

ANNA UNIVERSITY COIMBATORE

**CURRICULUM AND SYLLABI 2007
FULL TIME MODE
M.E.CAD/CAM**

SEMESTER-I

Code no.	Course title	L	T	P	M
THEORY					
	ADVANCED MATHEMATICS	3	1	0	100
	COMPUTER APPLICATIONS IN DESIGN	3	0	0	100
	FINITE ELEMENT ANALYSIS	3	0	0	100
	CNC MACHINES AND ROBOTICS	3	0	0	100
	MODELING AND ANALYSIS OF MANUFACTURING SYSTEM	3	0	0	100
	ELECTIVE-I	3	0	0	100
PRACTICAL					
	CAD&CAE LAB	0	0	3	100

SEMESTER-II

Code no.	Course title	L	T	P	M
THEORY					
	MECHANICAL VIBRATIONS	3	0	0	100
	FLEXIBLE COMPETITIVE MANUFACTURING SYSTEM	3	0	0	100
	MICRO ELECTRO MECHANICAL SYSTEMS DESIGN	3	0	0	100
	INTEGRATED PRODUCT AND PROCESS DEVELOPMENT	3	0	0	100
	ELECTIVE-II	3	0	0	100
	ELECTIVE-III	3	0	0	100
PRACTICAL					
	CAM LAB	0	0	3	100

SEMESTER-III

Code no.	Course title	L	T	P	M
THEORY					
	ELECTIVE-IV	3	0	0	100
	ELECTIVE-V	3	0	0	100
	ELECTIVE-VI	3	0	0	100
PRACTICAL					
	PROJECT WORK PHASE-I	0	0	12	200

SEMESTER-IV

Code no.	Course title	L	T	P	M
PRACTICAL					
	PROJECT WORK PHASE-II	0	0	24	400

**LIST OF ELECTIVES
M.E.CAD/CAM**

Course code	Course title	L	T	P	M
	INDUSTRIAL ROBOTICS AND EXPERT SYSTEMS	3	0	0	100
	MECHATRONICS SYSTEM DESIGN	3	0	0	100
	ADVANCED TOOL DESIGN	3	0	0	100
	PRODUCTIVITY MANAGEMENT AND RE-ENGINEERING	3	0	0	100
	APPLIED MATERIALS ENGINEERING	3	0	0	100
	COMPUTER AIDED PROCESS PLANNING	3	0	0	100
	METROLOGY AND NON DESTRUCTIVE TESTING	3	0	0	100
	DATA COMMUNICATION IN CAD/CAM	3	0	0	100
	COMPUTATIONAL FLUID DYNAMICS	3	0	0	100
	MODELING OF DYNAMIC SYSTEM	3	0	0	100
	DESIGN OF AUTOMOTIVE SYSTEMS	3	0	0	100
	DESIGN AND ANALYSIS OF THERMAL SYSTEMS	3	0	0	100
	DESIGN OF PLASTIC PARTS	3	0	0	100
	ENTERPRISE RESOURCE PLANNING	3	0	0	100
	ADVANCED MECHANISM DESIGN AND SIMULATION	3	1	0	100
	DESIGN FOR MANUFACTURE AND ASSEMBLY	3	0	0	100
	OPTIMIZATION TECHNIQUES IN DESIGN	3	0	0	100
	TRIBOLOGY IN DESIGN	3	0	0	100
	ADVANCED STRENGTH OF MATERIALS	3	0	0	100
	DESIGN OF MATERIAL HANDLING EQUIPMENT	3	0	0	100
	MECHANICS OF COMPOSITE MATERIALS	3	0	0	100
	DESIGN OF HYDRAULIC AND PNEUMATIC SYSTEM	3	0	0	100
	PRODUCT DATA MANAGEMENT	3	0	0	100
	RAPID PROTOTYPING AND TOOLING	3	0	0	100

**ED: Engineering Design,
CC: CAD/CAM**

**CD: Computer Aided Design
PC: Product Design and Commerce**

1. SIMULTANEOUS EQUATIONS AND NUMERICAL INTEGRATION 10

Solving of set of equations, Gauss elimination method, Choleski method, Iterative methods, Relaxation method, System of non-linear equations- Newton Raphson method -Newton-Cotes integration formulas, Trapezoidal rule, Simpson's rules, Gaussian quadrature, Adaptive integration, Examples.

2. BOUNDARY VALUE AND CHARACTERISTIC VALUE PROBLEMS 8

Shooting method, solution through a set of equations, derivative boundary conditions, Rayleigh-Ritz method, characteristic value problems, solution using Characteristic polynomial method, Jacobi method, Power method and Inverse power method.

3. CALCULUS OF VARIATIONS 6

Variation and its properties –Euler's equation – Functionals dependent on first and higher order derivatives - Functionals dependent on functions of several independent variables – Rayleigh Ritz method- Galerkin method.

