SETHU INSTITUTE OF TECHNOLOGY

PULLOOR, KARIAPATTI – 626 115.

(AN AUTONOMOUS INSTITUTION)

REGULATION – 2019

M.E CAD/CAM

CHOICE BASED CREDIT SYSTEM

CURRICULUM & SYLLABUS

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Pulloor, Kariapatti - 625 115

SETHU INSTITUTE OF TECHNOLOGY

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(***An Autonomous Institution***)

M.E. Degree Programme

CURRICULUM

Regulations 2019

M.E CAD/CAM

OVERALL COURSE STRUCTURE

S. No	Topic	Total no. Courses	Credits	Percentage
1	Programme-Core	8	20	29
2	Programme- Elective	5	15	22
3	Open Elective	1	3	4
4	Mandatory Credit Course	1	3	4
5	Audit Course	2	0	0
6	Project Work	3	29	41
TOTAL		20	70	100

COURSE CREDITS – SEMESTER WISE

Branch	I	II	III	IV	TOTAL
ME CAD CAM	16	16	22	16	70

Employability Courses
Skill Development Courses
Entrepreneurship Development Courses
Any two or all of the above

M.E CAD/CAM

REGULATION – 2019

(Applicable to the students admitted from the Academic Year 2019 – 2020 onwards)

CURRICULUM I TO IV SEMESTERS

SEMESTER I

SL. No.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	19PCD101	Computer Application in Design	3	0	0	3
2.	19PCD102	Advanced Finite Element Analysis	3	0	0	3
3.	19PGM701	Research Methodology and IPR	3	0	0	3
4.	19PGM801	Pedagogy Studies	2	0	0	0
5.		Programme Elective	3	0	0	3
PRACTICAL						
6.	19PCD103	Cad Laboratory	0	0	4	2
7.	19PCD104	Computer Aided Engineering Laboratory	0	0	4	2
TOTAL			**14**	**0**	**8**	**16**
Total Number of Credits: 16						

SEMESTER II

SL. No.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	19PCD201	Design for Manufacture, Assembly and Environments	3	0	0	3
2.	19PCD202	Applied Materials Engineering	3	0	0	3
3.	19PGM802	English for Research Paper Writing	2	0	0	0
4.		Programme Elective	3	0	0	3
PRACTICAL						
5.	19PCD203	Cam Laboratory	0	0	4	2
6.	19PCD204	Advanced Analysis and Simulation Laboratory	0	0	4	2
7.	19PCD205	Mini Project with Seminar	0	0	4	3
TOTAL			**11**	**0**	**12**	**16**
Total Number of Credits: 16						

SEMESTER III

SL. No.	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.		Programme Elective	3	0	0	3
2.		Programme Elective	3	0	0	3
3.		Programme Elective	3	0	0	3
4.		Open Elective	3	0	0	3
PRACTICAL						
5.	19PCD301	Project Work (PHASE – I)	0	0	20	10
TOTAL			**12**	**0**	**20**	**22**
Total Number of Credits: 22						

SEMESTER IV

SL. No.	COURSE CODE	COURSE TITLE	L	T	P	C
PRACTICAL						
1.	19PCD401	Project Work (PHASE – II)	0	0	32	16
TOTAL			**0**	**0**	**32**	**16**
Total Number of Credits: 16						

PROGRAMME ELECTIVE

S.No	Course Code	Course Title	L	T	P	C
1.	19PCD501	Mechatronics in Manufacturing Systems	3	0	0	3
2.	19PCD502	Tribology in Design	3	0	0	3
3.	19PCD503	Design of Hydraulic and Pneumatic Systems	3	0	0	3
4.	19PCD504	Data Communication in CAD/CAM	3	0	0	3
5.	19PCD505	Performance Modeling and Analysis of Manufacturing System	3	0	0	3
6.	19PCD506	Optimization Techniques in Design	3	0	0	3
7.	19PCD507	Industrial Safety Management	3	0	0	3
8.	19PCD508	Integrated manufacturing system	3	0	0	3
9.	19PCD509	Vibration Analysis and Control	3	0	0	3
10.	19PCD510	Metrology and Non Destructive Testing	3	0	0	3
11.	19PCD511	Advanced Mechanics of Materials	3	0	0	3
12.	19PCD512	Design of Material Handling Equipments	3	0	0	3
13.	19PCD513	Advanced Tool Design	3	0	0	3
14.	19PCD514	Mechanisms Design and Simulation	3	0	0	3
15.	19PCD515	Computational Fluid Dynamics in Manufacturing	3	0	0	3
16.	19PCD516	Reliability Engineering Models	3	0	0	3
17.	19PCD517	Maintenance Engineering and Management	3	0	0	3
18.	19PCD518	Industrial Robotics and Expert Systems	3	0	0	3
19.	19PCD519	Lean Manufacturing	3	0	0	3
20.	19PCD520	Design for Cellular Manufacturing Systems	3	0	0	3

21.	19PCD521	Integrated Product Design and Processes Development	3	0	0	3
22.	19PCD522	Competitive Manufacturing Systems	3	0	0	3
23.	19PCD523	Additive Manufacturing	3	0	0	3
24.	19PCD524	Integrated Mechanical Design	3	0	0	3
25.	19PCD525	Synthesis and Characterization of Nano materials	3	0	0	3
26.	19PCD526	Design and Analysis of Experiments	3	0	0	3
27.	19PCD527	Mechanical Behavior of Materials	3	0	0	3
28.	19PCD528	Material Testing and Characterization	3	0	0	3
29.	19PCD529	Composite Materials and Mechanics	3	0	0	3
30.	19PCD530	Advanced Optimization Techniques	3	0	0	3

LIST OF OPEN ELECTIVE

S. No	Course Code	Course Title	L	T	P	C
1.	19PCD601	Industrial Safety	3	0	0	3

19PCD101	COMPUTER APPLICATIONS IN DESIGN	L	T	P	C
		3	0	0	3

OBJECTIVES:

- This course aims at imparting knowledge on computer applications in design

UNIT I INTRODUCTION TO COMPUTER GRAPHICS FUNDAMENTALS 9

Output primitives (points, lines, curves etc.,), 2-D & 3-D transformation (Translation, scaling, rotation) windowing - view ports - clipping transformation

UNIT II CURVES AND SURFACES MODELING 9

Introduction to curves - Analytical curves: line, circle and conics – synthetic curves: Hermite cubic spline- Bezier curve and B-Spline curve – curve manipulations.

Introduction to surfaces - Analytical surfaces: Plane surface, ruled surface, surface of revolution and tabulated cylinder – synthetic surfaces: Hermite bicubic surface- Bezier surface and B-Spline surface- surface manipulations.

UNIT III NURBS AND SOLID MODELING 9

NURBS- Basics- curves, lines, arcs, circle and bi linear surface. Regularized Boolean set operations - primitive instancing - sweep representations - boundary representations – constructive solid Geometry - comparison of representations - user interface for solid modeling.

UNIT IV VISUAL REALISM 9

Hidden – Line – Surface – solid removal algorithms shading – coloring. Introduction to parametric and variational geometry based software's and their principles creation of prismatic and lofted parts using these packages.

UNIT V ASSEMBLY OF PARTS AND PRODUCT DATA EXCHANGE 9

Assembly modeling - interferences of positions and orientation - tolerances analysis – mass property calculations - mechanism simulation.

Graphics and computing standards– Open GL Data Exchange standards – IGES, STEP etc– Communication standards.

Total: 45 Periods

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

Course outcomes:

- **Apply** relevant algorithms to generate basic geometrical primitives and perform transformations.

- **Apply** the surface generation techniques for surface modelling using the analytical and synthetic curves .
- **Analyze** and synthesize solid model into solid primitives using CSG tree.
- **Develop** solid models using solid modeling techniques.
- **Analyze** the solid model to remove the hidden lines/surfaces using algorithms.
- **Demonstrate** the principles of assembly modelling and mechanism simulation to form assembly models and simulation models.

REFERENCES:

1. David F. Rogers, James Alan Adams "Mathematical elements for computer graphics" second edition, Tata McGraw-Hill edition.
2. Donald Hearn and M. Pauline Baker "Computer Graphics", Prentice Hall, Inc., 1992.
3. Foley, Wan Dam, Feiner and Hughes – Computer graphics principles & practices, Pearson Education – 2003.
4. Ibrahim Zeid Mastering CAD/CAM – McGraw Hill, International Edition, 2007.
5. William M Neumann and Robert F.Sproul "Principles of Computer Graphics", Mc Graw Hill Book Co. Singapore, 1989.

19PCD102	ADVANCED FINITE ELEMENT ANALYSIS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To develop a thorough understanding of the advanced finite element analysis techniques with an ability to effectively use the tools of the analysis for solving practical problems arising in engineering design

UNIT I BENDING OF PLATES AND SHELLS 8

Review of Elasticity Equations – Bending of Plates and Shells – Finite Element Formulation of Plate and Shell Elements - Conforming and Non-Conforming Elements – C0 and C1 Continuity Elements –Degenerated shell elements- Application and Examples

UNIT II NON-LINEAR PROBLEMS 10

Introduction – Iterative Techniques – Material non-linearity – Elasto Plasticity – Plasticity – Visco Plasticity – Geometric Non linearity – large displacement Formulation –Solution procedure- Application in Metal Forming Process and Contact Problems

UNIT III DYNAMIC PROBLEM 10

Direct Formulation – Free, Transient and Forced Response – Solution Procedures – Eigen solution-Subspace Iterative Technique – Response analysis-Houbolt, Wilson, Newmark – Methods. Explicit & Implict Methods-Lanchzos, Reduced method for large size system equations.

UNIT IV FLUID MECHANICS AND HEAT TRANSFER 9

Governing Equations of Fluid Mechanics – Solid structure interaction - Inviscid and Incompressible Flow – Potential Formulations – Slow Non-Newtonian Flow – Metal and Polymer Forming – Navier Stokes Equation – Steady and Transient Solution.

UNIT V ERROR ESTIMATES AND ADAPTIVE REFINEMENT 8

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

Total: **45 Periods**

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

- Understand the Finite Element Formulation of Plate and Shell Elements
- Gain knowledge in material & geometric non-and plasticity
- Solve problems under dynamic conditions by applying various techniques.
- Arrive at the solutions for fluid mechanics and heat transfer problems
- Acquire knowledge in error norms, convergence rates and refinement

REFERENCES BOOKS:

1. Reddy J.N, "An Introduction to the Finite element Method", McGraw – Hill, 1985.
2. Rao S.S, "Finite Element Method in Engineering", Pergammon Press, 1989.
3. Tirupati R Chandrupatla and Ashok. D. Belegundu, "Introduction of finite element in Engineering", Prentice hall of India, 1997.
4. Bathe K.J, "Finite Element Procedures in Engineering Analysis", 1990.Kobayashi S., Soo-IK-Oh and Altan, T, "Metal forming and the Finite element Methods", Oxford University Press, 1989.
5. Lewis R.W, Morgan K, Thomas H.R, and Seetharaman K.N, "The Finite Element Method in Heat Transfer Analysis", John Wiley, 1994.
6. L Darrell W. Pepper and Juan C. Heinrich M, **"**Finite Element Methods: Basic Concepts and Applications", Hemisphere publishing corporation, 1992.
7. Singiresu S. Ra, "The Finite Element Method in Engineering", Elsevier, 2005.

19PGM701	RESEARCH METHODOLOGY AND IPR	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide an overview on selection of research problem based on the Literature review
- To enhance knowledge on the Data collection and Analysis for Research design
- To outline the importance of ethical principles to be followed in Research work and IPR

UNIT I INTRODUCTION TO PROJECT FORMULATION 9

Meaning of research problem, Sources of research problem, Criteria, Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. 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, treatise, monographs-patents – web as a source – searching the web - Critical literature review – Identifying gap areas from literature review - Development of working hypothesis

UNIT II DATA COLLECTION, ANALYSIS AND ETHICS 9

Execution of the research - Observation and Collection of data - Methods of data collection Sampling Methods- Data Processing and Analysis strategies - Data Analysis with Statistical Packages - Hypothesis-testing - Generalization and Interpretation - Plagiarism, Application of results and ethics - Environmental impacts - Ethical issues - ethical committees

UNIT III REPORT,THESIS, PAPER AND RESEARCH PROPOSAL WRITING 9

Structure and components of scientific reports - Types of report – Technical reports and thesis – Significance – Different steps in the preparation – Layout, structure and Language of typical reports – Illustrations and tables - Bibliography, referencing and footnotes, how to write report- Paper Developing a Research Proposal- Format of research proposal- a presentation and assessment by a review committee

UNIT IV INTELLECTUAL PROPERTY 9

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

UNIT V PATENT RIGHTS AND NEW DEVELOPMENTS IN IPR 9

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.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- Identify and Formulate the Research Problem
- Collect and Analyze data from various sources of Literature.
- Write thesis effectively including technical reports and other contents.
- Explain the ethical principles to be followed while patenting or obtaining copyright.
- Apply for patent rights and demonstrate New developments in IPR

REFERENCES

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
2. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418p.
3. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, Ess Ess Publications. 2 volumes.
4. Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing. 270p.
5. Wadehra, B.L. 2000. Law relating to patents, trade marks, copyright designs and geographical indications. Universal Law Publishing.

