - V	**Micro Electro Mechanical Systems (MEMS):**	Lecture Hrs: 8

History, Effect of scaling, Fabrication Techniques: Oxidation, Physical Vapor disposition, Chemical Vapor Deposition, Lithography, Etching, Wafer bonding, LIGA, DRIE, Applications.

Text Books:

1. Michael B.Histand and David G. Alciatore, " Introduction to Mechatronics and Measurement Systems", McGraw-Hill International Editions, 1999.
2. Bradley, D.A., Dawson, D, Buru, N.C. and Loader, AJ, "Mechatronics ", Chapman and Hall, 1993.
3. Ramesh.S, Gaonkar, "Microprocessor Architecture, Programming and Applications" Wiley Eastern, 1998.

Reference Books:

1. Lawrence J.Kamm, " Understanding Electro-Mechanical Engineering, An Introduction to Mechatronics ", Prentice-Hall, 2000.
2. Ghosh, P.K. and Sridhar, P.R., 0000 to 8085, "Introduction to Microprocessors for Engineers and Scientists ", Second Edition, Prentice Hall, 1995.
3. W. Bolton, Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, Pearson Education; 4th edition, 2010.

Online Learning Resources:

- https://www.cet.edu.in/noticefiles/259_Lecturer%20Note%20on%20Mechatronics-ilovepdf-compressed.pdf
- https://lecturenotes.in/subject/137/mechatronics-mech
- http://engineering.nyu.edu/mechatronics/Control_Lab/Criag/Craig_RPI/2001/Mechatronics%20Lecture%20Notes.htm
- https://jcboseust.ac.in/mechanical/images/mtech1stsem/mechatronics_product_design.pdf
- https://www.youtube.com/watch?v=tAkkUNEknGk
- https://nptel.ac.in/courses/112/107/112107298/
- https://www.youtube.com/watch?v=ncSnIkBO-X0

Course Code		ADDITIVE MANUFACTURING	L	T	P	C
Semester	II	Program Elective Course - IV	3	0	0	3

Course Objectives:

- At the end of this course the students would have developed a thorough understanding of the principle methods, areas of usage, possibilities and limitations as well as environmental effects of the Rapid Prototyping Technologies.

Course Outcomes (CO): Student will be able to

- It helps the students to get familiarized with the various methods of rapid prototyping technologies and rapid tooling.

UNIT - I	**Introduction**	Lecture Hrs: 10

Introduction: 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. Role of AM in Industry 4.0.

UNIT - II	**Vat Photopolymerization, Material jetting and extrusion**	Lecture Hrs: 8

Working principle,Specifications, Materials used, Process, Applications, Advantages and Disadvantages, Case studies of the following AM Technologies

Vat Photopolymerization AM Systems: Photopolymers, photo polymerization Stereo lithography Apparatus (SLA), Direct Light Processing (DLP) and Continuous Direct Light Processing (CDLP).

Material Jetting AM Systems: Material Jetting, Nano particle jetting and Drop-On-Demand (DOD) material jetting **Binder Jetting AM Systems:** Three dimensional Printing (3DP).

Material Extrusion AM Systems: Fused Deposition Modeling (FDM)

UNIT - III	**Deposition methods.**	Lecture Hrs: 8

Working principle, Specifications, Materials used, Process, Applications, Advantages and Disadvantages, Case studies of the following AM Technologies

Powder Bed Fusion AM Systems: Selective laser sintering (SLS), Selective Laser Melting (SLM) and Direct Metal Laser Sintering (DMLS), Electron Beam Melting (EBM).

Direct Energy Deposition (DED) AM Systems: Laser Engineered Net Shaping (LENS) and Electron Beam Additive Manufacturing (EBAM).

Sheet Lamination AM Systems: Laminated Object Manufacturing (LOM) and Ultrasonic Additive Manufacturing (UAM).

Rapid Tooling: Introduction to Rapid Tooling (RT), Conventional Tooling Vs RT, Need for RT, Classification of Rapid Tooling, Direct and Indirect Tooling Methods, Soft and Hard Tooling methods.

UNIT - IV	**Reengineering, data formats and software's**	Lecture Hrs: 8

Reengineering in AM: Reengineering Engineering (RE) Methodologies and Techniques, Selection of RE systems, RE software, RE hardware, RE in product development

AM Data Formats: STL Format, STL File Problems, Consequence of Building Valid and Invalid Tessellated Models, STL file Repairs: Generic Solution, Slicing Algorithms: Rock Algorithm, Crawford's algorithm, Other Translators, Newly Proposed Formats. Mesh Refining by Sub division Techniques, Topology optimization and Additive Manufacturing.

AM Software's: Need for AM software, Features of various AM software's like Magics, Mimics, Solid View, View Expert, 3 D View, Velocity 2, Rhino, STL View 3 Data Expert and 3 D doctor, SurgiGuide, 3-matic, Simplant, MeshLab.

UNIT - V	**AM applications and cost estimation in AM**	Lecture Hrs: 8

AM Applications: Application – Material Relationship, Application in Design, Engineering Analysis and Planning, Aerospace, Automotive, Jewelry, Coin, GIS, Arts, Architecture. Medical and

Bioengineering Applications, Forensic Science and Anthropology, Visualization of Biomolecules.
Cost Estimation in AM: Cost Model, Build Time Model, Laser Scanning Vat Photopolymerization Example, Life-Cycle Costing.

Text Books:

1. Chee Kai Chua and Kah Fai Leong, "3D Printing and Additive Manufacturing Principles and Applications" Fifth Edition, World Scientific Publications, 2017
2. Ian Gibson, David W Rosen, Brent Stucker, "Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing", Springer, Second Edition, 2010.

Reference Books:

1. Frank W.Liou, "Rapid Prototyping & Engineering Applications", CRC Press, Taylor & Francis Group, 2011.
2. RafiqNoorani, **"**Rapid Prototyping: Principles and Applications in Manufacturing", John Wiley &Sons, 2006.

Online Learning Resources:

- NPTEL Course on Rapid Manufacturing. https://nptel.ac.in/courses/112/104/112104265/
- https://www.hubs.com/knowledge-base/introduction-fdm-3d-printing/
- https://slideplayer.com/slide/6927137/
- https://www.mdpi.com/2073-4360/12/6/1334
- https://www.centropiaggio.unipi.it/sites/default/files/course/material/2013-11-29%20-%20FDM.pdf
- https://lecturenotes.in/subject/197
- https://www.cet.edu.in/noticefiles/258_Lecture%20Notes%20on%20RP-ilovepdf-compressed.pdf
- https://www.vssut.ac.in/lecture_notes/lecture1517967201.pdf
- https://www.youtube.com/watch?v=NkC8TNts4B4

Course Code		DESIGN AND ANALYSIS OF EXPERIMENTS	L	T	P	C
Semester	II	Program Elective Course - IV	3	0	0	3

Course Objectives:

- To know the importance of quality in manufacturing industries.
- To understand the steps involved in Design of Experiments and ANOVA.
- To know how to apply ANOVA & DOE to develop a new manufacturing process.
- To know about the different standardization methods for manufacturing.
- To Understand and apply the principles of math, science, and engineering in design and manufacturing related activities.

Course Outcomes (CO):

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

- Understanding of time and motion study, work sampling, and process flow charting
- Critically observe manufacturing operations.
- Produce short technical reports individually and in teams.
- Contribute to the profitable growth of manufacturing businesses.
- Maintain high standards of professional and ethical responsibility.

UNIT - I	**Introduction**	Lecture Hrs: 8

Design of Experiments: Introduction, Task aids and Responsibilities for DOE process steps, DOE process steps description.

Analysis of variance (ANOVA): no-WAY anova, One-way ANOVA, two-way ANOVA, Critique of F-test, ANOVA for four level factors, multiple level factors.

UNIT - II	**Randomized block designs and factorial designs**	Lecture Hrs: 8

Randomized block designs: Randomized complete block design - Latin square designs - Graeco-Latin square design - Balanced incomplete block designs.