4. PARTIAL DIFFERENTIAL EQUATIONS - NUMERICAL SOLUTION 7

Laplace's equations, representations as a difference equation, Iterative methods for Laplace's equations, Poisson equation, derivative boundary conditions, irregular and non-rectangular grids, Matrix patterns, Sparseness, ADI method, Applications to heat flow problems.

5. PARABOLIC PARTIAL DIFFERENTIAL EQUATIONS 7

Explicit method, Crank-Nicholson method, derivative boundary condition, stability and convergence criteria, Parabolic equations in two or more dimensions, applications to heat flow problems.

6. HYPERBOLIC PARTIAL DIFFERENTIAL EQUATIONS 7

Solving wave equation by finite differences, stability of numerical method, method of characteristics, Wave equation in two space dimensions, computer programs.

Note: Assignments/Term papers using MATLAB / C / C++ to solve design problems.

TUTORIALS: 15, TOTAL: 60

REFERENCES

1. Curtis F Gerald and Patrick O Wheatley, "Applied Numerical Analysis", Pearson Education, 2002.
2. Rajasekaran S, "Numerical Methods in Science and Engineering – A Practical Approach", Wheeler Publishing, 1999, Second Edition.
3. Douglas J Faires and Riched Burden, "Numerical Methods", Brooks/Cole Publishing Company, 1998, Second Edition.
4. Steven C Chapra and Raymond P Canale, "Numerical Methods for Engineers with Software and Programming Applications", Tata McGraw Hill Edition, 2004.
5. John H Mathews and Kurtis D Fink, "Numerical Methods using MATLAB", Prentice Hall, 1998.
6. Ward Cheney and David Kincaid, "Numerical Mathematics and Computing", Brooks/Cole Publishing Company, 1999, Fourth Edition.

07ED102 COMPUTER APPLICATIONS IN DESIGN

3 0 0100

1. INTRODUCTION TO COMPUTER APPLICATIONS IN NEW PRODUCT DESIGN 9

Concept design – parametric sketching – constraints – computer graphics principles- 2D transformation, scaling, rotation – windowing, view ports – clipping – data exchange formats.

2. COMPUTERS IN DESIGN 10

Solid modeling of Mechanical components – associative features – Sheet metal components, nesting and development – plastic parts with draft and shrinkage allowance – Reverse engineering of components – assembly of parts – tolerance analysis – mass property calculations

3. COMPUTERS IN TOOLING DESIGN 9

Mould design – jigs and fixtures design – check for interferences – mechanism design and analysis – Rapid tooling

4. COMPUTERS IN DESIGN PRODUCTIVITY 8

Customizing various software by using visual basic, pro/program, script, LISP etc to write applications like design of shafts, gears etc.,

5. MANAGING PRODUCT DESIGN DATA 9

Version control – library creation – catalog making – standardization for design – collaborative design among peer groups – Design optimization for geometry - Design check, approval and validation.

Total: 45

REFERENCES

1. William M. Neumann and Robert Sproul “ Principles of Computer Graphics” McGraw Hill Book Co. Singapore 1989.
2. Ibrahim Zeid “CAD/CAM – Theory and Practice” – McGraw Hill, International Edition 1998.
3. P N Rao “CAD/CAM :Principles and Applications” Tata McGraw Hill , Second Edition. 2004.
4. Schlechtendahl, E. G, CAD – Data transfer for Solid Models, Springer Verlag, Berlin, 1989.
5. Donald Hearn and M Pauline Baker “Computer Graphics” Prentice Hall Inc 1992.

07ED103 FINITE ELEMENT ANALYSIS

3 0 0 100

1. INTRODUCTION & ONE-DIMENSIONAL PROBLEMS 10

Relevance of finite element analysis in design - Variational principles and methods – Weighted-Integral statements – Weak formulations – Ritz method – Method of weighted residuals – Applications of FEA - Finite element modeling – Co-ordinates and shape functions - Potential energy approach – Galerkin's approach – One dimensional finite element models in Solid mechanics and Heat transfer – Finite element model for beams

2. TWO-DIMENSIONAL PROBLEMS 10

Poisson equation – Laplace equation – Weak form – Element matrices for triangular and rectangular elements – Evaluation of integrals – Assembly – Axi-symmetric problems – Applications – Conduction and convection heat transfer - Torsional cylindrical member – Transient analysis - Theory of elasticity – Plane strain – Plane stress – Axi-symmetric problems – Principle of virtual displacement

3. ISOPARAMETRIC ELEMENTS 8

Introduction – Bilinear quadrilateral elements – Quadratic quadrilaterals – Hexahedral elements - Numerical integration – Gauss quadrature – Static condensation – Load considerations – Stress calculations – Examples of 2D and 3D applications