Additional reading

1. Anthony, M., Graziano, A.M. and Raulin, M.L., 2009. Research Methods: A Process of Inquiry, Allyn and Bacon.
2. Carlos, C.M., 2000. Intellectual property rights, the WTO and developing countries: the TRIPS agreement and policy options. Zed Books, New York.
3. Coley, S.M. and Scheinberg, C. A., 1990, "Proposal Writing", Sage Publications.
4. Day, R.A., 1992.How to Write and Publish a Scientific Paper, Cambridge University Press.
5. Fink, A., 2009. Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications
6. Leedy, P.D. and Ormrod, J.E., 2004 Practical Research: Planning and Design, Prentice Hall.
7. Satarkar, S.V., 2000. Intellectual property rights and Copy right. Ess Ess Publications

19**PGM801**	Pedagogy Studies	**L**	**T**	**P**	**C**
		2	**0**	**0**	**0**

Objectives:

- To make the students understand a range of cognitive capacities in human learners
- To explain the outcome-based education system
- To describe the curriculum design process

Unit I: Educational Psychology and Engineering Education (4)

Learning process, motivation and engagement, ICT in learning and teaching, Facilitating the learners, Engineering education and recent trends, Research in Engineering education, General maxims of teaching, Teacher-centered, learner-centered and learning-centered approaches, Becoming a reflective teacher, Disruptive Innovation in Education

Unit II: Outcome Based Education (4)

Outcome Based Education: A broad context for quality teaching and learning, planning for quality teaching and learning, Necessity for learning outcomes - Course Outcomes and Program Outcomes, Defining learning outcomes, learning outcomes in the cognitive domain, learning outcomes in the affective domain, learning outcomes in the psychomotor domain, Program Outcomes, Graduate Attributes, Program Educational Objectives, linking learning outcomes to teaching and assessment.

Unit III: Curriculum Design (4)

Curriculum design cycle, curriculum structure, credit and academic load, need assessment – feedback from stakeholders, concept of "Constructive alignment", the two loop approach of ABET, tuning approach of curriculum design, CDIO concept of curriculum design and implementation, Industry relevant curriculum design and implementation, concept mapping, Instructional design and delivery.

Unit IV: Teaching and Assessment Strategies (4)

Direct instruction as teaching strategy, co-operative learning, problem-solving, industry relevant teaching, role-play, case study, technology enabled teaching, research orientation, measurement and evaluation of students' achievement, assessment of learning outcomes - assessment tools: direct and indirect assessment tools, rubrics for assessment, attainment analysis, corrective action- curriculum updation, improvement in pedagogy, innovative assessment methods.

Course Outcomes:

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

1. Develop pedagogical expertise through an introduction to theoretically-based teaching methods and strategies
2. Write learning outcomes and link learning outcomes to appropriate assessments
3. Design syllabus and lesson plans that align with learning outcomes
4. Use technology to enhance teaching and learning
5. Choose teaching-learning strategies appropriate to the needs of the learners

References:

1) Dr.Sue Duchesne, Anne McMaugh, Sandra Bochner, Kerri-Lee Krause, "Educational Psychology for Learning and Teaching", Cengage Learning, 4th Edition, 2019.

2) *Lisa R. Lattuca, Patrick T. Terenzini, J. Fredericks Volkwein, and George D. Peterson, "*The Changing Face of Engineering Education*"* The Bridge, National Academy of Engineering, Summer 2006

3) Anderson, L. & Krathwohl , D. A Taxonomy for Learning, Teaching and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives . New York: Longman, 2001.

4) Blumberg, P. Developing learner-centred teaching: A practical guide for faculty. San Francisco: Jossey-Bass, 2017.

5) Teaching Support Services. Learning objectives. University of Guelph, Guelph, ntario. Retrieved from http://www.uoguelph.ca/tss/resources/idres/learningobjectives1.pdf

6) O.V. Boev, N.Gruenwald and G.Heitmann, "Engineering Curriculum Design aligned with Accrediation Standards", Hochschule Wismar Publishers, 2013

Fink, D. L. Integrated course design. Manhattan, KS: The IDEA Center, 2005. Retrieved from http://www.theideacenter.org/sites/default/files/Idea_Paper_42.pdf

19**PCD103**	**CAD LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**4**	**2**

OBJECTIVE:

- To understand the different type of solid model package and create the graphical solid model.
- Apply the principles of two-dimensional CAD in the solution of various design problems.

CAD Introduction.
Sketcher
Solid modeling –Extrude, Revolve, Sweep, etc and Variational sweep, Loft ,etc
Surface modeling –Extrude, Sweep, Trim ..etc and Mesh of curves, Free form etc
Feature manipulation – Copy, Edit, Pattern, Suppress, History operations etc.
Assembly-Constraints, Exploded Views, Interference check
Drafting-Layouts, Standard & Sectional Views, Detailing & Plotting.
CAD data Exchange formats- IGES, PDES, PARASOLID, DXF and STL

Exercises in Modeling and drafting of Mechanical Components - Assembly using Parametric and feature based Packages like PRO-E / SOLID WORKS /CATIA / NX etc

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

- **Create** of shafts, rounds, chamfers and slots models using computer aided design
- **Assemble** the part models using constraints
- familiarized with the computer applications in design and preparing drawings for various mechanical components.

TOTAL: 45 PERIODS

19**PCD104**	**COMPUTER AIDED ENGINEERING LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**4**	**2**

OBJECTIVES:

- To analysis the complex problem by using the ANSYS / ABAQUS etc.,
- Synthesize information and apply critical thinking skills to solve instructional problems typical to industry.

Analysis of Mechanical Components – Use of FEA Packages like ANSYS/ NASTRAN etc.,

Force and Stress analysis using link elements in Trusses, cables etc.
Stress and deflection analysis in beams with different support conditions.
Stress analysis of flat plates and simple shells.
Stress analysis of axi – symmetric components.
Thermal stress and heat transfer analysis of plates.
Thermal stress analysis of cylindrical shells.
Vibration analysis of spring-mass systems.
Model analysis of Beams.
Harmonic, transient and spectrum analysis of simple systems

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

- Analyze the problem with help of the Pro-E model (to import the model to the ANSYS) to get the various mechanical properties.

19**PCD201**	**DESIGN FOR MANUFACTURE, ASSEMBLY AND ENVIRONMENTS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To Design for Manufacture, Assembly and Environments is to create new and better ideas and improving the existing one
- To analyze and Redesign the component by the influence of man, machine, material and process

UNIT I INTRODUCTION 8

General design principles for manufacturability - strength and mechanical factors, mechanisms selection, evaluation method, Process capability - Feature tolerances -Geometric tolerances - Assembly limits -Datum features - Tolerance stacks

UNIT II FACTORS INFLUENCING FORM DESIGN 9

Working principle, Material, Manufacture, Design- Possible solutions - Materials choice -Influence of materials on form design - form design of welded members, forgings and castings.

UNIT III COMPONENT DESIGN - MACHINING CONSIDERATION 10

Design features to facilitate machining - drills - milling cutters - keyways – Doweling procedures, counter sunk screws - Reduction of machined area- simplification by separation - simplification by amalgamation - Design for machinability - Design for economy - Design for clampability - Design for accessibility - Design for assembly.

UNIT IV COMPONENT DESIGN - CASTING CONSIDERATION 8

Redesign of castings based on Parting line considerations - Minimizing core requirements, machined holes, redesign of cast members to obviate cores. Identification of uneconomical design - Modifying the design - group technology – Computer Applications for DFMA.

UNIT V DESIGN FOR THE ENVIRONMENT 10

Introduction – Environmental objectives – Global issues – Regional and local issues –Basic DFE methods – Design guide lines – Example application – Lifecycle assessment – Basic method – AT and T's environmentally responsible product assessment - Weighted sum assessment method – Lifecycle assessment method – Techniques to reduce environmental impact – Design to minimize material usage – Design for disassembly –Design for recyclability – Design for remanufacture – Design for energy efficiency –Design to regulations and standards.

Total: 45 Periods

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

- **Arrange** the Geometric tolerances
- **Discus** the minimize moulding core requirement
- **categorize** of materials on form design
- **Identify** the different part family in group technology
- **Assess** the Techniques to reduce environmental impact

REFERENCES:

1. Boothroyd G, "Design for Assembly Automation and Product Design", Marcel Dekker, New York, 1980.
2. Bralla, "Design for Manufacture handbook", McGraw hill, 1999.
3. Boothroyd, G, Heartz and Nike, "Product Design for Manufacture", Marcel Dekker, 1994.
4. Dickson, John. R and Corroda Poly, "Engineering Design and Design for Manufacture and Structural Approach", Field Stone Publisher, USA, 1995.
5. Fixel, J, "Design for the Environment ", McGraw hill, 1996.
6. Graedel T.and Allen By. B, "Design for the Environment Angle Wood Cliff ", Reason Pub., Prentice Hall, 1996.

19PCD202	APPLIED MATERIALS ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide knowledge in the areas of characterization of materials
- To impart knowledge on selection of materials for important applications

UNIT I PLASTIC BEHAVIOUR & STRENGTHENING 8

Mechanism of Plastic deformation, role of dislocations, yield stress, shear strength of perfect and real crystals –Strengthening mechanism, work hardening, solid solutioning, grain boundary strengthening, Poly phase mixture, precipitation, particle fibre and dispersion strengthening. Effect of temperature, strain and strain rate on plastic behaviour, Super plasticity.

UNIT II FRACTURE BEHAVIOUR 8

Griffith's theory stress intensity factor and fracture toughness-Toughening mechanisms – Ductile, brittle transition in steel-High temperature fracture, creep – Larson-Miller, Parameter – Deformation and fracture mechanism maps – Fatigue. Low and high cycle fatigue test, crack initiation and propagation mechanisms and Paris law – Effect of surface and metallurgical parameters on fatigue – fracture of non metallic materials – Failure analysis, sources of failure, procedure of failure analysis.

UNIT III CHARACTERIZATION OF MATERIALS 10

X-ray diffraction, Crystallography basics, characteristic spectrum, Bragg's law, Diffraction methods – Lauer, rotating crystal and powder methods. Optical microscopy, Construction and operation of Transmission electron microscope – Selected Area Electron Diffraction and image formation, specimen preparation techniques Scanning electron microscopy, Transmission electron microscopy, Atomic force microscope, thermal analysis techniques.

UNIT IV MATERIAL TESTING & SELECTION OF MATERIALS 9

Tension, Hardness, torsion, bending, fracture and impact tests. Motivation for selection of materials , cost basis and service requirements – selection for Mechanical properties, strength, toughness, fatigue and creep – Selection for surface durability corrosion and wear resistance – Relationship between materials selection and processing – Case studies in materials selection with Relevance to aero, auto, marine, machinery and nuclear applications.

UNIT V MODERN MATERIALS AND TREATMENT 10

Dual phase steels, high strength low alloy (HSLA) Steel, transformation included plasticity (TRIP) Steel, maraging steel, shape memory alloys, properties applications of engineering plastics and composites materials, advanced structural ceramics – Wc, TiC, TaC, Al_2O_3, SiC, Si_3N_4, CBN, diamond, heat treatment alloy and tool steels, vapour deposition – Plasma, PVD- thick and thin film deposition – Nano materials-production of Nano sized materials. **Total: 45 Periods**

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

- **Summarize** the behavior of materials under different loading conditions
- **Select** appropriate material for the application concerned
- **Apply** the modern materials
- **Describe** the deferent types of ceramics
- **Describe** the Relationship between materials selection and processing

REFERENCES:

1. George E. Dieter, "Mechanical Metallurgy", McGraw Hill,1988.
2. Charles J.A, Crane F.A.A. and Furness J.A.G, "Selection and use of Engineering Materials ", Third Edition, Butterworth – Heiremann, 1997.
3. Cullity B. D, "Elements of X-ray diffraction", Addison-Wesley Company Inc., Third Edition, Newyork, 2000.
4. Brandon D. G, "Modern Techniques in Metallography", Von Nostrand Inc NJ, USA, 1986.
5. Thomas G, "Transmission electron microscopy of metals", John Wiley, 1996.
6. James K.Wessel, Wiley and Intersam John, "The Hand book of Advance Materials ", Wilson Publishers, 2004.
7. Tadeu Z Burakowski, Tadenz. Wierzchon, "Surface Engg of Metals", Principles, Equipment, Technlogies, CRC press, 1998.
8. Thomas H.Courtney, "Mechanical Behaviour of Materials", McGraw Hill, 2nd edition, 2000.
9. Flinn R.A. and Trojan, P.K, "Engg Materials and their Applications ",4th Edition, Jaico, 1999.
10. Metals hand book, vol. 10, "Failure Analysis and Prevention",10th edition, 1999.
11. Weinberg, F, "Tools and Techniques in Physical Metallurgy", Marcel and Decker, 1970.

19PGM802	English for Research Paper Writing	L	T	P	C
		2	0	0	0

OBJECTIVES:

- To give and exposure on writing skills and readability
- To impart the knowledge of each section of the paper
- To enhance the student to write the good quality Research paper

UNIT-I INTRODUCTION TO RESEARCH 9

Introduction to Research Paper, Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs, Clarity and Removing Redundancy, Highlighting the Findings, Hedging and Criticizing, Paraphrasing and Plagiarism - Useful idioms & phrases.

UNIT-II STRUCTURE OF RESEARCH PAPER 6

Types of the Research papers, Regular Research Paper - Review Research Paper – Case Study Research Paper – Research Letters - Sections of a Paper, Title, Author names and affiliations - Corresponding author - Abstracts, Keywords, Highlights, Graphical Abstract - Introduction, Methods, Results, Discussion, Conclusions, Acknowledgment - the First Draft.