Factorial Designs:- Two levels - 2^k factorial designs - confounding and Blocking in factorial designs.

UNIT - III	**Laminated Object Manufacturing**	Lecture Hrs: 8

Fractional Factorial Designs: The One-Half and One-Quarter Fraction of the 2^k Design - General 2^{k-p} Fractional Factorial Design - Resolution.

Robust Design: comparison of classical and Taguchi's approach - orthogonal designs - S/N ratios - application to process and parameter design.

UNIT - IV	**Regression Analysis**	Lecture Hrs: 8

Introduction - simple Linear Regression Analysis - Multiple Linear Regression Model - Model Adequacy Checking.

UNIT - V	**RSM & Software's used for Design the experiments**	Lecture Hrs: 8

Response surface methodology- parameter - optimization - robust parameter design and its application to control of processes with high variability.

Software's - JMP, NCSS, Minitab, Design expert.

Text Books:

1. Montgomery DC, Design and Analysis of Experiments, 7th Edition, John Wiley & Sons, NY, 2008.

Reference Books:

1. Taguchi methods explained: Practical steps to Robust Design/Papan P.Bagchi/Prentice Hall Ind. Pvt. Ltd. New Delhi.
2. Charles R. Hicks, Kenneth V. Turner Jr., Fundamental concepts in the Design of Experiments, Oxford University press, 1999.
3. Bagchi, T.P. Taguchi Methods explained, pHl,2OO2.
4. Philip.J. Rose, Taguchi Techniques for quality Engineering, Prentice Hail, 2000.
5. Parurerselvam.. Design and Analysis of Expeiiments, pHliearnin Mode 9.2015.

Online Learning Resources:
• https://nptel.ac.in/courses/110/105/110105087/ • https://nptel.ac.in/courses/111/104/111104075/ • https://onlinecourses.nptel.ac.in/noc21_mg48/preview

Course Code		PROCESS AUTOMATION LABORATORY	L	T	P	C
Semester	II		0	0	4	2

Course Objectives:

- To train the students in writing programs for robot movements
- To train the students in handling FMS cell for different sequences
- To design the hydraulic and pneumatic circuits by using automation studio software
- To design the automated manufacturing systems by using workspace software.

Course Outcomes (CO):

Upon successful completion students should be able to:

- Demonstrate the pick and place Aristo Robot.
- Demonstrate the working of workspace software.
- Check the circuit designs whether working properly or not by using Automation studio software.

List of Experiments:

1. **WORKSPACE software.**
   a. Simulation of a manufacturing system for increasing production rate.
   b. Simulation of a simple automation system.
2. **AUTOMATION STUDIO software.**
   I. Hydraulic Circuits
   a. Introduction to Automation studio & its control
   b. Draw & Simulate the Hydraulic circuit for series & parallel cylinders connection
   c. Draw & Simulate Meter-in, Meter-out and hydraulic press and clamping.
   d. Sequencing circuits in hydraulics.
   e. Synchronizing circuits in hydraulics.
   II. Pneumatic circuits
   a. Sequencing circuits in Pneumatics.
   b. Synchronizing circuits in Pneumatics.
   c. Design and Simulation of simple pneumatic circuit by using Cascade Method.
   d. Design and Simulation of simple pneumatic circuit by using step counter method
3. **Aristo XT Six axis Robot**
   a. Introduction to Robot programming
   b. Robot programming exercises (Point-to-Point and continuous path task)
4. **Additive manufacturing machine**
   a. Introduction to Additive manufacturing Machine.
   b. Design and fabrication of simple symmetrical and unsymmetrical components.
5. **Mechatronics**
   a. Simulation on P Controller.
   b. Simulation on PI Controller.
   c. Simulation on PID Controller.
   d. Simulation of Hydraulic Actuation System.
   e. Simulation of Pneumatic Actuation System.
   f. Simulation on Stepper Motor.
   g. Simulation on Logic gates, decoders and flip-flops.

Course Code		CAM LABORATORY	L	T	P	C
Semester	II		0	0	4	2

Course Objectives:

- To get practical knowledge on manual part programming of CNC lathe machine by using G codes and M codes.
- To get practical knowledge on manual part programming of CNC milling and drilling machine by using G codes and M codes.
- To get the practical knowledge on APT language.

Course Outcomes (CO):

Upon successful completion students should be able to:

- Use an understanding of General and Machine (G& M) code to generate or edit a program which will operate a CNC Lathe.
- Apply mathematical methods to calculate Cartesian coordinates

List of Experiments:

1. Manual part programming (using G and M codes) in CNC Lathe Machine
   (a) Part programming for linear interpolation, circular interpolation, chamfering and grooving.
   (b) Part programming by using standard canned cycles for facing, turning, taper turning and thread cutting.
2. Manual part programming (using G and M codes) in CNC Milling Machine
   (a) Part programming for linear interpolation, circular interpolation and contour motions.
   (b) Part programming involving canned cycles for drilling, peck drilling and boring.
3. APT (Automatically Programmed Tools) language in CNC Milling and Lathe machine.
4. Cutting tool path generation using any one simulation package for different machining operation.

Course Code		ADVANCED TOOL DESIGN	L	T	P	C
Semester	III	Program Elective Course - V	3	0	0	3

Course Objectives:

- The purpose of this course is to make the students to get familiarized with the design of various tools that can be implemented for different mechanical operations.

Course Outcomes (CO):

- It helps the students to get familiarized with advanced tool design for various mechanical operations which includes cutting, jigs and fixtures, press tool dies and modern CNC machine tools.

UNIT - I	**INTRODUCTION TO TOOL DESIGN**	Lecture Hrs: 10

Introduction –Tool Engineering – Tool Classifications– Tool Design Objectives – Tool Design in manufacturing- Challenges and requirements- Standards in tool design-Tool drawings -Surface finish – Fits and Tolerances - Tooling Materials- Ferrous and Non ferrous Tooling Materials- Carbides, Ceramics and Diamond -Non metallic tool materials-Designing with relation to heat treatment.

UNIT - II	**DESIGN OF CUTTING TOOLS**	Lecture Hrs: 10

Mechanics of Metal cutting –Oblique and orthogonal cutting- Chip formation and shear angle - Single-point cutting tools – Milling cutters – Hole making cutting tools- Broaching Tools - Design of Form relieved and profile relieved cutters-Design of gear and thread milling cutters.

UNIT - III	**DESIGN OF JIGS AND FIXTURES**	Lecture Hrs: 10

Introduction – Fixed Gages – Gage Tolerances –selection of material for Gauges – Indicating Gages – Automatic gages – Principles of location – Locating methods and devices – Principles of clamping – Drill jigs – General considerations in the design of drill jigs – Drill bushings – Methods of construction – Types of Fixtures – Vice Fixtures – Milling Fixtures – Boring Fixtures – Broaching Fixtures.

UNIT - IV	**DESIGN OF PRESS TOOL DIES**	Lecture Hrs: 8

Types of Dies –Method of Die operation–Clearance and cutting force calculations- Blanking and Piercing die design – Pilots – Strippers and pressure pads- Presswork materials – Centre of pressure - Strip layout – Short-run tooling for Piercing – Bending dies – Drawing dies-Design and drafting.

UNIT - V	**TOOL DESIGN FOR CNC MACHINE TOOLS**	Lecture Hrs: 8

Introduction –Tooling requirements for Numerical control systems – Fixture design for CNC machine tools- Sub plate and tombstone fixtures-Universal fixtures– Cutting tools– Tool holding methods– Automatic tool changers and tool positioners – Tool presetting– General explanation of the Brown and Sharp machine.

Text Books:

1. Cyrll Donaldson, George H.LeCain, V.C. Goold, "Tool Design", Tata McGraw Hill Publishing Company Ltd., 2000.
2. E.G.Hoffman," Jig and Fixture Design", Thomson Asia Pvt Ltd, Singapore, 2004.

Reference Books:

1. Prakash Hiralal Joshi, "Tooling data", Wheeler Publishing, 2000
2. Venkataraman K., "Design of Jigs, Fixtures and Presstools", TMH, 2005.
3. Haslehurst M., "Manufacturing Technology", The ELBS, 1978.