4. STRUCTURAL DYNAMICS APPLICATIONS 9

Dynamic equations – Mass and damping matrices – Natural frequencies and modes – Reduction of number of DOF-response history – Model methods – Ritz vectors – Component mode synthesis – Harmonic response – Direct integration techniques – Explicit and implicit methods – Analysis by response spectra – Example problems

5. NON-LINEAR PROBLEMS & ERROR ESTIMATES 8

Introduction – Material non-linearity – Elasto Plasticity – Plasticity – Visco plasticity – Geometric non-linearity – Large displacement – Error norms and convergence rates – H-refinement with adaptivity – adaptive refinement

Total : 45

REFERENCES

1. Reddy J.N., "An Introduction to the Finite Element Method", McGraw Hill, International Edition, 1993.
2. Logan D.L., "A First Course in the Finite Element Method", Third Edition, Thomson Learning, 2002.
3. Cook, Robert Davis et al "Concepts and Applications of Finite Element Analysis", Wiley, John & Sons, 1999.
4. Segerlind L.J., "Applied Finite Element Analysis", John Wiley, 1984.
5. S.S.Rao, "Finite Element Analysis", 2002 Edition.
6. Zienkiewicz, O.C. and Taylor, R.L., "The Finite Element Method", Fourth Edition, Volumes 1 & 2, McGraw Hill International Edition, Physics Services, 1991.
7. Bathe K.J., "Finite Element Procedures in Engineering Analysis", Prentice Hall, 1990.

1. INTRODUCTION AND DESIGN FUTURES OF CNC MACHINES 6

Working principles of typical CNC lathes, turning centre, machining centre, CNC grinders, CNC gear cutting machines, wire cut EDM. Selection of CNC machine tools, structure, drive kinematics, gear box, main drive, selection of timing belts and pulleys, spindle bearings arrangement and installation. Re-circulating ball screws, linear motion guide ways, tool magazines, ATC, APC, chip conveyors tool turrets, pneumatic and hydraulic control system.

2. CONROL SYSTEMS AND INTERFACING 5

Open loop and closed loop systems, microprocessor based CNC systems, block diagram of a typical CNC system, description of hardware and software interpolation systems, standard and optional features of a CNC control system, comparison of different control system, feedback devices with a CNC system, spindle encoder.

3. PART PROGRAMMING OF A CNC LATHE 6

Process planning, tooling, preset and qualified tools, typical tools for turning and machining centres. Axes definition, machine and workpiece datum, turret datum, absolute and incremental programming, tape codes, ISO and EIA codes, G and M functions, tool offset information, soft jaws, tool nose radius compensation, long turning cycle, facing cycle, constant cutting velocity, threading cycle, peak drilling cycle, part programming examples.

4. Manual PART PROGRAMMING OF A MACHINING CENTRE 6

Co-ordinate systems, cutter diameter compensation, fixed cycles, drilling cycle, tapping cycle, boring cycle, fineboring, back boring cycle, area clearance programs, macro, parametric programming, part programming examples. CAD/CAM based NC programming, features of CAM packages.

5. FUNDAMENTAL CONCEPT OF ROBOTICS 6

History, present status and future trends, robotics and automation, laws of robotics, robot definition, robotics system and robot anatomy, specification of robots, resolution, repeatability and accuracy of a manipulator.

6. ROBOT DRIVES 7

Power transmission systems and control robot drive mechanisms, mechanical transmission method, rotary-to-rotary motion conversion, rotary-to-linear motion conversion end effectors, types, gripping problem, remote-centered compliance devices, control of actuator in robot mechanisms. Sensors for robotic applications.

7. TRANSFORMS AND KINEMATICS 9

Homogeneous co-ordinates, co-ordinate reference frames, homogeneous transformations for the manipulator, the forward and inverse problem of manipulator kinematics, motion generation, manipulator dynamics, robot programming.

Total: 45

REFERENCES

- 1) Radhakrishnan P, "Computer Numerical Control CNC machines" New central book agency, 1992.
- 2) Richard D Klafter, Thomas A cmielewski, Michael Negin, "Robotc Engineering, AnIntegrated approach", estern economy edition prentice hall Pvt. Ltd., 1989.
- 3) Mikell P Groover, Mitchell weiss, Roger N Nagel G Odrey, "Industrial Robotics", Mc-Graw Hill book co, NY, 1986.
- 4) Yoram Koren, "Computer control of manufacturing systems", Mc-Graw Hill book co, 986.
- 5) Programming instruction manuals of CNC lathes and machining centres, 2001
- 6) Shuman Y Nof, "Handbook of industrial robotics", John wiley and sons, New York, 1985.

07CC102 MODELING AND ANALYSIS OF MANUFACTURING SYSTEMS

3 0 0 100

1. MANUFACTURING SYSTEMS AND MODELS

10

Types and principles of manufacturing systems, types and uses of manufacturing models, physical models, mathematical models, model uses, model building.