UNIT-III METHODOLOGY, RESULTS & DISCUSSION AND CONCLUSION 9

Introduction – Writing preview of Research work – Review of literature – assimilating the points – Logical flow – Research gap - Writing the Methodology – Sequence - Specification – Explaining results – Interpretation and plotting – Discussion of the salient findings – Critical analysis – Writing the Conclusion

UNIT-IV SUBMISSION OF RESEARCH PAPER 6

References – Citations and Checking the Citations – Various forms of Citation - Guidelines for authors – Manuscript submission – Conflict of Interest - Authors reply for Reviewer comments – Point by Point Explanation – Resubmission – Acceptance – Copyright – Proof reading and final submission.

COURSE OUTCOMES

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

- Write research paper effectively with improved standard of language
- Explain the different sections of the Research paper
- Formulate the Acceptable Research Manuscript

REFERENCES

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

Additional Reading

1. MLA Handbook for Writers of Research Papers, The Modern Language Association of America, New York 2009

19**PCD203**	**CAM LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**4**	**2**

COURSE OBJECTIVES:

- To impart CNC part programming skills for turning and milling applications.
- To give a good exposure of CAM software in order to perform simulation and to generate CI
- To provide an adequate knowledge to use Computer Aided Measuring Instruments for manufacturing applications.

Simulation and Machining using CNC / DNC Machine Tools – Use of FEM Packages - Relational Data Base – Networking – Practice on Computer Aided Measuring Instruments – Image Processing – Software Development for Manufacturing – CNC Controllers – Use of advanced CNC Machining Packages – Business Data Processing.

EQUIPMENTS FOR CAM LAB

1. CAM Software for tool path generation for planer machining, contour machining, drilling, turning etc. & post processing modulus for different CNC controllers : 10 Nos
2. Medium production type CNC turning center with popular industrial type controller : 1
3. Medium production type CNC machining center with popular industrial type controller : 1
4. Bench Model CMM : 1
5. Vision & image processing software : 2
6. Data Processing Software : 2

TOTAL: 30 PERIODS

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

- Course would be helpful to understand the basic concepts in NC technology.
- This course would make familiar of the use of CAE and CAM software.
- Students would be able to apply the concepts of Machine Vision to various Industrial applications.

- Students would be trained to write and execute NC program on CNC production machines for different jobs.

19**PCD204**	**ADVANCED ANALYSIS AND SIMULATION LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**4**	**2**

OBJECTIVES:

To give exposure to software tools needed to analyze engineering problems.

To expose the students to different applications of simulation and analysis tools.

To learn and get familiar with the ANSYS Workbench.

To learn the basic steps of modelling MEMS devices using ANSYS Workbench.

To learn the simulation and analysis steps of the MEMS model.

SIMULATION

1. MATLAB basics, Dealing with matrices, Graphing-Functions of one variable and two variables
2. Use of Matlab to solve simple problems in vibration
3. Mechanism Simulation using Multibody Dynamic software

ANALYSIS

1. Structural analysis of Piston using ANSYS Workbench.
2. Structural Analysis of a Cantilever Using ANSYS Workbench
3. Structural Analysis of Simply Supported Beam Using ANSYS Workbench
4. Thermal analysis of Disc Brake using ANSYS Workbench
5. Thermal analysis of Piston using ANSYS Workbench

TOTAL: 60 PERIODS

OUTCOME:

Upon completion of this course, the Students can model, analyse and simulate experiments to meet real world system and evaluate the performance.

19**PCD205**	**MINI PROJECT WITH SEMINAR**	**L**	**T**	**P**	**C**
		0	**0**	**4**	**3**

OBJECTIVES:

- To inculcate the importance of communication skills
- To familiarize with the concepts in emerging engineering field

DESCRIPTION:

This course is introduced to enrich the communication skills of the student and to create awareness on recent development in Electrical and Electronics Engineering through Technical presentation. In this course, a student has to present at least two Technical papers or recent advances in Engineering / Technology that will be evaluated by a Committee constituted by the Head of the Department.

Students should work on a small research problem. Students have to carry out the project under the guidance of faculty member using the knowledge of subjects that he/she has learned. The student should submit the report at the end of the semester. The product should be demonstrated at the time of examination.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

After the successful completion of this course, the student will be able to

- Understand the basic concept of core subject
- Explain the concept in an effective manner
- Apply innovative ideas on emerging engineering field.
- Implement the novelty in mini projects
- Demonstrate the Technical ideas with good communication skill.

19**PCD301**	**PROJECT WORK (PHASE – I)**	**L**	**T**	**P**	**C**

0	**0**	**20**	**10**

OBJECTIVES

To identify a specific problem for the current need of the society and collecting information related to the same through detailed review of literature.

To develop the methodology to solve the identified problem.

To train the students in preparing project reports and to face reviews and viva-voce examination.

SYLLABUS

The student individually works on a specific topic approved by the head of the division under the guidance of a faculty member who is familiar in this area of interest. The student can select any topic which is relevant to the area of engineering design. The topic may be theoretical or case studies. At the end of the semester, a detailed report on the work done should be submitted which contains clear definition of the identified problem, detailed literature review related to the area of work and methodology for carrying out the work. The students will be evaluated through a viva-voce examination by a panel of examiners including one external examiner.

TOTAL: 180 PERIODS

OUTCOME:

At the end of the course the students will have a clear idea of their area of work and they will be in a position to carry out the remaining phase II work in a systematic way.

19PCD401	**PROJECT WORK (PHASE – II)**	**L**	**T**	**P**	**C**
		0	**0**	**32**	**16**

OBJECTIVES:

To solve the identified problem based on the formulated methodology.

To develop skills to analyze and discuss the test results, and make conclusions.

SYLLABUS:

The student should continue the phase I work on the selected topic as per the formulated methodology under the same supervisor. At the end of the semester, after completing the work to the satisfaction of the supervisor and review committee, a detailed report should be prepared and submitted to the head of the department. The students will be evaluated based on the report submitted and the viva-voce examination by a panel of examiners including one external examiner

TOTAL: 360 PERIODS

OUTCOME:

On completion of the project work students will be in a position to take up any challenging practical problem in the field of engineering design and find better solutions to it.

19PCD501	**MECHATRONICS IN MANUFACTURING SYSTEMS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To get knowledge about sensors and Transducers
- To study about microprocessors and programmable logic controllers
- To understand the design principles of Mechatronics

UNIT I INTRODUCTION 9

Introduction to Mechatronics - Systems - Mechatronics in Products – Measurement Systems - Control Systems - Traditional design and Mechatronics Design.

UNIT II SENSORS AND TRANSDUCERS 9

Introduction - Performance Terminology - Displacement, Position and Proximity - Velocity and Motion - Fluid pressure - Temperature sensors - Light sensors - Selection of sensors - Signal processing - Servo systems.

UNIT III MICROPROCESSORS IN MECHATRONICS 9

Introduction - Architecture - Pin configuration - Instruction set - Programming of Microprocessors using 8085 instructions - Interfacing input and output devices - Interfacing D/A converters and A/D converters – Applications - Temperature control - Stepper motor control - Traffic light controller.

UNIT IV PROGRAMMABLE LOGIC CONTROLLERS 9

Introduction - Basic structure - Input / Output processing - Programming –Mnemonics Timers, Internal relays and counters - Data handling - Analog input / output - Selection of PLC.

UNIT V DESIGN AND MECHATRONICS 9

Designing - Possible design solutions - Case studies of Mechatronics systems.

Total: 45 Periods

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

- **Distinguish** Traditional design and Mechatronics Design

- **Select** the suitable sensors for deferent application and components
- **Construct a** Program for traffic control by using 8085 instructions
- **Discuss** about the operation of timers
- **Sketch** a mechatronics system for Pick and place robot

REFERENCES:

1. Michael B.Histand, 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.
4. Lawrence J. Kamm, "Understanding Electro-Mechanical Engineering, An Introduction to Mechatronics ", Prentice-Hall, 2000.
5. Ghosh, P.K., Sridhar, P.R, "Introduction to Microprocessors for Engineers and Scientists", Prentice Hall, Second Edition, 1995.
6. W. Bolton, "Mechatronics", Pearson Education, 2006.

19PCD502	TRIBOLOGY IN DESIGN	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To know about the principles of wear, tear and friction

- To learn understand the different types of lubrication

UNIT I SURFACE INTERACTION AND FRICTION 8

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

UNIT II WEAR AND SURFACE TREATMENT 8

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

UNIT III LUBRICANTS AND LUBRICATION REGIMES 9

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

UNIT IV THEORY OF HYDRODYNAMIC AND HYDROSTATIC LUBRICATION 10

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

UNIT V HIGH PRESSURE CONTACTS AND ELASTO HYDRODYNAMIC LUBRICATION 10

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

Total: 45 Periods

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

- **List** the Properties of Surface features
- **Categorize** Wear of Metals and Non metals
- **Formulate the** one and two dimensional Reynolds Equation
- **Solve** the problems for bearings to find Stresses and deflections

- **Discus** the oil properties like viscosity etc…

REFERENCES:

1. Rabinowicz. E, "Friction and Wear of materials", John Willey &Sons, UK, 1995.
2. Cameron, A, "Basic Lubrication Theory", Ellis Herward Ltd., UK, 1981.
3. Halling J, "Principles of Tribology", Macmillian, 1984.
4. Williams J.A, "Engineering Tribology", Oxford Univ. Press, 1994.
5. S. K .Basu S .N. Sengupta and B.B. Ahuja, "Fundamentals of Tribology", Prentice – Hall of India Pvt Ltd, New Delhi, 2005.
6. G. W. Stachowiak, A.W .Batchelor, "Engineering Tribology", Butterworth-Heinemann, UK, 2005.

19PCD503 DESIGN OF HYDRAULIC AND PNEUMATIC SYSTEMS

L	T	P	C
3	0	0	3

OBJECTIVES:

- To know about the Hydraulic and pneumatic systems used in industries
- To learn about the installation and maintenance of hydraulic and pneumatic systems

UNIT I OIL HYDRAULIC SYSTEMS AND HYDRAULIC ACTUATORS 8

Hydraulic Power Generators – Selection and specification of pumps, pump characteristics. Linear and Rotary Actuators – selection, specification and characteristics.

UNIT II CONTROL AND REGULATION ELEMENTS 10

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

UNIT III HYDRAULIC CIRCUITS 8

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 10

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

UNIT V INSTALLATION, MAINTENANCE AND SPECIAL CIRCUITS 9

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

Total: 45 Periods

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

- **Illustrate the** specification, characteristics, and selection of pumps and accelerators
- **Explain** the application and working principles of valves
- **Design the** hydraulic circuit for real time applications
- **Design** the pneumatic circuit for real time applications**.**
- **Describe about** the illustration and maintenance of circuits

REFERENCES:

1. Antony Espossito, “Fluid Power with Applications”, Prentice Hall, 1980.
2. Dudleyt, A. Pease andJohn J. Pippenger, “Basic fluid power”, Prentice Hall, 1987.
3. Andrew Parr, “Hydraulic and Pneumatics ”, Jaico Publishing House, 1999.
4. Bolton. W, “Pneumatic and Hydraulic Systems”, Butterworth – Heinemann, 1997.
5. K.Shanmuga Sundaram, “Hydraulic and Pneumatic Controls: Understanding made Easy ” S. Chand and Co Book publishers, New Delhi, 2006.

L	T	P	C
3	0	0	3

OBJECTIVES:

- To know about the basics of operating systems

UNIT I DIGITAL COMPUTERS & MICRO PROCESSORS 9

Block diagram - register transfer language - arithmetic, logic and shift micro operations -instruction code - training and control instruction cycle - I/O and interrupt design of basic computer. Machine language - assembly language - assembler. Registers ALU and Bus Systems - timing and control signals - machine cycle and timing diagram - functional block diagrams of 80 x 86 and modes of operation. Features of Pentium Processors.

UNIT II OPERATING SYSTEM & ENVIRONMENTS 9

Types - functions - UNIX & WINDOWS NT - Architecture - Graphical User Interfaces. Compilers - Analysis of the Source program - the phases of a compiler - cousins of the compiler, the grouping of phases - compiler construction tools.

UNIT III COMMUNICATION MODEL 9

Data communication and networking - protocols and architecture - data transmission concepts and terminology - guided transmission media - wireless transmission – data encoding - asynchronous and synchronous communication - base band interface standards RS232C, RS449 interface.

UNIT IV COMPUTER NETWORKS 9

Network structure - network architecture - the OSI reference model services – network standardization – example - Managing remote systems in network - network file systems -net working in manufacturing.

UNIT V INTERNET 9

Internet services - Protocols - intranet information services - mail based service – system and network requirements - Internet tools - usenet - e-mail - IRC - www - FTP - Telnet.

Total: 45 Periods

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

- **Describe the** registers ALU and Bus Systems.
- **Review** the Graphical User Interface.
- **Conclude the** data transmission concepts and terminology
- **Describe the three elements** network protocol
- **Practice the www, email**

REFERENCES:

1. Morris Mano. M, “Computer System Architecture”, Prentice Hall, Prentice Hall of India, 1996.
2. Gaonkar R.S, “Microprocessor Architecture, Programming and Applications of 8085”, Penram International, 1997.
3. Peterson J.L, Galvin PandSilberschaz, A, “Operating Systems Concepts”, Addison Wesley, 1997.
4. Alfred V. Aho, Ravi Setjhi and Jeffrey D Ullman, “Compilers Principles Techniques and Tools”, Addison Wesley, 1986.
5. William Stallings, “Data of Computer Communications”, Prentice Hall, Prentice Hall of India, 1997.
6. Andrew S. Tanenbanum, “Computer Networks”, 3rd Edition, Prentice Hall of India, 1996.
7. Christian Crumlish, “The ABC's of the Internet”, BPB Publication, 1996.