Online Learning Resources:

- https://www.iare.ac.in/sites/default/files/lecture_notes/TOOL%20DESIGN_Lecture_Notes.pdf
- https://www.cet.edu.in/noticefiles/261_MMP%20Lecture%20Notes-ilovepdf-compressed.pdf
- https://www.vssut.ac.in/lecture-notes.php?url=production-engineering
- https://nptel.ac.in/courses/112/105/112105233/
- https://www.youtube.com/watch?v=7MkX-sW97rI
- https://nptel.ac.in/courses/112/105/112105126/#

Course Code		DESIGN FOR MANUFACTURING	L	T	P	C
Semester	III	Program Elective Course - V	3	0	0	3

Course Objectives:

- Students to study and know the Design philosophy, maching and joining processes, and factors for design.

Course Outcomes (CO): Student will be able to

- Students are able to know to make Design of the different kinds of the products to manufacture.

UNIT - I	**Introduction**	Lecture Hrs: 8

Design philosophy-steps in design process-general design rules for manufacturability-basic principles of designing 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 processes**	Lecture Hrs: 10

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 Turning, thread cutting, milling and drilling operations. Case studies.

UNIT - III	**Metal casting and forging**	Lecture Hrs: 8

Appraisal of various casting processes, selection of casting process,-general design considerations for casting-casting tolerance-use of solidification, simulation in casting design-product design rules for sand casting.
Design factors for forging – closed die forging design – parting lines of dies – drop forging die design – general design recommendations. Case studies
Casting and forging allowances.

UNIT - IV	**Metal joining**	Lecture Hrs: 8

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.

UNIT - V	**Sheet metal working and plastics**	Lecture Hrs: 8

Extrusion & Sheet metal work: Design guide lines extruded sections-design principles for punching, blanking, bending, deep drawing-Keeler Goodman forging line diagram – component design for blanking.

Plastics: Design and manufacture of plastic components

Text Books:

1. John cobert, Design for Manufacture: Strategies, Principles and Techniques, Adisson Wesley. 1995.
2. Geoffrey Boothroyd, Peter Dewhurst, Product Design for Manufacture and Assembly, CRC Press; 3/e, 2010.
3. Vannessa Dr Goodship, Design and Manufacture of Plastic Components for Multifunctionality, Publisher William Andrew, 1/e, 2015.

Reference Books:

1. George E. Dieter, ASM Handbook Volume 20: Materials Selection and Design, ASM International, 1997.

Online Learning Resources:

- https://nptel.ac.in/courses/112/101/112101005/
- https://www.iare.ac.in/sites/default/files/lecture_notes/DFMA_LECTURE_NOTES.pdf
- https://ocw.mit.edu/courses/mechanical-engineering/2-008-design-and-manufacturing-ii-spring-2004/lecture-notes/

- https://dokumen.tips/documents/design-for-manufacturing-and-assembly-1-lecture-notes-on-design-for-manufacturing.html
- https://www.youtube.com/watch?v=ofmbhbVCUqI
- https://onlinecourses.nptel.ac.in/noc21_me66/preview

Course Code		AUTOMATION IN MANUFACTURING	L	T	P	C
Semester	III	Program Elective Course - V	3	0	0	3

Course Objectives:

Students are study to know the over view of the automation in manufacturing like automatic material handling, assembling and production lines etc.

Course Outcomes (CO): Student will be able to

Students are able to know to understand the automation in manufacturing concept .

UNIT - I	**Over View of Manufacturing and Automation:**	Lecture Hrs: 10

Production systems, Automation in production systems, Automation principles and strategies, Manufacturing operations, production facilities. Basic elements of an automated system, levels of automation; Hardware components for automation and process control, programmable logic controllers and personal computers.

UNIT - II	**Material Handling and Identification Technologies:**	Lecture Hrs: 8

Material handling, equipment, Analysis. Storage systems, performance and location strategies, Automated storage systems, AS/RS, types. Automatic identification methods, Barcode technology, RFID.

UNIT - III	**Manufacturing Systems and Automated Production Lines:**	Lecture Hrs: 8

Manufacturing systems: components of a manufacturing system, Single station manufacturing cells; Manual Assembly lines, line balancing Algorithms, Mixed model Assembly lines, Alternative Assembly systems. Automated production lines, Applications, Analysis of transfer lines-With and without buffer

UNIT - IV	**Automated Assembly Systems:**	Lecture Hrs: 8

Fundamentals, Analysis of Assembly systems. Cellular manufacturing, part families, cooling, production flow analysis. Group Technology and flexible Manufacturing systems, Quantitative Analysis.

UNIT - V	**Machine learning**	Lecture Hrs: 10

Introduction: Basic definitions, types of learning, hypothesis space and inductive bias, evaluation, cross-validation.

Text Books:

1. Automation, production systems and computer integrated manufacturing/ Mikell. P Groover/PHI/3rd edition/2012.
2. CAD/CAM/CIM/ P. Radha Krishnan & S. Subrahamanyarn and Raju/New Age International Publishers/2003.

Reference Books:

1. System Approach to Computer Integrated Design and Manufacturing/ Singh/John Wiley /1996.
2. Computer Aided Manufacturing/Tien-Chien Chang, Richard A. Wysk and Hsu-Pin Wang/ Pearson/ 2009.
3. Manufacturing and Automation Technology / R Thomas Wright and Michael Berkeihiser / Good Heart/Willcox Publishers.

Online Learning Resources:

- https://www.youtube.com/watch?v=caJ_2TSQDhE
- https://www.youtube.com/watch?v=v-3TmN4HhLc

Course Code		BUSINESS ANALYTICS (Open Elective)	L	T	P	C
Semester			3	0	0	3

Course Objectives:

1. Understand the role of business analytics within an organization.
2. Analyze data using statistical and data mining techniques and understand relationships between the underlying business processes of an organization.
3. To gain an understanding of how managers use business analytics to formulate and solve business problems and to support managerial decision making.
4. To become familiar with processes needed to develop, report, and analyze business data.
5. Use decision-making tools/Operations research techniques.
6. Mange business process using analytical and management tools.
7. Analyze and solve problems from different industries such as manufacturing, service, retail, software, banking and finance, sports, pharmaceutical, aerospace etc.

Course Outcomes (CO):

At the end of this course the students are expected to,

1. Students will demonstrate knowledge of data analytics.
2. Students will demonstrate the ability of think critically in making decisions based on data and deep analytics.
3. Students will demonstrate the ability to use technical skills in predicative and prescriptive modeling to support business decision-making.
4. Students will demonstrate the ability to translate data into clear, actionable insights.

UNIT - I	**Business analytics & Statistical Tools:**	Lecture Hrs: 10

Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organisation, competitive advantages of Business Analytics.
Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview.

UNIT - II	**Trendiness and Regression Analysis:**	Lecture Hrs: 8

Trendiness and Regression Analysis: Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.

UNIT - III	**Organization Structures**	Lecture Hrs: 8

Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.

UNIT - IV	**Forecasting Techniques:**	Lecture Hrs: 8

Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models. Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.

UNIT - V	**Decision Analysis:**	Lecture Hrs: 10

Decision Analysis: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, SWOT ananlysis, The Value of Information, Utility and Decision Making.

Text Books:
1. Project Management: The Managerial Process by Erik Larson and, Clifford Gray.
Reference Books:
1. Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Pearson FT Press. 2. Business Analytics by James Evans, persons Education.

Course Code		INDUSTRIAL SAFETY	L	T	P	C
Semester		(Open Elective)	3	0	0	3

Course Objectives:

- Familiarize with the safety in industry
- Know the wear and corrosion and their prevention
- Explain Periodic and preventive maintenance

Course Outcomes (CO):

At the end of this course the students are expected to,

- understand the fundamentals of maintenance engineering .
- apply fault tracing technique to find the fault in industries.
- compare periodic and preventive maintenance

UNIT - I	**Industrial safety**	Lecture Hrs: 10

Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and fire fighting, equipment and methods.