2. MATERIAL FLOW SYSTEMS

12

Assembly lines-Reliable serial systems, approaches to line balancing, sequencing mixed models. Transfer lines and general serial systems-paced lines without buffers, unpaced lines. Shop scheduling with many products. Flexible manufacturing systems-system components, planning and control. Group technology-assigning machines to groups, assigning parts to machines. Facility layout-Quadratic assignments problem approach, graphic theoretic approach.

3. SUPPORTING COMPONENTS

7

Machine setup and operation sequencing-integrated assignment and sequencing. Material handling systems-conveyor analysis, AGV systems. Warehousing-storage and retrieval systems, order picking.

4. GENERIC MODELING APPROACHES

5

Analytical queuing models, a single workstation, open networks, closed networks. Empirical simulation models-even models, process models, simulation system, example manufacturing system.

5. SYNCHRONIZATION MANUFACTURING

5

Synchronization Vs Optimization, defining the structure, identifying the constraint, exploitation, buffer management.

6. PETRI NETS

6

Basic definitions-dynamics of Petri nets, transformation methods, event graphs, modeling of manufacturing systems.

Total: 45

REFERENCES

1. Ronald G Askin, "Modeling and Analysis of Manufacturing Systems", John Wiley and Sons, Inc, 1993
2. Mengchu Zhou, "Modeling, Simulation, and Control of Flexible Manufacturing Systems: A Petri Net Approach",
3. World Scientific Publishing Company Pvt Ltd. 2000
4. Jean Marie Proth and Xiaolan Xie, "Petri Nets: A Tool for Design and Management of Manufacturing Systems" John Wiley and Sons, New York, 1996
5. P Brandimarte, A Villa, "Modeling Manufacturing Systems" Springer Verlag, Berlin, 1999.

1. CAD (COMPUTER AIDED DRAFTING)

Modeling and Assembly of mechanical components using parametric and feature based packages. Introduction to CAD software, Part – Assembly –Drafting model of mechanical machine components like –Flange coupling, Universal coupling, Screw jack etc.

View: Orthographic view, Isometric view, Sectional view, Exploded view.

GD&T: Standard, Part list, Bill of Material, Machining symbols, Tolerance – Fits and Geometric.

2. CAE (COMPUTER AIDED ENGINEERING)

Analysis of mechanical machine components using analysis software.

Introduction of CAE software, STRUCTURAL Analysis: Static analysis -2D, 3D, Beam, Truss. THERMAL Analysis: 2D Conduction, 3D Convection. DYNAMICS Analysis: Modal analysis, Transient analysis.

Total: 45

1. FUNDAMENTALS OF VIBRATION**8**

Introduction – Single degree freedom free vibration systems – Damped vibrations – Single degree freedom forced vibration with elastically coupled viscous dampers, System Identification from frequency response, Support motion, Duhamel's Integral – Impulse Response function – Virtual work – Lagrange's equation— Transient Vibration

2. TWO DEGREE FREEDOM SYSTEM**8**

Free vibration of spring-coupled system – mass coupled system – Vibration of two degree freedom system – Forced vibration – Vibration Absorber – Vibration isolation.

3. MULTI-DEGREE FREEDOM SYSTEM**12**

Normal mode of vibration – Flexibility Matrix and Stiffness matrix – Eigen values and eigen vectors – orthogonal properties – Modal matrix-Modal Analysis – Forced Vibration by matrix inversion – Modal damping in forced vibration – Numerical methods for fundamental frequencies.

4. VIBRATION OF CONTINUOUS SYSTEMS**8**

Systems governed by wave equations – Vibration of strings – vibration of rods – Euler Equation for Beams – Effect of Rotary inertia and shear deformation – Vibration of plates.

5. EXPERIMENTAL METHODS IN VIBRATION ANALYSIS**9**

Vibration instruments – Vibration exciters Measuring Devices – Analysis – Vibration Tests – Free and Forced Vibration tests. Examples of Vibration tests – Industrial, case studies.

L : 45 T : 15**Total 60****REFERENCES:**

1. Benson H.Tongue, Principles of Vibration, 2nd edn., Oxford University Press, NY, 2002
2. Thomson, W.T. – “Theory of Vibration with Applications”, CBS Publishers and Distributors, New Delhi, 1990.
3. Rao, J.S., & Gupta, K. – “Ind. Course on Theory and Practice Mechanical Vibration”, New Age International (P) Ltd., 1984.
4. Den Hartog, J.P, “Mechanical Vibrations,” Dover Publications, 1990.
5. Rao, S.S.,” Mechanical Vibrations,” Addison Wesley Longman, 1995.