19PCD505	**PERFORMANCE MODELLING AND ANALYSIS OF MANUFACTURING SYSTEM**	**L**	**T**	**P**	**C**

3 0 0 3

OBJECTIVES:

- This course aims at imparting knowledge on modeling and analysis of manufacturing system

UNIT I MANUFACTURING SYSTEMS & CONTROL 9

Automated Manufacturing Systems - Modelling - Role of performance modelling -simulation models- Analytical models. Product cycle - Manufacturing automation -Economics of scale and scope - input/output model - plant configurations. Performance measures - Manufacturing lead-time - Work in process -Machine utilization - Throughput –Capacity - Flexibility - performability - Quality. Control Systems - Control system architecture - Factory communications - Local area networks - Factory net works – Open systems interconnection model - Net work to network interconnections – Manufacturing automation protocol - Database management system.

UNIT II MANUFACTURING PROCESSES 9

Examples of stochastic processes - Poisson process Discrete time Markov chain models -Definition and notation - Sojourn times in states - Examples of DTMCs in manufacturing -Chapman - Kolmogorov equation - Steady-state analysis. Continuous Time Markov Chain Models - Definitions and notation - Sojourn times in states - examples of CTMCs in manufacturing - Equations for CTMC evolution - Markov model of a transfer line. Birth and Death Processes in Manufacturing - Steady state analysis of BD Processes – Typical BD processes in manufacturing.

UNIT III QUEUING MODELS 9

Notation for queues - Examples of queues in manufacturing systems – Performance measures - Little's result - Steady state analysis of M/M/m queue, queues with general distributions and queues with breakdowns - Analysis of a flexible machine center.

UNIT IV QUEUING NETWORKS 9

Examples of QN models in manufacturing - Little's law in queuing networks – Tandem queue - An open queuing network with feedback - An open central server model for FMS Closed transfer line – Closed server model - Garden Newell networks.

UNIT V PETRINETS 9

Classical Petri Nets - Definitions - Transition firing and reachability – Representational power - properties - Manufacturing models. Stochastic Petri Nets - Exponential timed Petri Nets -Generalized Stochastic Petri Nets - modelling of KANBAN systems – Manufacturing models.

Total: 45 Periods

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

- **Explain the** Quality, Control Systems

- **Derive the** Equations for CTMC evolution
- **Analyze** the flexible machine center
- **Compose the** Generalized Stochastic Petri Net
- **Arrange** the cards for KAMBAN system

REFERENCES:

1. Tayfur Altiok, "Performance Analysis of Manufacturing Systems", Springer, 1997.
2. Trivedi, K.S, "Probability and Statistics with Reliability, Queuing and Computer Science Applications", Prentice Hall, New Jersey, 1982.
3. Gupta S.C., Kapoor V.K, "Fundamentals of Mathematical Statistics ", Sultan Chand and Sons, 3rd Edition, New Delhi, 1988.
4. Viswanadham, N, Narahari, Y, "Performance Modelling of Automated Manufacturing Systems", Prentice Hall of India, New Delhi, 1994.

19PCD506	OPTIMIZATION TECHNIQUES IN DESIGN	L	T	P	C
		3	0	0	3

OBJECTIVES:

- This course aims at imparting knowledge on various optimization techniques

UNIT I UNCONSTRAINED OPTIMIZATION TECHNIQUES 10

Introduction to optimum design - General principles of optimization – Problem formulation & their classifications - Single variable and multivariable optimization, Techniques of unconstrained minimization – Golden section, Random, pattern and gradient search methods – Interpolation methods.

UNIT II CONSTRAINED OPTIMIZATION TECHNIQUES 9

Optimization with equality and inequality constraints - Direct methods – Indirect methods using penalty functions, Lagrange multipliers - Geometric programming.

UNIT III ADVANCED OPTIMIZATION TECHNIQUES 10

Multi stage optimization – dynamic programming; stochastic programming; Multi objective optimization, Genetic algorithms and Simulated Annealing techniques; Neural network and Fuzzy logic principles in optimization.

UNIT IV STATIC APPLICATIONS 8

Structural applications – Design of simple truss members - Design applications – Design of simple axial, transverse loaded members for minimum cost, weight – Design of shafts and torsionally loaded members – Design of springs.

UNIT V DYNAMIC APPLICATIONS 8

Dynamic Applications – Optimum design of single, two degree of freedom systems, vibration absorbers. Application in Mechanisms – Optimum design of simple linkage mechanisms.

Total: 45 Periods

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

- **Apply** the optimization techniques in various problems
- **Formulate** the Optimization with equality and inequality constraints
- **Design** the simple truss members

- **Discuss the** Application linkage Mechanisms
- **Describe** the various steps involved in GA

REFERENCES:

1. Rao, Singaresu, S, "Engineering Optimization – Theory & Practice", New Age International (P) Limited, New Delhi, 2000.
2. Johnson Ray, C, "Optimum design of mechanical elements", Wiley, John & Sons, 1990.
3. Kalyanamoy Deb, "Optimization for Engineering design algorithms and Examples ", Prentice Hall of India Pvt, 1995.
4. Goldberg, D.E, "Genetic algorithms in search, optimization and machine", Barnen,Addison-Wesley, New York, 1989.

19PCD507	INDUSTRIAL SAFETY MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVE:

• To understand the basic concepts and Principles in the area Safety, health and hazards.

UNIT I SAFETY MANAGEMENT **9**

Evaluation of modern safety concepts - Safety management functions – safety organization, safety department - safety committee, safety audit – performance measurements and motivation – employee participation in safety - safety and productivity.

UNIT II OPERATIONAL SAFETY 9

Hot metal Operation - Boiler, pressure vessels - heat treatment shop - gas furnace operation – electroplating-hot bending pipes - Safety in welding and cutting. Cold-metal Operation - Safety in Machine shop - Cold bending and chamfering of pipes – metal cutting - shot blasting, grinding, painting - power press and other machines.

UNIT III SAFETY MEASURES 9

Layout design and material handling - Use of electricity - Management of toxic gases and chemicals - Industrial fires and prevention - Road safety - highway and urban safety -Safety of sewage disposal and cleaning - Control of environmental pollution – Managing emergencies in Industries - planning, security and risk assessments, on- site and off site. Control of major industrial hazards.

UNIT IV ACCIDENT PREVENTION 9

Human side of safety - personal protective equipment - Causes and cost of accidents. Accident prevention programmes - Specific hazard control strategies - HAZOP – Training and development of employees - First Aid- Fire fighting devices - Accident reporting, investigation.

UNIT V SAFETY, HEALTH, WELFARE & LAWS 9

Safety and health standards - Industrial hygiene - occupational diseases prevention -Welfare facilities - History of legislations related to Safety-pressure vessel act-Indian boiler act - The environmental protection act - Electricity act - Explosive act.

Total: 45 Periods

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

- **Evaluate** the concept of modern safety
- **Identify the** Safety rules for Machine shop
- **Demonstrate** about personal safety devises
- **Prepare the** planning, security and risk assessments

- **Summarize the** First Aid- Fire fighting devices

REFERENCES:

1. John V. Grimaldi and Rollin H. Simonds, "Safety Management", All India Travellers bookseller, New Delhi, 1989.
2. Krishnan N.V, "Safety in Industry", Jaico Publisher House, 1996.
3. Naseer Elahi, "Industrial safety management", Gyan Publishing House, 2006.
4. "Industrial safety and the law", P.M.C. Nair Publisher's, Trivandrum.
5. "Managing emergencies in industries", Loss Prevention of India Ltd., 1996.
6. Singh, U.K., Dewan, J.M , "Safety, Security and risk management ", APH Publishing Company, New Delhi, 1996.

19 PCD 508	INTERGRATED MANUFACTURING SYSTEM	L	T	P	C
		3	0	0	3

UNIT I INTRODUCTION 7

Objectives of manufacturing system-Production system facilities, Automation of production systems, manufacturing operations. Product/production relationship

UNIT II COMPUTER AIDED PLANNING AND CONTROL 8

Production planning and control-cost planning and control-inventory management-Material requirements planning (MRP) - MRP II, ERP - shop floor control-Factory data collection system- Automatic identification system-barcode technology- automated data collection system

UNIT III MANUFACTURING SYSTEMS 10

Introduction about Flexible manufacturing systems, Manual assembly lines – fundamentals, alternative systems, design for assembly, mixed model assembly and other considerations in assembly line design. Transfer lines – fundamentals, applications, analysis of transfer lines with no internal storage and storage buffers. Automated assembly systems – fundamentals, design and quantitative analysis

UNIT IV COMPUTER MONITORING 10

Types of production monitoring systems-structure model of manufacturing process -process control & strategies- direct digital control-supervisory computer control-computer in QC - contact inspection methods non-contact inspection method - computer-aided testing - integration of CAQC with CAD/CAM

UNIT V INTEGRATED MANUFACTURING SYSTEM 10

Definition - application - features - types of manufacturing systems- computer control system - DNC systems manufacturing cell. Overview of material handling equipment, considerations in material handling system design, principles of material handling-CAD/CAM system – human labor in the manufacturing system-computer integrated manufacturing system benefits. Rapid prototyping - Artificial Intelligence and Expert system in CIM

Total: 45 Periods

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

Name the Objectives of manufacturing system

Plan the Material requirements (MRP) - MRP II, ERP

Analysis of transfer lines with no internal storage and storage buffers

Describe the Artificial Intelligence and Expert system in CIM

TEXT BOOKS:

1. Groover M.P, " Automation, Production System and CIM ", Prentice-Hall, India, 1998.

REFERENCES:

1. David Bedworth," Computer Integrated Design and Manufacturing ", TMH, New Delhi, 1998.
2. YoremKoren," Computer Integrated Manufacturing Systems ", McGraw Hill,1983.
3. Ranky, Paul G.," Computer Integrated Manufacturing ", Prentice Hall International, 1986.
4. Yeomamas R.W. ,Choudry A. andTen Hagen P.J.W., " Design rules for a CIM system ", North Holland Amsterdam, 1985.

19PCD509	VIBRATION ANALYSIS AND CONTROL	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understands the Fundamentals of Vibration and its practical applications.
- To understand the working principle and operations of various vibrations Measuring instruments
- To understand the various Vibration control strategies

UNIT I FUNDAMENTALS OF VIBRATION **9**

Introduction -Sources Of Vibration-Mathematical Models- Displacement, velocity and Acceleration- Review Of Single Degree Freedom Systems -Vibration isolation Vibrometers and accelerometers -Response to Arbitrary and

non- harmonic Excitations Transient Vibration –Impulse loads-Critical Speed of Shaft-Rotor systems.

UNIT II TWO DEGREE FREEDOM SYSTEM 8

Introduction-Free Vibration of Undamped And Damped- Forced Vibration With Harmonic Excitation System – Coordinate Couplings And Principal Coordinates.

UNIT III MULTI-DEGREE FREEDOM SYSTEM AND CONTINUOUS SYSTEM 9

Multi Degree Freedom System –Influence Coefficients and stiffness coefficients-Flexibility Matrix and Stiffness Matrix – Eigen Values and Eigen Vectors-Matrix Iteration Method –Approximate Methods: Dunkerley, Rayleigh's, and Holzer Method –Geared Systems-Eigen Values & Eigen vectors for large system of equations using sub space,Lanczos method - Continuous System: Vibration of String, Shafts and Beams.

UNIT IV VIBRATION CONTROL 9

Specification of Vibration Limits –Vibration severity standards- Vibration as condition Monitoring tool-Vibration Isolation methods- -Dynamic Vibration Absorber, Torsional and Pendulum Type Absorber- Damped Vibration absorbers-Static and Dynamic Balancing-Balancing machines-Field balancing – Vibration Control by Design Modification- - Active Vibration Control.

UNIT V EXPERIMENTAL METHODS IN VIBRATION ANALYSIS 10

Vibration Analysis Overview - Experimental Methods in Vibration Analysis.-Vibration Measuring Instruments - Selection of Sensors- Accelerometer Mountings. –Vibration Exciters-Mechanical, Hydraulic, Electromagnetic And Electrodynamics –Frequency Measuring Instruments - System Identification from Frequency Response -Testing for resonance and mode shapes.

Total: 45 Periods

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

- **Calculate** the critical speed of shaft.
- **Analyze** the vibration of undammed and damped.
- **Analyze** the Vibration of String, Shafts and Beams.
- **Describe about the** selection of sensors.
- **Experiment** on vibration analyze

REFERENCES:

1. Rao, S.S, "Mechanical Vibrations", Addison Wesley Longman, 1995.

2. Thomson W.T, "Theory of Vibration with Applications", CBS Publishers and Distributors, New Delhi, 1990.
3. Ramamurti .V, " Mechanical Vibration Practice with Basic Theory", Narosa, New Delhi, 2000.
4. Graham Kelly.S and Shashidar K. Kudari, "Mechanical Vibrations", Tata McGraw–Hill Publishing Com. Ltd., New Delhi, 2007.
5. V. Rao Dukkipati, and J. Srinivas , "Reference book of Mechanical Vibrations", PHI COURSE private Ltd., New Delhi, 2007.
6. R. N. Iyengar, "Elements of Mechanical Vibration", I.K International publishing house private Ltd., New Delhi, 2010.