UNIT - II	**Fundamentals of maintenance engineering**	Lecture Hrs: 8

Fundamentals of maintenance engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

UNIT - III	**Wear and Corrosion and their prevention:**	Lecture Hrs: 8

Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

UNIT - IV	**Fault tracing:**	Lecture Hrs: 8

Fault tracing: Fault tracing-concept and importance, decision treeconcept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

UNIT - V	**Periodic and preventive maintenance**	Lecture Hrs: 10

Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance.

Text Books:

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.
2. Maintenance Engineering, H. P. Garg, S. Chand and Company.

Reference Books:

1. Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication.
2. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London

Course Code		OPERATIONS RESEARCH	L	T	P	C
Semester		(Open Elective)	3	0	0	3

Course Objectives:

- To impart the basic concepts of modeling, models and statements of the operations research.
- Formulate and solve linear programming problem/situations.
- Model strategic behaviour in different economic situations.
- To solve transportation problems to minimize cost.
- Apply Queuing theory to solve problems of traffic congestion, counters in banks, railway bookings etc.

Course Outcomes (CO):

After completion of this course the student can be able to

- develop mathematical models for practical problems. (L3)
- apply linear programming to transportation problems. (L3)
- solve games using various techniques. (L3)
- solve production scheduling and develop inventory policies. (L6)
- apply optimality conditions for constrained and unconstrained nonlinear problems. (L3)
- apply dynamic programming methods. (L3)

UNIT - I	**Introduction to OR and LP**	Lecture Hrs: 8

Introduction to Operations Research (OR): OR definition - Classification of Models, modeling – Methods of solving OR Models, limitations and applications of OR models

Linear Programming(LP): Problem Formulation, Graphical Method, Simplex Method, Big-M Method, Two–Phase Simplex Method, Special Cases of LP- Degeneracy, Infeasibility and Multiple Optimal Solutions; Concept of dual theorem

UNIT - II	**Transportation and Assignment Problems:**	Lecture Hrs: 8

Transportation and Assignment Problems: Transportation Problem – Formulation; Different Methods of Obtaining Initial Basic Feasible Solution –North West Corner Rule, Least Cost Method, Vogel's Approximation Method; Optimality Method – Modified Distribution (MODI) Method; Special Cases – Unbalanced Transportation Problem, Degenerate Problem. Assignment Problem – Formulation, Hungarian Method for Solving Assignment Problems, Traveling Salesman problem.

UNIT - III	**Game theory and job sequencing**	Lecture Hrs: 8

Game theory: Optimal solution of two person zero sum games, the max min and min max principle. Games without saddle points, mixed strategies. Reduction by principles of dominance, arithmetic, algebraic method and graphical method.

Job Sequencing: Introduction to Job shop Scheduling and flow shop scheduling, Solution of Job Sequencing Problem, Processing of n Jobs through two machines, Processing of n Jobs through m machines, graphical method

UNIT - IV	**Queuing theory & Inventory control**	Lecture Hrs: 8

Queuing Theory: Introduction – Terminology, Arrival Pattern, Service Channel, Population, Departure Pattern, Queue Discipline, Birth & Death Process, Single Channel Models with Poisson Arrivals, Exponential Service Times with infinite and finite queue length; Multichannel Models with Poisson Arrivals, Exponential Service Times with infinite queue length.

Inventory Control: Introduction, Deterministic models – EOQ model with and without shortages, Production model, Buffer stock and discount inventory models with single price breaks. Selective inventory control..

UNIT - V	**Replacement and Maintenance Analysis and DP**	Lecture Hrs: 10

Replacement and Maintenance Analysis: Introduction – Types of Maintenance, Make or buy decision. Types of Replacement Problems, Determination of Economic Life of an Asset, and Simple Probabilistic Model for Items which completely fail-Individual Replacement Model, Group

Replacement Model.

Dynamic Programming (DP): Introduction –Bellman's Principle of Optimality – Applications of Dynamic Programming – Shortest Path Problem – Capital Budgeting Problem – Solution of Linear Programming Problem by DP..

Text books:

1. Sharma S.D., Operations Research: Theory, Methods and Applications, 15th Edition, Kedar Nath Ram Nath, 2010
2. Taha H.A., Operations Research, 9th Edition, Prentice Hall of India, New Delhi, 2010.

Reference Books:

1. Hiller F.S., and Liberman G.J., Introduction to Operations Research, 7th Edition, Tata McGraw Hill, 2010.
2. Sharma J.K., Operations Research: Theory and Applications, 4th Edition, Laxmi Publications, 2009.
3. Prem kumar Gupta and Hira, Operations Research, 3rd Edition, S Chand Company Ltd., New Delhi, 2003.
4. Pannerselvam R., Operations Research, 2nd Edition, Pentice Hall of India, New Delhi, 2006.
5. Sundaresan.V, and Ganapathy Subramanian.K.S, Resource Management Techniques: Operations Research, A.R Publications, 2015.

Online Learning Resources:

- http://www2.informs.org/Resources/
- http://www.mit.edu/~orc/
- http://www.ieor.columbia.edu/
- http://www.universalteacherpublications.com/univ/ebooks/or/Ch1/origin.htm
- http://www.wolfram.com/solutions/OperationsResearch/
- http://nptel.iitm.ac.in/video.php?subjectId=112106134
- http://www.youtube.com/watch?feature=player_detailpage&v=ug7O1lSZyg0
- http://www2.ensc.sfu.ca/undergrad/courses/ENSC201/Unit09/lecture9.html

Course Code		SUPPLY CHAIN MANAGEMENT (Open Elective)	L	T	P	C
Semester			3	0	0	3

Course Objectives:

- Explain the basics of supply chain management.
- Familiarize inventory management techniques and models to ensure EOQ batch size under risk management.
- Demonstrate various distribution strategies for shipment of products.
- Focus on evaluating of strategic alliance partners and understanding of RDBMS

Course Outcomes (CO):

After completion of this course the student can be able to

- apply the concepts of supply chain management for demand forecasting. (L3)
- make use of SCM and inventory management for procurement(L3)
- analyse the shipment activities and related issues (L4)
- build third party alliances. (L5)
- adapt the RDBMS data for communications and analyzing future challenges and understand e-commerce strategies(L6)

UNIT - I	**Understanding the supply chain**	Lecture Hrs: 8

What is SCM? Why SCM? The Complexity, Key issues in SCM Logistics network - Introduction, Data Collection, Transportation, Ware house Management, Strategic location of ware houses, Demand forecasting, Role of aggregate planning, MRP, ERP, Managing variability, Key features of Network configuration.

UNIT - II	**Inventory management:**	Lecture Hrs: 8

Inventory management: Concepts of Materials Management, Economic lot size model, Effect of Demand uncertainly, Fixed order costs, Variable lead frames, Inventory under certainly & uncertainty, Risk Management

UNIT - III	**Distribution strategies:**	Lecture Hrs: 8

Distribution strategies: Introduction, Centralized vs Decentralized control, Direct shipment, Cross Docking, Push based vs Pull based supply chain.

UNIT - IV	**Strategic alliances:**	Lecture Hrs: 8

Third party Logistics (3PL), Retailer – supplier relationship issues, requirements, success & failures, Distributor integration Types & issues.

UNIT - V	**MIS & SCM:**	Lecture Hrs: 10

Relational Data Base Management (RDBMS), System Architecture, Communications, and Implementation of ERP, Decision support systems for SCM: Analytical tools, Presentation tools, Smooth production flow Current issues & directing challenges for future, e-Commerce strategies and world class supply chain management.

Text Books:

1. Sunil Chopra, Peter Meindl, Supply Chain Management: Strategy, Planning, and Operation, 4/e, Pearson, 2010.
2. David N. Burt, Donald W. Dobler , World Class Supply Management: The Key to Supply Chain Management, 2/e, McGraw-Hill/Irwin, 2003.