07CC201 FLEXIBLE COMPETITIVE MANUFACTURING SYSTEM

3 0 0 100

1. MANUFACTURING IN A COMPETITIVE ENVIRONMENT 9

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

2. GROUP TECHNOLOGY 9

Part families - classification and coding - Production flow analysis - Machine cell design - Benefits.

3. FLEXIBLE MANUFACTURING SYSTEMS 9

Introduction - Components of FMS - Application workstations - Computer control and functions - Planning, scheduling and control of FMS - Scheduling - Knowledge based scheduling - Hierarchy of computer control - Supervisory computer.

4. COMPUTER SOFTWARE, SIMULATION AND 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.

5. 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 - Karban system - strategic implications - implementation issues - MRD JIT - Lean manufacture.

Total: 45

References

1. Groover M.P., " Automation, Production Systems and Computer Integrated Manufacturing ", Prentice-Hall of India Pvt. Ltd., New Delhi, 1996.
2. Jha, N.K. " Handbook of Flexible Manufacturing Systems ", Academic Press Inc., 1991.
3. Kalpakjian, " 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.

1. INTRODUCTION 9

Overview-Microsystems and microelectronics - Working principle of Microsystems -micro actuation techniques-micro sensors-types-microactuators-types-micropump-micromotors-micro-valves-microgrippers-scaling laws-scaling in geometry-scaling in rigid body dynamics- scaling in electrostatic forces- scaling in electricity- scaling in fluid mechanics-scaling in heat transfer.

2. MATERIALS AND FABRICATION PROCESS 9

Substrates and wafer-single crystal silicon wafer formation-ideal substrates-mechanical properties-silicon compounds - SiO_2 , SiC , Si_3N_4 and polycrystalline silicon - Silicon piezoresistors - Gallium arsenide, Quartz-piezoelectric crystals-polymers for MEMS - conductive polymers – Photolithography - Ion implantation - Diffusion – Oxidation –CVD - Physical vapor deposition - Deposition by epitaxy - etching process

3. MICROMECHANICS 9

Introduction-static bending of thin plates-circular plates with edge fixed - rectangular plate with all edges fixed and square plate with all edges fixed – Mechanical vibration-resonant vibration- micro accelerometers-design theory and damping coefficients- thermo mechanics-thermal stresses-fracture mechanics-stress intensity factors, fracture toughness and interfacial fracture mechanics.

4. MICRO SYSTEM MANUFACTURING 9

Clean room technology-Bulk Micro manufacturing- surface micro machining –LIGA-SLIGA-Micro system packaging-materials-die level-device level-system level-packaging techniques-die preparation-surface bonding-wire bonding-sealing

5. MICRO SYSTEM DESIGN 9

Design considerations-process design-mask layout design- mechanical design-applications of micro system in -automotive industry-bio medical –aero space-telecommunications.

Total: 45

REFERENCES

1. Mohamed Gad-el-Hak, The MEMS Hand book, CRC press 2002.
2. Julian W.Gardner,Vijay K.Varadan,Osama O.Awadel Karim,Microsensors MEMS and Smart Devices, John Wiley & sons Ltd.,2001.
3. S.Fatikow,U.Rembold,Microsystem Technology and Microrobotics,Springer-Verlag Berlin Heidelberg ,1997.
4. Tai-Ran Hsu,MEMS & Microsystems Design and Manufacture,Tata McGraw-Hill,2006.
5. Francis E.H Tay and W.O Choong, Microfluidics and BioMEMS Applications, Springer, 2002.

1. INTRODUCTION

9

Characteristics of Successful Product Development-Interdisciplinary activity-Duration and Costs of Product Development- Challenges of Product Development -Development Processes and Organizations-A Generic Development Process-Concept Development: The Front-End Process Adapting the Generic Product Development Process- The AMF Development Process-Product Development Organizations-The AMF Organization

2. PRODUCT PLANNING

9

Product Planning Process- Identifying Opportunities- Evaluating and Prioritizing Projects-Allocating Resources and Timing- Pre-Project Planning-Reflect on the Results and the Process-Identifying Customer Needs- Raw Data from Customers- Interpreting Raw Data in Terms of Customer Needs-Organizing the Needs into a Hierarchy-Establishing the Relative Importance of the Needs-Reflecting on the Results and the Process

3. PRODUCT SPECIFICATIONS

9

Specifications - Specifications Established - Establishing Target Specifications-Setting the Final Specifications-Concept Generation-The Activity of Concept Generation-Clarify the Problem- Search Externally-Search Internally-Explore Systematically- Reflect on the Results and the Process.