19PCD510	METROLOGY AND NON DESTRUCTIVE TESTING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce different types of sensors, transducers and strain gauges used for Measurement.
- To give knowledge about Statistical measures and tools
- To familiarize students with non destructive testing on machine components

UNIT I MEASURING MACHINES 9

Tool Maker's microscope - Co-ordinate measuring machines - Universal measuring machine - Laser viewers

for production profile checks - Image shearing microscope – Use of computers - Machine vision technology - Microprocessors in metrology.

UNIT II STATISTICAL QUALITY CONTROL 9

Data presentation - Statistical measures and tools - Process capability - Confidence and tolerance limits - Control charts for variables and for fraction defectives - Theory of probability - Sampling - ABC standard - Reliability and life testing.

UNIT III LIQUID PENETRANT AND MAGNETIC PARTICLE TESTS 9

Characteristics of liquid penetrants - different washable systems - Developers -applications -methods of production of magnetic fields - Principles of operation of magnetic particle test - Applications –Advantages and limitations.

UNIT IV RADIO GRAPHY 9

Sources of ray-x-ray production - properties of d and x rays - film characteristics -exposure charts - contrasts - operational characteristics of x ray equipment -applications.

UNIT V ULTRASONIC AND ACOUSTIC EMISSION TECHNIQUES 9

Production of ultrasonic waves - different types of waves - general characteristics of waves - pulse echo method - A, B, C scans - Principles of acoustic emission techniques Advantages and limitations - Instrumentation - applications.

Total: 45 Periods

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

- **Identify** the sensors and transducers used for stress analysis.
- **Apply** the Control charts for variables and for fraction defectives.
- **Explain** the Principles of operation of magnetic particle test.
- **Review the** different types of waves.
- **List** out the benefits and limitation of acoustic emission techniques

REFERENCES:

1. Jain R.K, “Engineering Metrology”, Khanna Publishers, 1997.
2. Barry Hull and Vernon John, “Non Destructive Testing”, MacMillan, 1988.
3. American Society for Metals, “Metals Hand Book”, 1976.

4. Progress in Acoustic Emission, "Proceedings of 10th International Acoustic Emission Symposium", Japanese Society for NDI, 1990.

19PCD511	ADVANCED MECHANICS OF MATERIALS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- This course aims at imparting knowledge on advanced mechanics of materials

UNIT I ELASTICITY 9

Stress-Strain relations and general equations of elasticity in Cartesian, Polar and curvilinear coordinates, differential equations of equilibrium-compatibility-boundary conditions-representation of three-dimensional stress of a tension generalized hook's law- St. Venant's principle - plane stress - Airy's stress function. Energy methods.

UNIT II SHEAR CENTER AND UNSYMMETRICAL BENDING 10

Location of shear center for various thin sections - shear flows. Stresses and deflections in beams subjected to unsymmetrical loading-kern of a section.

UNIT III CURVED FLEXIBLE MEMBERS AND STRESSES IN FLAT PLATES 10

Circumference and radial stresses – deflections - curved beam with restrained ends -closed ring subjected to concentrated load and uniform load - chain links and crane hooks. Solution of rectangular plates – pure bending of plates – deflection – uniformly distributed load – various end conditions.

UNIT IV TORSION OF NON-CIRCULAR SECTIONS 8

Torsion of rectangular cross section - St.Venants theory - elastic membrane analogy -Prandtl's stress function - torsional stress in hollow thin walled Stress

UNIT V STRESSES IN ROTARY SECTIONS AND CONTACT STRESSES 8

Radial and tangential stresses in solid disc and ring of uniform thickness and varying thickness allowable speeds. Methods of computing contact stress deflection of bodies in point and line contact applications.

Total: 45 Periods

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

- **Calculate the** stress-strain relation.
- **Locate the** shear center for various thin sections.
- **Calculate** the Tensional stress in hollow thin walled Stress.
- **Evaluate the** Torsion of rectangular cross section
- **List** the application of Methods of computing contact stress deflection of bodies in point and line contact

REFERENCES:

1. Arthur P Boresi, Richard J. Schmidt, "Advanced mechanics of materials", John Wiley, 2002.
2. Timoshenko and Goodier, "Theory of Elasticity", McGraw Hill.

3. Robert D. Cook, Warren C. Young, "Advanced Mechanics of Materials", Mcmillan pub. Co., 1985.
4. Srinath L.S, "Advanced Mechanics of solids", Tata McGraw Hill , 1992..
5. Ryder G.H, "Strength of Materials", Macmillan, India Ltd., 2007.

19PCD512	DESIGN OF MATERIAL HANDLING EQUIPMENTS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- This course aims at imparting knowledge on Design of material handling equipments

UNIT I MATERIALS HANDLING EQUIPMENT 8

Types, selection of material handling equipment and applications.

UNIT II DESIGN OF HOISTS 10

Design of hoisting elements: Welded and roller chains - Hemp and wire ropes - Design of ropes, pulleys, pulley systems, sprockets and drums, Load handling attachments. Design of forged hooks and eye hooks – crane grabs - lifting magnets - Grabbing attachments -Design of arresting gear - Brakes: shoe, band and cone types.

UNIT III DRIVES OF HOISTING GEAR 9

Hand and power drives - Traveling gear - Rail traveling mechanism - cantilever and monorail cranes - slewing, jib and luffing gear - cogwheel drive - selecting the motor ratings.

UNIT IV CONVEYORS 9

Types - description - design and applications of Belt conveyors, apron conveyors and escalators Pneumatic

conveyors, Screw conveyors and vibratory conveyors.

UNIT V ELEVATORS **9**

Bucket elevators: design - loading and bucket arrangements - Cage elevators - shaft way, guides, counter weights, hoisting machine, safety devices - Design of fork lift trucks.

Total: 45 Periods

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

- **Define the** material handling equipments
- **Discuss** the about Brakes, shoe, band and cone types.
- **Select** the motor rating.
- **Differentiate** the Pneumatic conveyors, Screw conveyors
- **Design** the fork lift trucks.

REFERENCES:

1. Rudenko N, "Materials handling equipment", ELnvee Publishers, 1970.
2. Spivakovsy A.O and Dyachkov V.K., "Conveying Machines", Volumes I and II, 1985.
3. Alexandrov M, "Materials Handling Equipments", MIR Publishers,1981.
4. Boltzharol A, "Materials Handling Handbook", The Ronald Press Company, 1958.
5. P.S.G. Tech, "Design Data Book", Kalaikathir Achchagam, Coimbatore, 2003.
6. Lingaiah. K. and Narayana Iyengar, "Machine Design Data Hand Book", Suma Publishers, Vol. 1 and 2, Bangalore, 1983.

19PCD513	ADVANCED TOOL DESIGN	L	T	P	C
		3	0	0	3

OBJECTIVES:

- This course aims at imparting knowledge on advanced tool design

UNIT I INTRODUCTION TO TOOL DESIGN 8

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 9

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 10

Introduction – Fixed Gages – Gage Tolerances –selection of material for Gages –Indicating Gages – Automatic gages – Principles of location – Locating methods and devices – Principles of clamping – Drill jigs – Chip formation in drilling – General considerations in the design of drill jigs – Drill bushings – Methods of construction – Thrust and Turning Moments in drilling - Drill jigs and modern manufacturing- Types of Fixtures – Vise Fixtures – Milling Fixtures – Boring Fixtures – Broaching Fixtures – Lathe Fixtures – Grinding Fixtures – Modular Fixtures – Cutting Force Calculations.

UNIT IV DESIGN OF PRESS TOOL DIES 10

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

UNIT V DESIGN FOR CNC MACHINE TOOLS 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.

Total: 45 Periods

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

- **Select** the materials for cutting tools
- **Explain about the** Oblique and orthogonal cutting
- **Describe** the design procedure for jig
- **Calculate the** Clearance and cutting force of press die.
- **List out** the tool holding methods.

REFERENCES:

1. Cyrll Donaldson, George H.LeCain and, Goold V.C, "Tool Design", Tata McGraw Hill Publishing Company Ltd., 2000.
2. Hoffman E.G, "Jig and Fixture Design", Thomson Asia Pvt Ltd., Singapore, 2004.
3. Prakash Hiralal Joshi, "Tooling data", Wheeler Publishing, 2000.
4. Venkataraman K, "Design of Jigs, Fixtures and Press tools", TMH, 2005.
5. Haslehurst M, "Manufacturing Technology", the ELBS, 1978.

19PCD514	MECHANISMS DESIGN AND SIMULATION	L	T	P	C
		0	0	3	3

OBJECTIVES:

- This course aims at imparting knowledge on mechanisms design and simulation

UNIT I INTRODUCTION 9

Review of fundamentals of kinematics-classifications of mechanisms-components of mechanisms – mobility analysis – formation of one D.O.F. multi loop kinematic chains, Network formula – Gross motion concepts-Basic kinematic structures of serial and parallel robot manipulators-Compliant mechanisms-Equivalent mechanisms.

UNIT II KINEMATIC ANALYSIS 9

Position Analysis – Vector loop equations for four bar, slider crank, inverted slider crank, geared five bar and six bar linkages. Analytical methods for velocity and acceleration Analysis– four bar linkage jerk analysis. Plane complex mechanisms-auxiliary point method. Spatial RSSR mechanism-Denavit-Hartenberg Parameters – Forward and inverse kinematics of robot manipulators.

UNIT III PATH CURVATURE THEORY, COUPLER CURVE 9

Fixed and moving centroides, inflection points and inflection circle. Euler Savary equation, graphical constructions – cubic of stationary curvature. Four bar coupler curve-cuspcrunode-coupler driven six-bar mechanisms-straight line mechanisms.

UNIT IV SYNTHESIS OF FOUR BAR MECHANISMS 9

Type synthesis – Number synthesis – Associated Linkage Concept. Dimensional synthesis – function generation, path generation, motion generation. Graphical methods-Pole technique-inversion technique-point

position reduction-two, three and four position synthesis of four- bar mechanisms. Analytical methods-Freudenstein's Equation-Bloch's Synthesis.

UNIT V SYNTHESIS OF COUPLER CURVE BASED MECHANISMS & CAM MECHANISMS **9**

Cognate Lingages-parallel motion Linkages. Design of six bar mechanisms-single dwell double dwell-double stroke. Geared five bar mechanism-multi-dwell. Cam Mechanisms determination of optimum size of cams. Mechanism defects. Study and use of Mechanism using Simulation Soft-ware packages. Students should design and fabricate a mechanism model as term project.

Total: 45 Periods

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

- **Derive** the formation of one D.O.F. multi loop kinematic chains, Network formula. -
- **Analyze** the methods for velocity and acceleration.
- **Solve the** Euler Savory equation, graphical constructions.
- **Design a** six bar mechanisms.
- **Describe** the analytical method for four bar mechanism

REFERENCES:

1. Robert L Norton, "Design of Machinery", Tata McGraw Hill, 2005.
2. Sandor G.N and Erdman A.G, "Advanced Mechanism Design Analysis and Synthesis", Prentice Hall, 1984.
3. Uicker J.J, Pennock G. R and Shigley J.E, "Theory of Machines and Mechanisms", Oxford University Press, 2005.
4. Amitabha Ghosh,and Asok Kumar Mallik, "Theory of Mechanism and Machines", EWLP, Delhi, 1999.
5. Kenneth J, Waldron and Gary L. Kinzel, "Kinematics, Dynamics and Design of Machinery", John Wiley-sons, 1999.
6. Ramamurti V, "Mechanics of Machines", Narosa , 2005.

19PCD515	COMPUTATIONAL FLUID DYNAMICS IN MANUFACTURING	L	T	P	C
		0	0	3	3

UNIT I GOVERNING DIFFERENTIAL EQUATION AND FINITE DIFFERENCE METHOD 10

Classification, Initial and Boundary conditions – Initial and Boundary Value problems –Finite difference method, Central, Forward, Backward difference, Uniform and nonuniform Grids, Numerical Errors, Grid Independence Test.

UNIT II CONDUCTION HEAT TRANSFER 9

Steady one-dimensional conduction, Two and three dimensional steady state problems, Transient one-dimensional problem, Two-dimensional Transient Problems.

UNIT III INCOMPRESSIBLE FLUID FLOW 9

Governing Equations, Stream Function – Verticity method, Determination of pressure for viscous flow, SIMPLE Procedure of Patankar and Spalding, Computation of Boundary layer flow, finite difference approach.

UNIT IV CONVECTION HEAT TRANSFER AND FEM 9

Steady One-Dimensional and Two-Dimensional Convection – diffusion, Unsteady one dimensional convection – diffusion, Unsteady two-dimensional convection – Diffusion –Introduction to finite element method – solution of steady heat conduction by FEM –Incompressible flow – simulation by FEM.