Reference Books:

1. John Joseph Coyle, Edward J. Bardi, C. John Langley, The Management of Business Logistics: A Supply Chain Perspective, South-Western/Thomson Learning, 2003.
2. Upendra Kachru ,Logistics and Supply Chain Management, Excel Books, 2009.

Online Learning Resources:

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Course Code		COMPOSITE MATERIALS (Open Elective)	L	T	P	C
Semester			3	0	0	3

Course Objectives:

- Introduce composite materials and their applications to students.
- Build proper background for stress and strength analysis in the design of composite materials and structures.

Course Outcomes (CO): Student will be able to

After completion of the course student can be able to**:**

- Understanding of types, manufacturing processes, and applications of composite materials.
- Understanding the theory behind polymer matrix composites

UNIT - I	**INTRODUCTION**	Lecture Hrs: 8

Definition – Classification and characteristics of Composite materials. Advantages and application of composites. Functional requirements of reinforcement and matrix. Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

UNIT - II	**REINFORCEMENTS**	Lecture Hrs: 8

Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements. Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures. Isostrain and Isostress conditions.

UNIT - III	**Manufacturing of Metal Matrix Composites:**	Lecture Hrs: 8

Manufacturing of Metal Matrix Composites: Casting – Solid State diffusion technique, Cladding – Hot isostatic pressing. Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving. Properties and applications.

UNIT - IV	**Manufacturing of Polymer Matrix Composites:**	Lecture Hrs: 8

Manufacturing of Polymer Matrix Composites: Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding. Properties and applications.

UNIT - V	**Strength:**	Lecture Hrs: 10

Strength: Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

Text Books:

1. R.W.Cahn – VCH, Material Science and Technology – Vol 13 – Composites, West Germany.
2. WD Callister, Jr., Adapted by R. Balasubramaniam, Materials Science and Engineering, An introduction. John Wiley & Sons, NY, Indian edition, 2007.

Reference Books:

1. "Composite Materials"., H K Shivanand, B V Babu Kiran, ASIAN BOOKS, 2011
2. "Fundamentals of Composite Manufacturing", A.B. Strong, SME, 1989.
3. "Composite materials", S.C. Sharma, Narosa Publications, 2000.

Online Learning Resources:

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Course Code		Waste to Energy (Open Elective)	L	T	P	C
Semester			3	0	0	3

Course Objectives:

- Introduce conversion of waste to energy
- Familiarize the fundamentals of biomass pyrolysis
- Explain about biomass combustion

Course Outcomes (CO):

After completion of this course the student can be able to

- use of various conversation techniques for convert the waste into energy.(L4)
- apply optimization methods to engineering problems.(L3)
- implement Biomass energy programme in India.(L3)
- compare bio gasification techniques. (L4)

UNIT - I	Introduction to Energy from Waste:	Lecture Hrs: 8

Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors

UNIT - II	Biomass Pyrolysis:	Lecture Hrs: 8

Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

UNIT - III	Biomass Gasification	Lecture Hrs: 8

Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

UNIT - IV	Biomass Combustion:	Lecture Hrs: 8

Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

UNIT - V	Biogas:	Lecture Hrs: 10

Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India..

Text Books:

1. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.

Reference Books:

1. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
2. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.

Online Learning Resources:

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Course Code		MECHATRONICS (Open Elective)	L	T	P	C
Semester			3	0	0	3

Course Objectives:

- Introduce Mechatronics.
- Familiarize the fundamentals of Signal conditioning and precision mechanical systems
- Explain about microcontroller overview.

Course Outcomes (CO):

After completion of this course the student can be able to

- use of digital I/O for signal conditioning.
- implement Electronic interface subsystems.
- compare various types of electromechanical drives.

UNIT - I	**Introduction:**	Lecture Hrs: 8

Introduction: Definition - Trends - Control Methods: Stand alone, PC Based (Real Time Operating Systems, Graphical User Interface, Simulation) - Applications: SPM, Robot, CNC, FMS, CIM.

UNIT - II	**Signal Conditioning:**	Lecture Hrs: 8

Signal Conditioning: Introduction - Hardware - Digital I/O , Analog input - ADC , resolution , speed channels Filtering Noise using passive components - Resistors, capacitors - Amplifying signals using OP amps -Software - Digital Signal Processing

UNIT - III	**Precision Mechanical Systems:**	Lecture Hrs: 8

Precision Mechanical Systems: Pneumatic Actuation Systems - Electro-pneumatic Actuation Systems - Hydraulic Actuation Systems - Electro-hydraulic Actuation Systems - Timing Belts - Ball Screw and Nut - Linear Motion Guides - Linear Bearings - Bearings- Motor / Drive Selection. .

UNIT - IV	**Electronic Interface Subsystems:**	Lecture Hrs: 8

Electronic Interface Subsystems: Motors Isolation schemes- opto coupling, buffer IC's - Protection schemes - circuit breakers, over current sensing, resettable fuses, Power Supply - Bipolar transistors/ mosfets.

Electromechanical Drives: Relays and Solenoids - Stepper Motors - DC brushed motors - DC brushless motors - DC servo motors - PWM's - Pulse Width Modulation - Variable Frequency Drives.

UNIT - V	**Microcontrollers Overview:**	Lecture Hrs: 10

Microcontrollers Overview: 8051 Microcontroller , micro processor structure - Digital Interfacing - Analog Interfacing - Digital to Analog Convertors - Analog to Digital Convertors - Applications, Programming -Assembly.

Programmable Logic Controllers: Basic Structure - Programming: Ladder diagram - Timers, Internal Relays and Counters - Shift Registers - Master and Jump Controls - Data Handling - Analog input / output - PLC Selection, interface - R232 etc.,-Applications.

Text Books:

1. Mechatronics Electronics Control Systems in Mechanical and Electrical Engineering , WBolton, Pearson Education Press, 3rd edition, 2005.
2. Mechatronics, Ganesh.S.H, Jones and Bartlett publications.

Reference Books:

1. Mechatronics Source Book, Newton C Braga, Thomson Publications, Chennai.
2. Mechatronics, N. Shanmugam, Anuradha Agencies Publisers.
3. Mechatronics System Design, Devdasshetty,Richard,Thomson.
4. Mechatronics, M.D.Singh, J.G.Joshi, PHI.

Online Learning Resources:

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Course Code		OPTIMIZATION TECHNIQUES THROUGH MATLAB (Open Elective)	L	T	P	C
Semester			3	0	0	3

Course Objectives:

- Introduce basics of MATLAB
- Familiarize the fundamentals of optimization
- Explain single variable optimization using various methods
- Implement multi variable optimization using various methods
- Train various evolutionary algorithms.

Course Outcomes (CO):

After completion of this course the student can be able to

- use optimization terminology and concepts, and understand how to classify an optimization problem.(L4)
- apply optimization methods to engineering problems.(L3)
- implement optimization algorithms.(L3)
- compare different genetic algorithms. (L5)
- solve multivariable optimization problems. (L4)

UNIT - I	**Introduction to MAT LAB:**	Lecture Hrs: 8

Introduction to MAT LAB: Overview, MATLAB Preliminaries, Basics of MATLAB, Beyond the Basics of MATLAB, Popular Functions and Commands, Plotting using MATLAB, Optimization with MATLAB.

UNIT - II	**Introduction to Optimization:**	Lecture Hrs: 8

Introduction to Optimization: Statement of an optimization problem, Classifications of optimization Problems: Single variable optimization, Multi variable optimization with no constraints, Multi variable optimization with equality constraints, Multi variable optimization with inequality constraints, Convex and Concave programming.

UNIT - III	**Single Variable Optimization:**	Lecture Hrs: 8

Single Variable Optimization: Finite difference method, Central difference method, Runge-Kutta method, interval halving method, golden section method with MATLAB code.

UNIT - IV	**Multi Variable Optimization:**	Lecture Hrs: 8

Multi Variable Optimization: Conjugate gradient method, Newton's method, Powell's method, Flectcher- Reeves method, Hook and Jeeves method, interior penalty function with MATLAB code.