4. CONCEPT SELECTION

9

Concept Selection- Overview of Methodology-Concept Screening-Concept Testing-Define the Purpose of the Concept Test- Choose a Survey Population- Choose a Survey Format-Communicate the Concept- Measure Customer Response-Interpret the Results- Reflect on the Results and the Process

5. PRODUCT ARCHITECTURE

9

Product Architecture-Implications of the Architecture-Establishing the Architecture-Delayed Differentiation-Platform Planning-Related System-Level Design Issues

Total 45

REFERENCE:

1. Product Design and Development , Karl T. Ulrich and Steven .D Epingner , McGraw-Hill International Edns. 1999.
2. Kevin Otto and Kristin Wood, "Product Design" Pearson Publication, 2004
3. Tool Design – Integrated Methods for successful Product Engineering, Stuart Pugh, Addison Wesley Publishing, New York, NY, 1991, ISBN 0-202-41639-5
4. Effective Product Design and Development, Stephen Rosenthal, Business One Orwin, Homewood, 1992,ISBN, 1-55623-603-4
5. Concurrent Engg. /Integrated Product Development. Kenneth Crow, DRM Associates, 26/3, Via Olivera, Palos Verdes, CA 90274(310) 377-569, Workshop Book

07CC2L1

CAM Lab

0 0 3 100

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.

Total 45

1. INTRODUCTION AND ROBOT KINEMATICS**10**

Definition need and scope of Industrial robots – Robot anatomy – Work volume – Precision movement – Classifications of Robots.

Robot Kinematics – Direct and inverse kinematics – Robot trajectories – Control of robot manipulators – Robot dynamics – Methods for orientation and location of objects.

2. 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.

3. ROBOT SENSORS**9**

Transducers and Sensors – Sensors in Robot – Tactile sensor – Proximity and range sensors – Sensing joint forces – Robotic vision system – Image Gribbing – Image processing and analysis – Image segmentation – Pattern recognition – Training of vision system.

4. 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.

5. ROBOT PROGRAMMING, ARTIFICIAL INTELLIGENCE AND EXPORT SYSTEMS**8**

Methods of Robot Programming – Characteristics of task level languages lead through programming methods – Motion interpolation. Artificial intelligence – Basics – Goals of artificial intelligence – AI techniques – problem representation in AI – Problem reduction and solution techniques - Application of Artificial Intelligence in Robots.

Total: 45**REFERENCES:**

1. K.S.Fu, R.C. Gonzalez and C.S.G. Lee, "Robotics Control, Sensing, Vision and Intelligence", Mc Graw Hill, 1987.
2. Yoram Koren," Robotics for Engineers' Mc Graw-Hill, 1987.
3. Kozyrey, Yu. "Industrial Robots", MIR Publishers Moscow, 1985.
4. Richard. D, Klafter, Thomas, A, Chmielewski, 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 G. Odrey," Industrial Robotics Technology, Programming and Applications", Mc Graw-Hill, Int. 1986.
7. Timothy Jordanides et al ,"Expert Systems and Robotics ", Springer –Verlag, New York, May 1991.

07CC002 MECHATRONICS SYSTEM DESIGN 3 0 0 100

- 1. INTRODUCTION 3**
Introduction to Mechatronics - Systems - Mechatronics in Products - Measurement Systems - Control Systems - Traditional design and Mechatronics Design.
- 2. SENSORS AND TRANSDUCERS 12**
Introduction - Performance Terminology - Displacement, Position and Proximity - Velocity and Motion - Fluid pressure - Temperature sensors - Light sensors - Selection of sensors - Signal processing - Servo systems.
- 3. MICROPROCESSORS IN MECHATRONICS 15**
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.
- 4. PROGRAMMABLE LOGIC CONTROLLERS 8**
Introduction - Basic structure - Input / Output processing - Programming -Mnemonics Timers, Internal relays and counters - Data handling - Analog input / output - Selection of PLC.
- 5. DESIGN AND MECHATRONICS 7**
Designing - Possible design solutions - Case studies of Mechatronics systems.

Total 45

REFERENCE

1. Michael B.Histand and David G. Alciatore, "Introduction to Mechatronics and Measurement Systems", McGraw-Hill International Editions, 1999.
2. Bradley, D.A., Dawson, D, Buru, N.C. and Loader, A J., " Macaronis ", 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. and Sridhar, P.R., 0000 to 8085, "Introduction to Microprocessors for Engineers and Scientists ", Second Edition, Prentice Hall, 1995.

1. TOOL-DESIGN METHODS 5

Introduction – The Design Procedure – Statement of the problem – The Needs Analysis – Research and Ideation – Tentative Design Solutions – The Finished Design – Drafting and Design Techniques in Tooling drawings – Screws and Dowels – Hole location – Jig-boring practice – Installation of Drill Bushings – Punch and Die Manufacture – Electro-discharge machining – Electro-discharge machining for cavity.