UNIT V TURBULENCE MODELS 8

Algebraic Models – One equation model, K – º Models, Standard and High and Low Reynolds number models, Prediction of fluid flow and heat transfer using standard codes

Total: 45 Periods

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

- **Solve the** Initial and Boundary Value problems.
- **Describe** about the Two-dimensional Transient Problems.
- **Estimate** the Solution of steady heat conduction by FEM.
- **Apply** the standard code for heat transfer
- **Describe** the one dimensional method for convection heat transfer

REFERENCES:

1. Muralidhar.K and Sundararajan.T, "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, 1995.
2. Ghoshdasdidar P.S, "Computer Simulation of flow and heat transfer", Tata McGraw- Hill Publishing Company Ltd., 1998.
3. Subas and Patankar.V, "Numerical heat transfer fluid flow", Hemisphere Publishing Corporation, 1980.
4. Taylor.C and Hughes J.B, "Finite Element Programming of the Navier- Stokes Equation", Pineridge Press Ltd., U.K,1981.
5. Anderson D.A, Tannehill J.I. and Pletcher R.H, "Computational fluid Mechanics and Heat Transfer", Hemisphere Publishing Corporation, New York, 1984.
6. Fletcher C.A.J, "Computational Techniques for Fluid Dynamics 1- Fundamental and General Techniques", Springer – Verlag, 1987.
7. Fletcher C.A.J, "Computational Techniques for Fluid Dynamics 1-Specific Techniques for Different Flow Categories", Springer – Verlag, 1987.
8. Bose T.X, "Numerical Fluid Dynamics", Narosa Publishing House, 1997.

19PCD516	RELIABILITY ENGINEERING MODELS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- This course aims at imparting knowledge on reliability engineering models

UNIT I RELIABILITY CONCEPT 9

Reliability definition – Quality and Reliability– Reliability mathematics – Reliability functions – Hazard rate – Measures of Reliability – Design life –A priori and posteriori probabilities – Mortality of a component –Bath tub curve – Useful life.

UNIT II FAILURE DATA ANALYSIS 10

Data collection –Empirical methods: Ungrouped/Grouped, Complete/Censored data –Time to failure distributions: Exponential, Weibull – Hazard plotting – Goodness of fit tests.

UNIT III RELIABILITY ASSESSMENT 10

Different configurations – Redundancy – m/n system – Complex systems: RBD – Baye's method – Cut and tie sets – Fault Tree Analysis – Standby system.

UNIT IV RELIABILITY MONITORING 8

Life testing methods: Failure terminated – Time terminated – Sequential Testing –Reliability growth monitoring – Reliability allocation – Software reliability.

UNIT V RELIABILITY IMPROVEMENT 8

Analysis of downtime – Repair time distribution – System MTTR – Maintainability prediction – Measures of maintainability – System Availability – Replacement theory.

Total: 45 Periods

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

- **Explain** about the reliability**.**
- **Solve** reliability problem using Exponential, Weibull distributions

- **Describe** the Goodness of fit tests.
- **Analyze** the Sequential Testing.
- **Explain** the maintainability prediction.

REFERENCES:

1. Charles E. Ebeling, "An introduction to Reliability and Maintainability engineering", TMH, 2000.
2. Roy Billington and Ronald N. Allan, "Reliability Evaluation of Engineering Systems", Springer, 2000.
3. Joel A. Nachlas, "Reliability Engineering: Probabilistic Models and Maintenance Methods", Tailor and Francis group 2005.
4. E. Balagurusamy , "Reliability Engineering", Tata McGraw-Hill Education, 1984 .

19PCD517	MAINTENANCE ENGINEERING AND MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:

- This course aims at imparting knowledge on maintenance engineering and management in industrial applications

UNIT I INTRODUCTION 8

Maintenance definition – Maintenance objectives – Maintenance management –Functions of maintenance department – Tero technology – Maintenance costs- The Tero technology system - The Tero technology process – introducing Tero technology into programmes – strategies for Tero technology.

UNIT II MAINTENANCE MODELS 10

Maintenance policies – Imperfect maintenance – PM versus b/d maintenance – Optimal PM schedule and product characteristics – Inspection decisions: Maximizing profit –Minimizing downtime – Replacement models.

UNIT III MAINTENANCE LOGISTICS 10

Maintenance staffing – Human factors –Resource requirements: Optimal size of service facility – Optimal repair effort – Maintenance planning and scheduling – Spares planning –Capital spare.

UNIT IV MAINTENANCE QUALITY 8

Five Zero concept –FMECA – Maintainability prediction– Design for maintainability –Maintainability allocation – Reliability Centered Maintenance.

UNIT V TOTAL PRODUCTIVE MAINTENANCE 9

TPM fundamentals – Chronic and sporadic losses – Six big losses – OEE as a measure TPM pillars Autonomous maintenance –TPM implementation-

Total: 45 Periods

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

- **Define the objectives of** Maintenance .
- **Explain** the preventive maintenance.

- **Summarize the** Maintenance scheduling methods
- **Explain** the Reliability Centered Maintenance.
- **Describe** the TBM implementation

REFERENCES:

1. Seichi Nakajima, "Total Productive Maintenance", Productivity Press, 1993. Andrew K.S.Jardine and Albert H.C.Tsang, "Maintenance, Replacement and Reliability", Taylor and Francis, 2006.
2. Bikas Badhury and Basu S.K, "Tero Technology: Reliability Engineering and Maintenance Management", Asian Books, 2003.
3. Seichi Nakajima, "Total Productive Maintenance", Productivity Press, 1993.
4. R. C. Mishra and K. Pathak , "Maintenance Engineering And Management", PHI COURSE private Ltd, 2012.

19PCD518	INDUSTRIAL ROBOTICS AND EXPERT SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- This course is designed to provide students with the fundamental knowledge of robotics to be used in the various industrial applications.
- To give knowledge about the Industrial Robots programming software.
- Familiar with the application of sensors in robotics.

UNIT I INTRODUCTION AND ROBOT KINEMATICS 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 9

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 ROBOT SENSORS 9

Transducers and Sensors – Tactile sensor – Proximity and range sensors – Sensing joint forces – 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 APPLICATION 9

Robot work cell design and control – Safety in Robotics – Robot cell layouts – Multiple Robots and machine interference – Robot cycle time analysis. Industrial application of robots.

UNIT V ROBOT PROGRAMMING, ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS 8

Methods of Robot Programming – Characteristics of task level languages lead through programming methods – textual robot languages - Motion interpolation. 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.

Total: 45 Periods

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

- **Explain** the Methods for orientation
- **Classify** the Robot motors.
- **Differentiate** the transducers and sensors
- **Explain the** Multiple Robots and machine interference.
- **Describe** the artificial intelligence

REFERENCES:

1. K.S.Fu, R.C. Gonzalez and C.S.G. Lee, "Robotics Control, Sensing, Vision and Intelligence", McGraw Hill, 1987.
2. Yoram Koren, "Robotics for Engineers", McGraw-Hill, 1987.
3. Kozyrey.Yu, "Industrial Robots", MIR Publishers Moscow,1985.
4. Richard. D, Klafter, Thomas. A, Chmielewski and Michael Negin, "Robotics Engineering – An Integrated Approach", Prentice-Hall of India Pvt. Ltd., 1984.
5. Deb S.R, "Robotics Technology and Flexible Automation", Tata Mc Graw-Hill, 1994.
6. Mikell P. Groover, Mitchell Weis, Roger, N. Nagel Nicholas and G. Odrey, "Industrial Robotics Technology, Programming and Applications", McGraw-Hill, Int,1986.

19PCD519	LEAN MANUFACTURING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- The aim is to appreciate the students with the background, applications and current status of lean manufacturing and to make them understand the relevant basic principles in this field

UNIT I INTRODUCTION **9**

The mass production system – Origin of lean production system – Necessity – Lean revolution in Toyota – Systems and systems thinking – Basic image of lean production – Customer focus – Muda (waste).

UNIT II STABILITY OF LEAN SYSTEM **9**

Standards in the lean system – 5S system – Total Productive Maintenance – standardized work –Elements of standardized work – Charts to define standardized work – Man power reduction – Overall efficiency - standardized work and Kaizen – Common layouts.

UNIT III JUST IN TIME **9**

Principles of JIT – JIT system – Kanban – Kanban rules – Expanded role of conveyance – Production leveling – Pull systems – Value stream mapping.

UNIT IV JIDOKA (AUTOMATION WITH A HUMAN TOUCH) **9**

Jidoka concept – Poka-Yoke (mistake proofing) systems – Inspection systems and zone control – Types and use of Poka-Yoke systems – Implementation of Jidoka

UNIT V WORKER INVOLVEMENT AND SYSTEMATIC PLANNING METHODOLOGY **9**

Involvement – Activities to support involvement – Quality circle activity – Kaizen training - Suggestion Programmes – Hoshin Planning System (systematic planning methodology) – Phases of Hoshin Planning – Lean culture.

Total: 45 Periods

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

- **Explain** the lean production Systems
- **Describe** about the 5S system.
- **State** the principle of JIT
- **Apply** the Poka -Yoke system
- **Summarize** the systematic planning methodology

REFERENCES:

1. Jeffrey Liker, "The Toyota Way: Fourteen Management Principles from the World's Greatest Manufacturer", McGraw Hill, 2004.
2. Michael L. George, "Lean Six SIGMA: Combining Six SIGMA Quality with Lean Production Speed", McGraw Hill, 2002.
3. Taiichi Ohno, "Toyota Production System: Beyond Large-Scale Production", Taylor and Francis, Inc., 1988.
4. Pascal Dennis, "Lean manufacturing simplified", Productivity Press New York, 2007.

19PCD520	DESIGN OF CELLULAR MANUFACTURING SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To impart knowledge on group technology, optimization algorithms, implementation of GT/CMS, Performance measurements and economical aspects of CMS.

UNIT I INTRODUCTION 9

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

UNIT II CMS PLANNING AND DESIGN 10

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

UNIT III IMPLEMENTATION OF GT/CMS 10

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

UNIT IV PERFORMANCE MEASUREMENT AND CONTROL 8

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

UNIT V ECONOMICS OF GT/CMS 8

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

Total: 45 Periods

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

- **Describe** the characteristics of groups.
- **Explain** about Traditional and non-traditional approaches of Problem solving.
- **Analyze the** Human and economical aspects of CMS.
- **Differentiate** the Conventional Vs group use of computer models in GT/CMS.
- **Prepare** the planning for material requirement

REFERENCES:

1. Askin R.G. and Vakharia A.J.G.T, "Planning and Operation, in The automated factory-Hand Book: Technology and Management", Cleland.D.I and Bidananda.B, TAB Books, NY, 1991.

2. Kamrani, A.K, Parsaei, H.R and Liles, D.H, "Planning, design and analysis of cellular manufacturing systems", Elsevier,1995.
3. Burbidge J.L, "Group Technology in Engineering", Mechanical Engineering publications, London, 1979.
4. Shahrukh A. Iran , "Hand book of Cellular Manufacturing Systems ", john wiley and sons Canada 1999.
5. N.Singh, and D.Rajamani, "Cellular Manufacturing Systems: Design, Planning and Control", Springer London, Limited, 2011.
6. Irani S.A, "Cellular Manufacturing Systems", Hand Book.

19PCD521	INTEGRATED PRODUCT DESIGN AND PROCESS DEVELOPMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To analysis of Customer need and feasibility of manufacturing the product.
- To analysis and Redesign the component by the influence of Experts and competitive behavior.
- To design the component by functional one and to satisfy the customer.

UNIT I INTRODUCTION **9**

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

UNIT II CONCEPT GENERATION, SELECTION AND TESTING **9**

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

UNIT III PRODUCT ARCHITECTURE **9**

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

UNIT IV INDUSTRIAL DESIGN **9**

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

UNIT V DESIGN FOR MANUFACTURING AND PRODUCT DEVELOPMENT **9**

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

Total: 45 Periods

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

- **Summarize** the integration of customer, designer, material supplier and process planner, Competitor and customer
- **Select** the suitable Testing Methodologies for component, product
- **Create** architecture for product development management
- **Apply** the CAE, CAD, CAM tools
- **Describe** the Principles of prototyping

REFERENCES:

1. Karl T. Ulrich, Steven D. Eppinger, "Product Design and Development", McGraw – Hill International Edns, 1999.
2. Kemnneth Crow, "Concurrent Engg. Integrated Product Development", Palos Verdes.
3. Stephen Rosenthal, Business One Orwin, "Effective Product Design and Development", Homewood, 1992.
4. Stuart Pugh, "Tool Design – Integrated Methods for successful Product Engineering", Addison Wesley Publishing, Newyork, NY, 1991.
5. Clark, Kim B, and Takahiro fujimoto, "Product Development performance; strategy, organization and management in the work auto industry", Harvard Business school press, Boston, 1991.

19PCD522 COMPETITIVE MANUFACTURING SYSTEMS L T P C

3 0 0 3

OBJECTIVES:

- To impart knowledge on the pace of changes in the manufacturing technology.
- To emphasize the knowledge on the quality improvement, automation, and advanced manufacturing techniques
- To know about how to create the highest-caliber products quickly, efficiently, inexpensively, and in synchronization with the marketing, sales, and customer service of the company

UNIT I MANUFACTURING IN A COMPETITIVE ENVIRONMENT 9

Automation of manufacturing process - Numerical control - Adaptive control – material handling and movement - Industrial robots - Sensor technology - flexible fixtures – Design for assembly, disassembly and service.

UNIT II GROUP TECHNOLOGY&FLEXIBLE MANUFACTURING SYSTEMS 9

Part families - classification and coding - Production flow analysis - Machine cell design -Benefits. Components of FMS - Application work stations - Computer control and functions - Planning, scheduling and control of FMS-Head changing FMS- Scheduling - Knowledge based scheduling - Hierarchy of computer control - Supervisory computer.