UNIT - V	**Evolutionary Algorithms:**	Lecture Hrs: 10

Evolutionary Algorithms: Overview, Genetic Algorithms: Basics of Genetic Algorithms, Options in MATLAB, Multi Objective Optimization using Genetic Algorithms, Ant Colony Optimization, Simulated Annealing, Particle Swarm Optimization.

Text Books:

1. Rao V.Dukkipati, MATLAB: An Introduction with Applications, Anshan, 2010.
2. Achille Messac, Optimization in practice with MATLAB, Cambridge University Press, 2015.
3. Jasbir S Arora, Introduction to optimum design, 2/e. Elsevier, 2004.

Reference Books:

1. Cesar Perez Lopez, MATLAB Optimization Techniques, Academic press, Springer publications, 2014.
2. Steven C.Chapra, Applied Numerical Methods with MATLAB for Engineers and scientists, 4/e, McGraw-Hill Education, 2018.

Online Learning Resources:

Course Code		AUTOMOTIVE ELECTRONICS (Open Elective)	L	T	P	C
Semester			3	0	0	3

Course Objectives:

- To understand the use of electronics in the automobile.
- To appreciate the various electronic and the instrumentation systems used in automobile.

Course Outcomes (CO):

After completion of this course the student can be able to

- Obtain an overview of automotive components, like sensors, actuators, communication protocols and safety systems employed in today's automotive industry .
- Interface automotive sensors and actuators with microcontrollers.
- Know, the various display devices that are used in automobiles.

UNIT - I	**Introduction to microcomputer**:	Lecture Hrs: 8

Introduction to microcomputer: Microcomputer: Buses, memory, timing, CPU registers; Microprocessor architecture: Initialization, operation codes, program counter, branch and jump instructions, subroutine. Analog to digital converters and Digital to analog converters, sampling, polling and interrupts, digital filters, lookup table.

UNIT - II	**Sensors and actuators:**	Lecture Hrs: 8

Sensors and actuators: Speed sensors, Pressure sensors: Manifold Absolute Pressure sensor, knock sensor, Temperature sensors: Coolant and Exhaust gas temperature, Exhaust Oxygen level sensor, Position sensors: Throttle position sensor, accelerator pedal position sensor and crankshaft position sensor, Air mass flow sensor. Solenoids, stepper motors and relays.

UNIT - III	**Electronic engine management system**	Lecture Hrs: 8

Electronic engine management system: Electronic engine control: Input, output and control strategies, electronic fuel control system, fuel control modes: open loop and closed loop control at various modes, EGR control, Electronic ignition systems – Spark advance correction schemes, fuel injection timing control.

UNIT - IV	**Electronic vehicle management system:**	Lecture Hrs: 8

Electronic vehicle management system: Cruise control system, Antilock braking system, electronic suspension system, electronic steering control, traction control system, Transmission control, Safety: Airbags, collision avoiding system, low tire pressure warning system..

UNIT - V	**Automotive instrumentation system**	Lecture Hrs: 10

Automotive instrumentation system: Input and output signal conversion, multiplexing, fuel quantity measurement, coolant temperature and oil pressure measurement, display devices- LED, LCD, VFD and CRT, Onboard diagnostics(OBD), OBD-II, off board diagnostics.

Text Books:

1. Understanding Automotive Electronics, William B Ribbens, Newne Butterworth-Heiner 6th edition 2003.
2. Crouse W H, Automobile Elctrical Equipment, McGraw Hill Book Co.Inc, Newyork 2005.

Reference Books:

1. Bechhold "Understanding Automotive Electronics", SAE, 1998.
2. Robert Bosch "Automotive Hand Book", SAE (5th Edition), 2000.
3. Tom Denton,"Automobile Electrical and Electronic Systems" 3rd edition- Edward Arnold, London - 2004.
4. Eric Chowanietz - 'Automotive Electronics' - SAE International USA – 1995.

Course Code		RAPID PROTOTYPING (Open Elective)	L	T	P	C
Semester			3	0	0	3

Course Objectives:

- Familiarize techniques for processing of CAD models for rapid prototyping.
- Explain fundamentals of rapid prototyping techniques.
- Demonstrate appropriate tooling for rapid prototyping process.
- Focus Rapid prototyping techniques for reverse engineering.
- Train Various Pre – Processing, Processing and Post Processing errors in RP Processes.

Course Outcomes (CO):

After completion of this course the student can be able to

- use techniques for processing of CAD models for rapid prototyping. (L3)
- understand and apply fundamentals of rapid prototyping techniques. ((L3)
- use appropriate tooling for rapid prototyping process. (L3)
- use rapid prototyping techniques for reverse engineering. (L3)
- identify Various Pre – Processing, Processing and Post Processing errors in RP processes. (L3)

UNIT - I	**Introduction**	Lecture Hrs: 8

Introduction**:** Introduction to Prototyping, Traditional Prototyping Vs. Rapid Prototyping (RP), Need for time compression in product development, Usage of RP parts, Generic RP process, Distinction between RP and CNC, other related technologies, Classification of RP.

RP Software**:** Need for RP software, MIMICS, Magics, SurgiGuide, 3-matic, 3D-Doctor, Simplant, Velocity2, VoXim, SolidView, 3DView, etc., software, Preparation of CAD models, Problems with STL files, STL file manipulation, RP data formats: SLC, CLI, RPI, LEAF, IGES, HP/GL, CT, STEP

UNIT - II	Solid and Liquid Based RP Systems**:**	Lecture Hrs: 8

Solid and Liquid Based RP Systems**:** Stereolithography (SLA): Principle, Process, Materials, Advantages, Limitations and Applications. Solid Ground Curing (SGC): Principle, Process, Materials, Advantages, Limitations, Applications. Fusion Deposition Modeling (FDM): Principle, Process, Materials, Advantages, Limitations, Applications. Laminated Object Manufacturing (LOM): Principle, Process, Materials, Advantages, Limitations, Applications.

UNIT - III	Powder Based RP Systems**:**	Lecture Hrs: 8

Powder Based RP Systems**:** Principle and Process of Selective Laser Sintering (SLS), Advantages, Limitations and Applications of SLS, Principle and Process of Laser Engineered Net Shaping (LENS), Advantages, Limitations and Applications of LENS, Principle and Process of Electron Beam Melting (EBM), Advantages, Limitations and Applications of EBM.

Other RP Systems: Three Dimensional Printing (3DP): Principle, Process, Advantages, Limitations and Applications. Ballastic Particle Manufacturing (BPM): Principle, Process, Advantages, Limitations, Applications. Shape Deposition Manufacturing (SDM): Principle, Process, Advantages, Limitations, Applications.

UNIT - IV	**Rapid Tooling and Reverse Engineering**	Lecture Hrs: 8

Rapid Tooling: Conventional Tooling Vs. Rapid Tooling, Classification of Rapid Tooling, Direct and Indirect Tooling Methods, Soft and Hard Tooling methods.

Reverse Engineering (RE): Meaning, Use, RE – The Generic Process, Phases of RE Scanning, Contact Scanners and Noncontact Scanners, Point Processing, Application Geometric Model, Development.

UNIT - V	**Errors in RP process and RP Applications**	Lecture Hrs: 10

Errors in RP Processes: Pre-processing, processing, post-processing errors, Part building errors in SLA, SLS, etc.

RP Applications: Design, Engineering Analysis and planning applications, Rapid Tooling, Reverse Engineering, Medical Applications of RP.

Text Books:

1. Chua C.K., Leong K.F. and Lim C.S., Rapid Prototyping: Principles and Applications, 2/e Edition, World Scientific Publishers, 2003.
2. Ian Gibson, David W. Rosen, Brent Stucker, Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, 1st Edition, Springer, 2010.
3. Rafiq Noorani, Rapid Prototyping: Principles and Applications in Manufacturing, John Wiley & Sons, 2006.