2. TOOLING MATERIALS AND HEAT TREATMENT 9

Introduction – Properties of Materials – Ferrous Tooling Materials – Tool steels – Cast Iron – Mild, or low-carbon Steel – Nonmetallic Tooling Materials – Nonferrous Tooling Materials – Metal cutting Tools – Single-point cutting tools – Milling cutters – Drills and Drilling – Reamer classification – Taps – Tap classification- the selection of carbide cutting tools – Determining the insert thickness for carbide tools

3. DESIGN OF DRILL JIGS 9

Introduction – Fixed Gages – Gage Tolerances – The 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 – Drill jigs and modern manufacturing

4. DESIGN OF FIXTURES AND DIES 14

Introduction – Fixtures and economics – Types of Fixtures – Vise Fixtures – Milling Fixtures – Boring Fixtures – Broaching Fixtures – Lathe Fixtures – Grinding Fixtures – Types of Die construction – Die-design fundamentals – Blanking and Piercing die construction – Pilots – Strippers and pressure pads- Presswork materials – Strip layout – Short-run tooling for Piercing – Bending dies – Forming dies – Drawing operations.

5. TOOL DESIGN FOR NUMERICALLY CONTROLLED MACHINE TOOLS 8

Introduction – The need for numerical control – A basic explanation of numeric control – Numerical control systems in use today – Fixture design for numerically controlled machine tools – Cutting tools for numerical control – Tool holding methods for numerical control – Automatic tool changers and tool positioners – Tool presetting – Introduction – General explanation of the Brown and sharp machine – tooling for Automatic screw machines

Total 45

REFERENCES:

- 1 Cyril Donaldson, George H.LeCain, V.C. Goold, "Tool Design", Tata McGraw Hill Publishing Company Ltd., 2000.
- 2 Prakash Hiralal Joshi, "Tooling data", Wheeler Publishing, 2000

07CC004 PRODUCTIVITY MANAGEMENT AND RE-ENGINEERING 3 0 0 100

1. INTRODUCTION 5

Productivity concepts - Macro and Micro factors of productivity, Productivity benefit model, productivity cycle.

2. PRODUCTIVITY MODELS 12

Productivity measurement at International, National and Organizational level, Total productivity models. Productivity management in manufacturing and service sector. Productivity evaluation models, Productivity improvement models and techniques.

3. ORGANIZATIONAL TRANSFORMATION 8

Principles of organizational transformation and re-engineering, fundamentals of process reengineering, preparing the workforce for transformation and reengineering, methodology, guidelines, DSMCQ and PMP model.

4. RE-ENGINEERING PROCESS IMPROVEMENT MODELS 10

PMI models, Edosomwan model, Moen and Nolan strategy for process improvement, LMICIP model, NPRDC model.

5. RE-ENGINEERING TOOLS AND IMPLEMENTATION 10

Analytical and process tools and techniques - Information and communication technology - Enabling role of IT, RE-opportunities, process redesign - cases. Software methods in BPR - specification of BP, case study - Order, processing, user interfaces, maintainability and reusability

Total 45

REFERENCES

- 1 Sumanth, D.J., " Productivity engineering and management ", TMH, New Delhi, 1990.
- 2 Edosomwan, J.A., " Organizational transformation and process re-engineering", British Library cataloging in pub. data, 1996.
- 3 Rastogi, P.N. " Re-Engineering and Re-inventing the enterprise ", Wheeler pub. New Delhi, 1995.
- 4 Premvrat, Sardana, G.D. and Sahay, B.S, " Productivity Management - A systems approach ", Narosa Pub. New Delhi, 1998.

1. ELASTIC AND PLASTIC BEHAVIOUR**10**

Elasticity in metals and polymers - Mechanism of plastic deformation, role of dislocations, yield stress, shear strength of perfect and real crystals - Strengthening mechanisms, work hardening, solid solution strengthening, grain boundary strengthening, poly phase mixture, precipitation, particle, fiber and dispersion strengthening. Effect of temperature, strain and strain rate on plastic behaviors - Super plasticity - Deformation of non-crystalline material

2. FRACTURE BEHAVIOUR**10**

Griffith 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.

3. SELECTION OF MATERIALS**10**

Motivation for selection, 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.

4. MODERN METALLIC MATERIALS**7**

Dual phase steels, Micro alloyed, High strength low alloy (HSLA) steel, Transformation induced plasticity (TRIP) steel, Maraging steel - Intermetallics, Ni and Ti aluminides - Smart materials, shape memory alloys - Metallic glass - Quasi crystal and nano crystalline materials.

5. NON METALLIC MATERIALS**8**

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

Total No. of Hours: 45**REFERENCES:**

1. Thomas H.Courtney, " Mechanical Behaviour of Materials ", (2nd Edition), McGraw-Hill, 2000.
2. Charles J.A., Crane, F.A.A and Furness, J.A.G., " Selection and use of Engineering Materials ", (3rd Edition), Butterworth-Heinemann, 1977.
3. Flinn, R.A. and Trojan, P.K., " Engineering Materials and their Applications ", (4th Edition), Jaico, 1999.
4. George E.Dieter, " Mechanical Metallurgy ", McGraw Hill, 1988.
5. Metals Hand Book, Vol.10, " Failure Analysis and Prevention ", (10th Edition), 1994.