UNIT III COMPUTER SOFTWARE, SIMULATION & DATABASE OF FMS 9

System issues - Types of software - specification and selection - Trends - Application of simulation - software - Manufacturing data systems - data flow - CAD/CAM considerations -Planning FMS database.

UNIT IV LEAN MANUFACTURING 9

Origin of lean production system – Customer focus – Muda (waste) – Standards – 5S system – Total Productive Maintenance – standardized work –Man power reduction –Overall efficiency - Kaizen – Common layouts - Principles of JIT - Jidoka concept – Poka-Yoke (mistake proofing) - Worker Involvement– Quality circle activity – Kaizen training -Suggestion Programmes – Hoshin Planning System (systematic planning methodology) –Lean culture.

UNIT V JUST IN TIME 9

Characteristics of JIT - Pull method - quality -small lot sizes - work station loads – close supplier ties – flexible work force - line flow strategy - preventive maintenance – Kanban system – strategic implications - implementation issues - Lean manufacture

Total: 45 Periods

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

- **Revise** the applications of different sensors
- **List out the** Components of FMS and their applications

- **Design** for assembly, disassembly of manufacturing equipments/components
- **Illustrate** the Quality circle activity
- **Prepare** the implementation issues of Kanban system

REFERENCES:

1. Groover M.P, "Automation, Production Systems and Computer Integrated Manufacturing ", Third Edition, Prentice-Hall, 2007.
2. Pascal Dennis, "Lean Production Simplified: A Plain-Language Guide to the World's Most Powerful Production System ", Productivity Press, Second edition, New York, 2007.Jha N.K, "Handbook of Flexible Manufacturing Systems ", Academic Press Inc., 1991.
3. Kalpkjian, "Manufacturing Engineering and Technology", Addison-Wesley Publishing Co., 1995.
4. Taiichi Ohno, Toyota, "Production System Beyond Large-Scale production Productivity", Press (India) Pvt.Ltd, 1992.

19PCD523	ADDITIVE MANUFACTURING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To educate students with fundamental and advanced knowledge in the field of Additive manufacturing technology and the associated Aerospace, Architecture, Art, Medical and Industrial applications.

UNIT I INTRODUCTION 7

Need - Development of AM systems – AM process chain - Impact of AM on Product Development - Virtual Prototyping- Rapid Tooling – RP to AM -Classification of AM processes-Benefits- Applications.

UNIT II REVERSE ENGINEERING AND CAD MODELING 10

Basic concept- Digitization techniques – Model reconstruction – Data Processing for Rapid Prototyping: CAD model preparation, Data requirements – Geometric modeling techniques: Wire frame, surface and solid modeling – data formats - Data interfacing, Part orientation and support generation, Support structure design, Model Slicing, Tool path generation-Software for AM- Case studies.

UNIT III LIQUID BASED AND SOLID BASED ADDITIVE MANUFACTURING SYSTEMS 10

Stereolithography Apparatus (SLA): Principle, pre-build process, part-building and post-build processes, photo polymerization of SL resins, part quality and process planning, recoating issues, materials, advantages, limitations and applications.

Solid Ground Curing (SGC): working principle, process, strengths, weaknesses and applications. Fused deposition Modeling (FDM): Principle, details of processes, process variables, types, products, materials and applications. Laminated Object Manufacturing (LOM): Working Principles, details of processes, products, materials, advantages, limitations and applications - Case studies.

UNIT IV POWDER BASED ADDITIVE MANUFACTURING SYSTEMS 10

Selective Laser Sintering (SLS): Principle, process, Indirect and direct SLS- powder structures, materials, post processing, surface deviation and accuracy, Applications. Laser Engineered Net Shaping (LENS): Processes, materials, products, advantages, limitations and applications– Case Studies.

UNIT V OTHER ADDITIVE MANUFACTURING SYSTEMS 8

Three dimensional Printing (3DP): Principle, basic process, Physics of 3DP, types of printing, process capabilities, material system. Solid based, Liquid based and powder based 3DP systems, strength and weakness, Applications and case studies. Shape Deposition Manufacturing (SDM), Ballastic Particle Manufacturing (BPM), Selective Laser Melting, Electron Beam Melting.

Total: 45 Periods

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

- **Develop** the additive manufacturing systems
- **Model** the Wire frame, surface and solid modeling by Geometric modeling techniques
- **Describe** the solid ground curing.

- **Formulate** the SDM
- **Summarize** the strength and weakness of 3DP systems.

REFERENCES:

1. Groover M.P, "Automation, Production System and CIM", Prentice-Hall, India, 1998.
2. Gibson I, Rosen D.W, Choudry A and Stucker B, "Additive Manufacturing Methodologies Rapid prototyping to direct digital manufacturing", Springer, 2011.
3. Chua C.K, Leong K.F and Lim C.S, "Rapid prototyping: Principles and applications", second edition World Scientific Publishers, 2010.
4. Gebhardt A, "Rapid prototyping", Hanser Gardener Publications, 2003.
5. Liou L.W and Liou F.W. "Rapid Prototyping And Engineering Applications: A tool box for prototype development ", CRC Press, 2011.
6. Kamrani, A.K and Nasr E.A, "Rapid Prototyping: Theory and practice ", Springer, 2006.
7. Hilton P.D and Jacobs P.F, "Rapid Tooling: Technologies and Industrial Applications", CRC press, 2005.

19PCD524	**INTEGRATED MECHANICAL DESIGN (Use of Approved Data Book is Permitted)**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES:

- To analysis and Design of shafts for different applications.
- To Integrate the design of different type Gears ,Gear boxes, brakes and belts
- To integrate the design of Elevators, Machine Tools, and Escalators, using the design of shaft, bearing, spring, rope, chain, belt, motor, flywheel and pulleys.

UNIT I FUNDAMENTALS 8

Phases of design – Standardization and interchangeability of machine elements -Process and Function Tolerances – Individual and group tolerances – Selection of fits for different design situations – Design for assembly and modular constructions – Concepts of integration –BIS, ISO, DIN, BS, ASTM Standards. Oblique stresses – Transformation Matrix - Principal stresses – Maximum shear stress - Theories of Failure – Ductile vs. brittle component design

UNIT II DESIGN OF SHAFTS 10

Analysis and Design of shafts for different applications – integrated design of shaft, bearing and casing – Design for rigidity

UNIT III DESIGN OF GEARS AND GEAR BOXES 11

Principles of gear tooth action – Gear correction – Gear tooth failure modes – Stresses and loads – Component design of spur, helical, bevel and worm gears – Design for subassembly – Integrated design of speed reducers and multi-speed gear boxes –application of software packages.

UNIT IV BRAKES 8

Dynamics and thermal aspects of vehicle braking – Integrated design of brakes for machine tools, automobiles and mechanical handling equipments.

UNIT V INTEGRATED DESIGN 8

Integrated Design of systems consisting of shaft, bearings, springs, motor, gears, belt, rope, chain, pulleys, Cam and Follower, flywheel etc. Example - Design of Elevators, Escalators, Gear Box, Machine Tools.

Total: 45 Periods

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

- **Select** suitable fits for different design situations
- **Apply** the software packages to design mechanical component
- **Describe** the dynamics and thermal aspects of vehicle braking systems
- **Analyze** various types of gear
- **Solve** the problems of Design for Elevators, Escalators, Gear Box

REFERENCES:

1. Norton L. R, "Machine Design – An Integrated Approach ", Pearson Education, 2005.

2. Newcomb, T.P, and Spur, R.T, "Automobile Brakes and Braking Systems", Chapman and Hall, 2nd Edition, 1975.
3. Maitra G.M, "Hand Book of Gear Design", Tata McGraw Hill, 1985.
4. Shigley, J.E, "Mechanical Engineering Design", McGraw Hill, 1986.
5. Prasad. L. V, "Machine Design", Tata McGraw Hill, New Delhi, 1992.
6. Alexandrov, M, "Materials Handling Equipments", MIR Publishers, 1981.
7. Boltzharol, A, "Materials Handling Handbook", The Ronald Press Company, 1958.

APPROVED DATA BOOKS:

1. P.S.G. Tech, "Design Data Book ", Kalaikathir Achchagam, Coimbatore, 2003.
2. Lingaiah.K. and NarayanaIyengar, "Machine Design Data Hand Book ", Suma Publishers, 1983.

19PCD525	SYNTHESIS AND CHARACTERIZATION OF NANO MATERIALS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- This course aims at imparting knowledge on synthesis and characterization of nano materials

UNIT I BULK SYNTHESIS 9

Synthesis of bulk nano-structured materials –sol gel processing –Mechanical alloying and mechanical milling- Inert gas condensation technique – Nanopolymers – Bulk and nano composite materials.

UNIT II CHEMICAL APPROACHES 9

Self-assembly, self-assembled monolayers (SAMs). Langmuir-Blodgett (LB) films, clusters, colloids, zeolites, organic block copolymers, emulsion polymerization, template synthesis, and confined nucleation and/or growth. Biomimetic Approaches: polymer matrix isolation, and surface-templated nucleation and/or crystallization. Electrochemical Approaches: anodic oxidation of alumina films, porous silicon, and pulsed electrochemical deposition.

UNIT III PHYSICAL APPROACHES 9

Vapor deposition and different types of epitaxial growth techniques- pulsed laser deposition, Magnetron sputtering - Micro lithography (photolithography, soft lithography, micromachining, e-beam writing, and scanning probe patterning).

UNIT IV NANOPOROUS MATERIALS 9

Nanoporous Materials – Silicon - Zeolites, mesoporous materials - nanomembranes and carbon nanotubes - AgX photography, smart sunglasses, and transparent conducting oxides –molecular sieves – nanosponges.

UNIT V CHARACTERIZATION OF NANOPHASE MATERIALS 9

Fundamentals of the techniques – experimental approaches and data interpretation – applications/limitations of Xray characterization: – X-ray sources – wide angle, extended x-ray absorption technique – Electron microscopy: SEM/TEM – high resolution imaging – defects in nanomaterials – Spectroscopy: – electron energy-loss mechanisms – electron filtered imaging – prospects of scanning probe microscopes – optical spectroscopy of metal/semiconductor nanoparticles.

Total: 45 Periods

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

- **Describe** about Bulk and Nano composite materials.
- **List** out the self-assembled monolayers(SMS)
- **Discus** the operation of Magnetron sputtering device
- **Collect** the experimental approaches and data interpretation.
- **Distinguish** the Nano membranes and carbon nanotubes.

REFERENCES:

1. S.P. Gaponenko, “Optical Properties of semiconductor Nano crystals ”,Cambridge University Press, 1980.
2. W.Gaddand, D.Brenner, S.Lysherski and G.J.Infrate, “Handbook of NanoScience, Engg. and Technology”, CRC Press,2002.

3. K. Barriham, D.D. Vvedensky, "Low dimensional semiconductor structures: fundamental and device applications", Cambridge University Press, 2001.
4. G. Cao, "Nanostructures & Nanomaterials: Synthesis, Properties &Applications ,Imperial College Press", 2004.
5. J.George, "Preparation of Thin Films", Marcel Dekker, Inc.,New York, 2005.
6. C. N. R. Rao, A. Muller, A. K. Cheetham, "The Chemistry of Nano materials: Synthesis, Properties and Applications", Wiley-VCH, Verlag GmbH, Volume 1, Germany, 2004.
7. C. Brechignac P. Houdy M. Lahmani, "Nanomaterials and Nano chemistry", Springer Berlin Heidelberg, Germany, 2006.
8. Guozhong Cao, "Nanostructures & Nanomaterials Synthesis, Properties G;Z: Applications",World Scientific Publishing Private, Ltd., Singapore, 2004.
9. Zhong Lin Wang, "Characterization Of Nanophase Materials", Wiley-VCH, Verlag GmbH, Germany, 2004.
10. Carl C. Koch, "Nanostructured Materials: Processing, Properties and Potential Applications", Noyes Publications, William Andrew Publishing Norwich,New York, U.S.A, 2002.

19PCD526	DESIGN AND ANALYSIS OF EXPERIMENTS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- This course aims at imparting knowledge on design and analysis of experiments

UNIT I EXPERIMENTAL DESIGN FUNDAMENTALS 8

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

UNIT II SINGLE FACTOR EXPERIMENTS 9

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

UNIT III MULTIFACTOR EXPERIMENTS 10

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

UNIT IV SPECIAL EXPERIMENTAL DESIGNS 10

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

UNIT V TAGUCHI METHODS 8

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

Total: 45 Periods

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

- **Derive** the linear regression model.
- **Describe** the single, multi factor experiments
- **Solve** using factorial Experiments.
- **Describe** Taguchi methods
- **Design** using Orthogonal Arrays.

REFERENCES:

1. Montgomery D.C, "Design and Analysis of experiments", John Wiley and Sons,2003.
2. Nicolo Belavendram, "Quality by Design; Taguchi techniques for industrial experimentation", Prentice Hall, 1995.
3. Phillip J.Rose, "Taguchi techniques for quality engineering", McGraw Hill, 1996.
4. Angela M. Dean and, Daniel Voss, "Design and Analysis of Experiments", springer,1999.