Reference Books:

1. Liou W. Liou, Frank W., Liou, Rapid Prototyping and Engineering Applications: A Tool Box for Prototype Development, CRC Press, 2007.
2. Pham D.T. and Dimov S.S., Rapid Manufacturing; The Technologies and Application of RPT and Rapid tooling, Springer, London 2001.
3. Gebhardt A., Rapid prototyping, Hanser Gardener Publications, 2003.
4. Hilton P.D. and Jacobs P.F., Rapid Tooling: Technologies and Industrial Applications, CRC Press, 2005.

Online Learning Resources:

Course Code		PROGRAMMING OF ROBOT AND ITS CONTROL (Open Elective)	L	T	P	C
Semester			3	0	0	3

Course Objectives:

- Learn the fundamental concepts of industrial robotic technology.
- Apply the basic mathematics to calculate kinematic and dynamic forces in robot manipulator.
- Understand the robot controlling and programming methods.
- Describe concept of robot vision system . .

Course Outcomes (CO):

After completion of this course the student can be able to

- explain fundamentals of Robots. (L2)
- apply kinematics and differential motions and velocities. (L3)
- demonstrate control of manipulators. (L2)
- understand robot vision. (L2)
- develop robot cell design and programming. (L3)

UNIT - I	**Fundamentals of Robots:**	Lecture Hrs: 8

Fundamentals of Robots: Introduction, definition, classification and history of robotics, robot characteristics and precision of motion, advantages, disadvantages and applications of robots.

UNIT - II	**Robot Actuators And Feedback Components**	Lecture Hrs: 8

Robot Actuators And Feedback Components: Actuators, Pneumatic, Hydraulic actuators, Electric & Stepper motors, comparison. Position sensors - potentiometers, resolvers, encoders - velocity sensors, Tactile sensors, Proximity sensors.

UNIT - III	**Robot Programming:**	Lecture Hrs: 8

Robot Programming: Methods of programming - requirements and features of programming languages, software packages, problems with programming languages. VAL, RAIL, AML, C, C++.

UNIT - IV	**Control of Manipulators:**	Lecture Hrs: 8

Control of Manipulators: Open- and close-loop control, the manipulator control problem, linear control schemes, characteristics of second-order linear systems, linear second-order SISO model of a manipulator joint, joint actuators, partitioned PD control scheme, PID control Scheme, computer Torque control, force control of robotic manipulators, description of force-control tasks, force control strategies, hybrid position/force control, impedance force/torque control.

UNIT - V	**Robot Vision:**	Lecture Hrs: 10

Robot Vision: Introduction, architecture of robotic vision system, image processing, image acquisition camera, image enhancement, image segmentation, imaging transformation, Camera transformation and calibrations, industrial applications of robot vision.

Text Books:

1. Mikell P. Groover and Mitchell Weiss, Roger N. Nagel,Nicholas G.Odrey , Industrial Robotics — Mc Graw Hill, 1986.
2. R K Mittal and I J Nagrath, Robotics and control, Illustrated Edition, Tata McGraw Hill India 2003.

Reference Books:

1. Saeed B. Niku, Introduction to Robotics – Analysis, System, Applications, 2nd Edition, John Wiley & Sons, 2010.
2. H. Asada and J.J.E. Slotine, Robot Analysis and Control, 1st Edition Wiley- Interscience, 1986.
3. Robert J. Schillin, Fundamentals of Robotics: Analysis and control, Prentice-Hall Of India

Pvt. Limited, 1996.
4. Mohsen shahinpoor, A robot Engineering text book, Harper & Row Publishers,1987.
5. John.J.Craig Addison, Introduction to Robotics: Mechanics and Control, Wesley, 1999.
6. K.S. FU, R.C. Gonzalez and C.S.G Lee, Robotics: Control, sensing, vision, and intelligence . Mc Graw Hill, 1987.
7. Richard D. Klafter, Thomas Robotic Engineering an integrated approach, PHI publications 1988.

Online Learning Resources:

Course Code		INDUSTRY 4.0 (Open Elective)	L	T	P	C
Semester			3	0	0	3

Course Objectives:

- This course is designed to offer learners an introduction to Industry 4.0 and its applications.
- Learners will gain deep insights into how smartness is being harnessed from data.
- Learners will understand what needs to be done in order to overcome the challenges.
- To familiarize in Industry 4.0 in healthcare services.

Course Outcomes (CO):

After completion of this course the student can be able to

- explain fundamentals of Robots. (L2)
- apply kinematics and differential motions and velocities. (L3)
- demonstrate control of manipulators. (L2)
- understand robot vision. (L2)
- develop robot cell design and programming. (L3)

UNIT - I	Introduction to Industry 4.0:	Lecture Hrs: 8

Introduction to Industry 4.0- The Various Industrial Revolutions, Digitalisation and the Networked Economy, Drivers, Enablers, Compelling Forces and Challenges for Industry 4.0, Comparison of Industry 4.0 Factory and Today's Factory, Trends of Industrial Big Data and Predictive Analytics for Smart Business Transformation

UNIT - II	Internet of Things (IoT)	Lecture Hrs: 8

Internet of Things (IoT) & Industrial Internet of Things (IIoT) & Internet of Services, Smart Manufacturing, Smart Devices and Products, Smart Logistics, Smart Cities, Predictive Analytics.

UNIT - III	Technologies for enabling Industry 4.0 :	Lecture Hrs: 8

Technologies for enabling Industry 4.0 - Cyber Physical Systems, Robotic Automation and Collaborative Robots, Support System for Industry 4.0, Mobile Computing, Cyber Security.

UNIT - IV	3D printing technologies	Lecture Hrs: 8

3D printing technologies, selection of material and equipment, develop a product using 3D printing in Industry 4.0 environment.

UNIT - V	IOT Case studies	Lecture Hrs: 10

IoT case studies, Industry 4.0 in healthcare services, Strategies for competing in an Industry 4.0 world.

Text Books:

1. Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things", Apress, 2016.
2. Lan Gibson, David W. Rosen and Brent Stucker, "Additive Manufacturing Technologies Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010.

Reference Books:

1. Andreas Gebhardt, "Understanding Additive Manufacturing: Rapid Prototyping, Rapid Tooling, Rapid Manufacturing", Hanser Publisher, 2011.
2. J. Chanchaichujit, A.Tan, Meng, F., Eaimkhong, S. "Healthcare 4.0 Next Generation Processes with the Latest Technologies", Palgrave Pivot, 2019.

Online Learning Resources:

Course Code		DISASTER MANAGEMENT (Audit Course 1 and 2)	L	T	P	C
Semester			2	0	0	0

Course Objectives:

- learn to demonstrate a critical understanding of key concepts in disaster risk reduction and
- humanitarian response.
- critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple
- perspectives.
- develop an understanding of standards of humanitarian response and practical relevance in
- specific types of disasters and conflict situations.
- critically understand the strengths and weaknesses of disaster management approaches,
- planning and programming in different countries, particularly their home country or the countries they work in

Course Outcomes (CO):

After completion of this course the student can be able to

- explain various reasons for disasters in India (L2)
- demonstrate Disaster Prone Areas In India (L2)
- understand risk assessment and disaster mitigation. (L2)

UNIT - I	**Introduction**	Lecture Hrs: 8

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**:	Lecture Hrs: 8

Repercussions Of Disasters And Hazards: 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**	Lecture Hrs: 8

Disaster Prone Areas In India: 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**	Lecture Hrs: 8

Disaster Preparedness And Management: 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 & Disaster Mitigation**	Lecture Hrs: 10

Risk Assessment: 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.

Disaster Mitigation: Meaning, Concept And Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs Of Disaster Mitigation In India.

Text Books:

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company.
2. Sahni, PardeepEt.Al. (Eds.)," Disaster Mitigation Experiences And Reflections", Prentice

Hall Of India, New Delhi.
Reference Books:
1. Goel S. L. , Disaster Administration And Management Text And Case Studies" ,Deep &Deep Publication Pvt. Ltd., New Delhi.
Online Learning Resources:

Course Code		SANSKRIT FOR TECHNICAL KNOWLEDGE (Audit Course 1 and 2)	L	T	P	C
Semester			2	0	0	0

Course Objectives:

- To get a working knowledge in illustrious Sanskrit, the scientific language in the world
- Learning of Sanskrit to improve brain functioning
- Learning of Sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power
- The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature

Course Outcomes (CO):

After completion of this course the student can be able to

- Understanding basic Sanskrit language
- Ancient Sanskrit literature about science & technology can be understood
- Being a logical language will help to develop logic in students

UNIT - I		Lecture Hrs: 8

- Alphabets in Sanskrit,
- Past/Present/Future Tense,
- Simple Sentences

UNIT - II		Lecture Hrs: 8

- Order
- Introduction of roots
- Technical information about Sanskrit Literature

UNIT - III		Lecture Hrs: 8

- Technical concepts of Engineering-Electrical, Mechanical,
- Architecture, Mathematics

Text Books:

1. "Abhyaspustakam" – Dr.Vishwas, Samskrita-Bharti Publication, New Delhi.
2. "Teach Yourself Sanskrit" Prathama Deeksha-VempatiKutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication.

Reference Books:

1. "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi.

Online Learning Resources:

Course Code		VALUE EDUCATION	L	T	P	C
Semester		(Audit Course 1 and 2)	2	0	0	0

Course Objectives:

Students will be able to

- Understand value of education and self- development.
- Imbibe good values in students.
- Let the should know about the importance of character.

Course Outcomes (CO):

After completion of this course the student can be able to

- Knowledge of self-development
- Learn the importance of Human values
- Developing the overall personality

UNIT - I		Lecture Hrs: 8

- Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism.
- Moral and non- moral valuation. Standards and principles.
- Value judgments

UNIT - II		Lecture Hrs: 8

- 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		Lecture Hrs: 8

- 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 brotherhood and religious tolerance.
- True friendship.
- Happiness Vs suffering, love for truth.
- Aware of self-destructive habits.
- Association and Cooperation.
- Doing best for saving nature

Text Books:

1. "Abhyaspustakam" – Dr.Vishwas, Samskrita-Bharti Publication, New Delhi.
3. "Teach Yourself Sanskrit" Prathama Deeksha-VempatiKutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication.

Reference Books:

2. "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi.

Online Learning Resources:

Course Code		CONSTITUTION OF INDIA	L	T	P	C
Semester		(Audit Course 1 and 2)	2	0	0	0

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 of nationhood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

Course Outcomes (CO):

After completion of this course the student can be able to

- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
- 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 through adult suffrage in the Indian Constitution.
- Discuss the passage of the Hindu Code Bill of 1956.

UNIT - I	**Introduction**	Lecture Hrs: 8

History of Making of the Indian Constitution:

- History, Drafting Committee, (Composition & Working)

Philosophy of the Indian Constitution:

- Preamble, Salient Features.

UNIT - II	**Contours of Constitutional Rights & Duties:**	Lecture Hrs: 8

Contours of Constitutional Rights & Duties:

- 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 - III	**Organs of Governance:**	Lecture Hrs: 8

Organs of Governance:

- 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 - IV	**Local Administration:**	Lecture Hrs: 8
Local Administration: • District's Administration head: Role and Importance, • Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. • Pachayati raj: Introduction, PRI: ZilaPachayat. • Elected officials and their roles, CEO ZilaPachayat: Position and role. • Block level: Organizational Hierarchy (Different departments), • Village level: Role of Elected and Appointed officials, • Importance of grass root democracy		
UNIT - V	**Election Commission:**	Lecture Hrs: 10
Election Commission: • Election Commission: Role and Functioning. • Chief Election Commissioner and Election Commissioners. • State Election Commission: Role and Functioning. • Institute and Bodies for the welfare of SC/ST/OBC and women.		
Text 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.		
Reference Books:		
1. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014. 2. 4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.		
Online Learning Resources:		

Course Code		PEDAGOGY STUDIES	L	T	P	C
Semester		(Audit Course 1 and 2)	2	0	0	0

Course Objectives:

- Review existing evidence on the review topic to inform programme design and policy making undertaken by the DfID, other agencies and researchers.
- Identify critical evidence gaps to guide the development.

Course Outcomes (CO):

After completion of this course the student can be able to

- What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries?
- What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
- How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

UNIT - I	**Introduction and Methodology:**	Lecture Hrs: 8

- 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:	Lecture Hrs: 8

- Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries.
- Curriculum, Teacher education.

UNIT - III		Lecture Hrs: 8

- Evidence on the effectiveness of pedagogical practices
- 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:	Lecture Hrs: 8

- Professional development: alignment with classroom practices and follow-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**	Lecture Hrs: 10

- Research design
- Contexts
- Pedagogy
- Teacher education
- Curriculum and assessment
- Dissemination and research impact.

Text Books:

1. Ackers J, Hardman F (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.

Reference Books:

1. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.
2. 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.
3. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
4. Chavan M (2003) Read India: A mass scale, rapid, 'learning to read' campaign.

Online Learning Resources:

www.pratham.org/images/resource%20working%20paper%202.pdf.

Course Code		STRESS MANAGEMENT BY YOGA	L	T	P	C
Semester	I	(Audit Course 1 and 2)	2	0	0	0

Course Objectives:

- To achieve overall health of body and mind.
- To overcome stress.

Course Outcomes (CO): Student will be able to

Students will be able to:

- Develop healthy mind in a healthy body thus improving social health also.
- Improve efficiency.

UNIT - I	**Basic Concepts**	Lecture Hrs: 8

Definitions of Eight parts of yog. (Ashtanga)

UNIT - II	**Yam and Niyam**	Lecture Hrs: 8

Yam and Niyam:

Do`s and Don't's in life.

i) Ahinsa, satya, astheya, bramhacharya and aparigraha
ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan

UNIT - III	**Asan and Pranayam**	Lecture Hrs: 8

Asan and Pranayam:

i) Various yog poses and their benefits for mind & body
ii) Regularization of breathing techniques and its effects-Types of pranayam

Textbooks:

1. Janardan Swami Yogabhyasi Mandal 'Yogic Asanas for Group Tarining-Part-I', Nagpur.
2. Swami Vivekananda "Rajayoga or conquering the Internal Nature", Advaita Ashrama (Publication Department), Kolkata.

Reference Books:

1. Yoga Student Handbook, Class XI, Trainee manual, Centra Board of Secondary Education, India.
2. Acharya Yatendra, Yoga & Stress Management, Fingerprint! Publishing, 2019.

Online Learning Resources:

- https://www.youtube.com/watch?v=bMEqN8yGMu4
- https://www.youtube.com/watch?v=Jf5qUhz-FVk
- https://www.artofliving.org/us-en/how-to-incorporate-the-8-limbs-of-yoga-into-your-practice
- https://www.youtube.com/watch?v=kxVNwXGlXRk

Course Code		PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS (Audit Course 1 and 2)	L	T	P	C
Semester			2	0	0	0

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 (CO):

After completion of this course the student can be able to

- Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life.
- The person who has studied Geeta will lead the nation and mankind to peace and prosperity.
- Study of Neetishatakam will help in developing versatile personality of students.

UNIT - I	Neetisatakam	Lecture Hrs: 8

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)

UNIT - II		Lecture Hrs: 8

- Approach to day to day work and duties.
- Shrimad BhagwadGeeta: 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.

UNIT - III		Lecture Hrs: 8

- Statements of basic knowledge.
- Shrimad BhagwadGeeta: Chapter2-Verses 56, 62, 68
- Chapter 12 -Verses 13, 14, 15, 16,17, 18
- Personality of Role model. Shrimad BhagwadGeeta:
- Chapter2-Verses 17, Chapter 3-Verses 36,37,42,
- Chapter 4-Verses 18, 38,39
- Chapter18 – Verses 37,38,63

Text Books:

1. "Srimad Bhagavad Gita" by Swami SwarupanandaAdvaita Ashram (Publication Department), Kolkata

Reference Books:

1. Bhartrihari's Three Satakam (Niti-sringar-vairagya) by P.Gopinath, Rashtriya Sanskrit Sansthanam, New Delhi.