19PCD527	MECHANICAL BEHAVIOR OF MATERIALS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- This course aims at imparting knowledge on mechanical behavior of materials

UNIT I BASIC CONCEPTS OF STRESS 10

Definition, State of Stress at a point, Stress tensor, invariants of stress tensor, principle stresses, stress ellipsoid, derivation for maximum shear stress and planes of maximum shear stress, octahedral shear stress, Deviatoric and Hydrostatic components of stress, Invariance of deviatoric stress tensor, plane stress.

UNIT II TRUE STRESS AND TRUE STRAIN 10

von-Mises and Tresca yield criteria, Haigh–Westergard stress space representation of von - Mises and Tresca yield criteria, effective stress and effective strain, St. Venants theory of plastic flow, Prandtle–Reuss and Levy–Mises constitutive equations of plastic flow, Strain hardening and work hardening theories, work of plastic deformation.

UNIT III MICROMECHANICS OF COMPOSITES 9

Introduction about composites Mechanical properties: Prediction of Elastic constant, micromechanical approach, Halpin-Tsai equations, Transverse stresses. Thermal properties: Hygrothermal stresses, mechanics of

load transfer from matrix to fibre.

UNIT IV MODERN METALLIC MATERIALS 8

Dual phase steels, High strength low alloy steel, Transformation induced plasticity Steel, Maraging steel, Nitrogen steel – Intermetallics, Ni and Ti aluminides – smart materials, shape memory alloys – Metallic glass and nano crystalline materials.

UNIT V NON METALLIC MATERIALS 8

Polymeric materials – Formation of polymer structure – Production techniques of fibers, foams, adhesives and coating – structure, properties and applications of engineering polymers – Advanced structural ceramics, WC, TIC, TaC, Al2O3, SiC, Si3N4 CBN and diamond – properties, processing and applications.

Total: 45 Periods

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

- **Explain** the basic concept of stresses
- **Describe** the true stress and true strain
- **Analyze** the properties composite high strength low alloy steel
- **Summarize** the modern metallic materials.
- **Explain the** application nonmetallic materials

REFERENCES:

1. George E.Dieter, "Mechanical Metallurgy", McGraw Hill,1988.
2. Thomas H. Courtney, "Mechanical Behavior of Materials", McGraw Hill, 2nd edition, 2000.
3. Charles J.A., Crane F.A.A. and Furness J.A.G, "Selection and use of Engineering Materials", Third Edition, Butterworth – Heiremann, 1997.
4. Flinn R.A. and Trojan P.K, "Engineering Materials and their Applications",4th Edition, Jaico, 1999.
5. Ashby M.F, "materials selection in Mechanical Design", Butter worth, 2nd Edition, 1999.
6. Timoshenko and Goodieer, "Theory of Elasticity", Mcgraw Hill Publications, 3rd Edition.
7. Madleson, "Theory of Plasticity".

8. Chakrabarty.J, "Theory of Plasticity", 2nd Edition, McGraw Hill, 1998.
9. Metals Hand book, "Failure Analysis and Prevention" 10th Edition, jaico, 1999.

19PCD528	MATERIAL TESTING AND CHARACTERIZATION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- This course aims at imparting knowledge on various techniques of material characterization.

UNIT I MICTRO STRUCTURAL EVALUATION 9

Principles of Optical Microscopy – Specimen Preparation Techniques – Polishing and Etching – Polarization Techniques – Quantitative Metallography – Estimation of grain size – ASTM grain size numbers – Microstructure of Engineering Materials.

UNIT II CRYSTALSTRUCTURE ANALYSIS 9

Elements of Crystallography – X- ray Diffraction – Bragg's law – Techniques of X-ray Crystallography – Debye – Scherer camera – Geiger Diffractometer – analysis of Diffraction patterns – Inter planer spacing – Identification of Crystal Structure, Elements of Electron Diffraction.

UNIT III ELECTRON MICROSCOPY 9

Interaction of Electron Beam with Materials – Transmission Electron Microscopy – Specimen Preparation – Imaging Techniques – BF and DF – SAD – Electron Probe

Microanalysis – Scanning Electron Microscopy – Construction and working of SEM – various Imaging Techniques – Applications- Atomic Force Microscopy- Construction and working of AFM – Applications.

UNIT IV MECHANICAL TESTING – STATIC TESTS 9

Hardness – Brinell, Vickers, Rockwell and Micro Hardness Test – Tensile Test – Stress – Strain plot – Proof Stress – Ductility Measurement – Impact Test – Charpy and Izod.

UNIT V MECHANICAL TESTING – DYNAMIC TESTS 9

Fatigue – Low and High Cycle Fatigues – Rotating Beam and Plate Bending HCF tests – S-N curve – LCF tests – Crack Growth studies – Creep Tests – LM parameters – Applications of Dynamic Tests.

Total: 45 Periods

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

- **Explain** the Microstructure of Engineering Materials.
- **Describe** about the Crystal structure analyze
- **Summarize** the application of electron microscope
- **Identify** the mechanical testing methods
- **Analyze** the materials using Creep Tests.

REFERENCES:

1. Culity B.D., Stock S.R& Stock S, "Elements of X ray Diffraction", Prentice Hall, 3rd Edition,2001.
2. Dieter G.E, "Mechanical Metallurgy", McGraw Hill, 3rd Edition, ISBN: 0070168938,1995.
3. Davis, H.E., Hauck G and Troxell G.E, "The Testing of engineering Materials", McGraw Hill, College Divn., 4th Edition,1982.
4. Goldsten,I.J, Dale.E, Echin.N.P and Joy D.C, "Scanning Electron Microscopy and X ray-Micro Analysis", Plenum Publishing Corp,ISBN – 0306441756, 2nd Edition, , 2000.
5. Newby J, "Metals Hand Book- Metallography & Micro Structures", ASM International, 9th Edition,1989.
6. Grundy P.J. and Jones G.A, "Electron Microscopy in the Study of Materials", Edward Arnold Ltd., 1976.
7. Morita. S, Wiesendanger. R, and Meyer. E, "Noncontact Atomic Force Microscopy", Springer, 2002.

19PCD529	COMPOSITE MATERIALS AND MECHANICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To study the behavior of composite materials and to investigate the failure and fracture characteristics.

UNIT I INTRODUCTION 9

Introduction to Composites, Classifying composite materials, Commonly used fiber and matrix constituents, Composite Construction, Properties of Unidirectional Long Fiber Composites, Short Fiber Composites-Surface Preparation and Bonding Techniques.

UNIT II STRESS STRAIN RELATIONS 9

Concepts in solid mechanics, Hooke's law for orthotropic and anisotropic materials, Linear Elasticity for Anisotropic Materials, Rotations of Stresses, Strains, Residual Stresses.

UNIT III ANALYSIS OF LAMINATED COMPOSITES 9

Governing equations for anisotropic and orthotropic plates. Angle-ply and cross ply laminates. Static, dynamic and stability analysis for simpler cases of composite plates. Inter laminar stresses.

UNIT IV FAILURE AND FRACTURE OF COMPOSITES 9

Netting Analysis, Failure Criterion, Maximum Stress, Maximum Strain, Fracture Mechanics of Composites, Sandwich Construction.

UNIT V APPLICATIONS AND DESIGN 9

Metal and Ceramic Matrix Composites, Applications of Composites, Composite Joints, Design with Composites, Review, Environmental Issues.

Total: 45 Periods

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

- **Classify** the composite materials.
- **Analyze** the different type's stresses and laminated composites
- **Device** failure and fracture of composite
- **List out** the application of metal and ceramic
- **Understand** the Environmental Issues

REFERENCES:

1. Daniel and Ishai, “Engineering Mechanics of Composite Materials”, Oxford University Press, 2005.
2. Jones R.M, “Mechanics of composite materials”, McGraw-Hill, Kogakusha Ltd. Tokyo, 1975.
3. Agarwal B.D and Broutman L.J, “Analysis and Performance of fiber composites”, John-Wiley and Sons,1980.
4. Michael W.Hyer, “Stress Analysis of Fiber-Reinforced Composite Materials”, McGraw Hill,1999.
5. Mukhopadhyay.M, “Mechanics of Composite Materials and Structures”, University Press, India, 2004.

19PCD530 ADVANCED OPTIMIZATION TECHNIQUES

L	T	P	C
3	0	0	3

OBJECTIVES:

- This course aims at imparting knowledge on various optimization techniques in advance level

UNIT I INTRODUCTION **8**

Classification of optimization problems, concepts of design vector, Design constraints, constrains surface, objective function surface and multi-level optimization, parametric linear programming

UNIT II EXPERIMENTAL DESIGN FUNDAMENTALS **9**

Importance of experiments, experimental strategies, basic principles of design, terminology, ANOVA, steps in

experimentation, sample size, normal probability plot, linear regression model.

UNIT III DECISION ANALYSIS 10

Decision Trees, Utility theory, Game theory, Multi Objective Optimization, MCDM- Goal Programming, Analytic Hierarchy process

UNIT IV NON-TRADITIONAL OPTIMIZATION 10

Introduction to Genetic algorithms-Applications- introduction to Simulated Annealing-application.

UNIT V NEURAL NETWORK 8

Artificial neural network – Activation function –Supervised COURSE – unsupervised COURSE-back propagation network- self organized network- hop-field network

Total: 45 Periods

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

- **Review** the fundamentals experimental design
- **Analyze** the Utility theory, Game theory.
- **Describe the** decision analyze method
- **Illustrate** the GA,SA
- **Explain** the Activation functions

REFERENCES:

1. Rao, Singaresu, S, "Engineering Optimization – Theory & Practice", John wilely and sons, 1996.
2. Kalyanamoy Deb, "Optimization for Engineering design", Prentice Hall of India Pvt, 2003
3. Ravindran Phillips Solberg, "Operations Research – Principles and Practice", John Wiley India, 2006.
4. Fredrick S.Hillier and G.J.Liberman, "Introduction to Operations Research", McGraw Hill Inc., 1995.
5. Christos H. Papadimitriou, Kenneth Steiglitz, "Combinatorial Optimization", PHI, 2006.

19PCD601	INDUSTRIAL SAFETY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the operational safety
- To understand the safety management

UNIT I ACCIDENT INVESTIGATION AND ANALYSIS 9

Concept of an Accident, reportable and non reportable accidents, reporting to statutory authorities. Principles of accident prevention-accident investigation and analysis-Unsafe act and unsafe condition-Domino sequence-cost of accidents-permanent total disabilities, Permanent partial disabilities, Temporary total disabilities-Calculation of frequency rate and severity rate of accidents.

UNIT II ERGONOMICS AND HUMAN BEHAVIOUR 9

Introduction to ergonomics and its area of application in the work system. Anatomy, Posture and body mechanics-low back pain, risk factors for musculoskeletal disorders in the work place-behavioral aspects of posture - effectiveness. Individual differences, Factors contributing to personality, fitting the man to the job. Motivation -job satisfaction - Frustration and conflicts, reaction to frustration, emotion and frustration. Attitudes - determination of attitudes- changing attitudes.

UNIT III HAZARDS AND THEIR CONTROL 9

Physical hazards-Noise, heat, vibration, ionizing and non-ionizing radiations, and effects. Chemical hazards-dusts, fumes, mist, vapor, fog, gases, types, concentration, exposure Vs dose, TLV. Mechanical hazards. Engineering control methods- use of personal protective equipments.

UNIT IV FIRE PREVENTION AND PROTECTION **9**

Fire triangle-principles of fire extinguishing- various classes of fires- A, B, C, D types of fire extinguishers- Industrial fire protection systems. Sprinklers- Fire hydrants- Alarm and detection systems- other suppression systems- CO2 system, foam system and DCP system.

UNIT V SAFETY MANAGEMENT TECHNIQUES, EDUCATION AND TRAINING **9**

Incident Recall Technique (IRT), disaster control, Job safety Analysis, Safety survey, safety inspection. Safety training programs, seminars, conferences, competitions- method of promoting safe practice- motivation- creating awareness, awards, celebrations, safety posters, safety displays, safety incentive scheme- domestic safety and training. **Total: 45 Periods**

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

- **Evaluate** the concept of accident prevention& accident investigation
- **Identify** the human behavior
- **Demonstrate** hazards and their control
- **Prepare the** fire prevention and protection
- **Summarize the** safety management techniques

TEXT BOOKS:

1. Heinrich.H.W. "Industrial Accident Prevention", McGraw Hill Company, New York, 1980.
2. John V. Grimaldi and Rollin H. Simonds, "Safety Management" , All India Travellers Book Seller, New Delhi, 1989.
3. E.J.McCormick and M.S. Sanders "Human Factors in Engineering and Design", TMH, New Delhi, 1982.
4. Hand Book of "Occupational Safety and Health", National Safety Council, Chicago, 1982.
5. Derek, James, "Fire Prevention Hand Book", Butter Worths and Company, London, 1986.

REFERENCES:

1. Krishnan.N.V. "Safety Management in Industry", Jaico Publishing House, Bombay, 1997.
2. Lees, F. P. "Loss Prevention in Process Industries", Butter Worth publications, London, 2nd Edition, 1990.
3. Dan Peterson, "Techniques of Safety Management", McGraw Hill Company, Tokyo, 1981.
4. "Accident Prevention Manual for Industrial Operations", N.S.C. Chicago, 1982.
5. Hunter, Gomos, "Engineering Design for Safety", McGraw Hill Inc., 1992.

6. Encyclopedia of “Occupational Health and Safety” Vol I and II, Published by International Labour Office, Geneva, 1985.
7. Gupta. R.S., “Hand Book of Fire Technology”, Orient Longman, Bombay, 1977.