1. INTRODUCTION 9

Introduction to Process Planning and Production Planning – Process Planning in the Manufacturing cycle - Process Planning and Concurrent Engineering, CAPP, Group Technology.

2. PART DESIGN REPRESENTATION 9

Design Drafting - Dimensioning - Conventional tolerance - Geometric tolerance - CAD - input / output devices - topology - Geometric transformation - Perspective transformation - Data structure - Geometric modelling for process planning - GT layout, GT- coding - The optiz system - The MICLASS system- CODE system.

3. PROCESS ENGINEERING AND PROCESS PLANNING 9

Experienced, based planning - Decision table and decision trees - Process capability analysis – Process boundaries – Process parameters – Process optimization. Process Planning - Variant process planning - Generative approach - Forward and Backward planning, Input format, AI.

4. COMPUTER AIDED PROCESS PLANNING SYSTEMS 9

Logical Design of a Process Planning - Implementation considerations -manufacturing system components, production Volume, No. of production families - CAM-I, CAPP, MIPLAN, APPAS, AUTOPLAN and PRO, CPPP.

5. AN INTERGRADED PROCESS PLANNING SYSTEMS 9

Totally integrated process planning systems - An Overview – TIPPS Design philosophy- CAD Interface, Modulus structure – Interactive surface identification, Process knowledge- Description language - Data Structure, operation - Input and Display of CAD model- surface identification - select process- select process parameters- Report Generation- Testing results, Expert process planning.

Total: .45**REFERENCES**

1. Gideon Halevi and Roland D. Weill, " Principles of Process Planning ", A logical approach, Chapman & Hall, 1995.
2. Tien-Chien Chang, Richard A.Wysk, "An Introduction to automated process planning systems ", Prentice Hall, 1985.
3. Chang, T.C., " An Expert Process Planning System ", Prentice Hall, 1985.
4. Nanua Singh, " Systems Approach to Computer Integrated Design and Manufacturing ", John Wiley & Sons, 1996.
5. Rao,P.N " Computer Aided Manufacturing ", Tata McGraw Hill Publishing Co., 2001.

1. 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.

2. 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.

3. 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.

4. 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.

5. 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

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 ", Vol.II, 1976.
4. Progress in Acoustic Emission, " Proceedings of 10th International Acoustic Emission Symposium ", Japanese Society for NDI, 1990.

1. 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

2. 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.

3. 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.

4. 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.

5. 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

References

1. Morris Mano. M., "Computer System Architecture", Prentice Hall of India, 1996.
2. Gaonkar R.S., "Microprocessor Architecture, Programming and Applications of 8085", Penram International, 1997
3. Peterson J.L., Galvin P. and Silberschaz, A., "Operating Systems Concepts", Addison Wesley, 1997.
4. Alfred V. Aho, Ravi Setjhi, Jeffrey D Ullman, "Compilers Principles Techniques and Tools", Addison Wesley, 1986.
5. William Stallings, "Data of Computer Communications" Pearson Educational Pvt. Ltd, 2002.
6. Andrew S. Tanenbanum "Computer Networks", Prentice Hall of India 3rd Edition, 1999.
7. Christian Crumlish, "The ABC's of the Internet", BPB Publication, 1996.

1. 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 non-uniform Grids, Numerical Errors, Grid Independence Test.

2. CONDUCTION HEAT TRANSFER 10

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

3. INCOMPRESSIBLE FLUID FLOW 10

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

4. CONVECTION HEAT TRANSFER AND FEM 10

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.

5. TURBULENCE MODELS 5

Algebraic Models – One equation model, $k - \epsilon$ Models, Standard and High and Low Reynolds number models, Prediction of fluid flow and heat transfer using standard codes.

Total : 45 hrs

REFERENCES

- 1 John D. Anderson, Computational Fluid Dynamics, McGraw-Hill International Editions, 1995
- 2 Muralidhar, K., and Sundararajan, T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, 1995.
- 3 Ghoshdasdar, P.S., "Computer Simulation of flow and heat transfer" Tata McGraw-Hill Publishing Company Ltd., 1998.
- 4 Subas, V. Patankar "Numerical heat transfer fluid flow", Hemisphere Publishing Corporation, 1980.
- 5 Anderson, D.A., Tannehill, J.I., and Pletcher, R.H., "Computational fluid Mechanics and Heat Transfer", Hemisphere Publishing Corporation, New York, USA, 1984.
- 6 Fletcher, C.A.J. "Computational Techniques for Fluid Dynamics 1", Fundamental and General Techniques, Springer – Verlag, 1987.
- 7 Bose, T.X., "Numerical Fluid Dynamics", Narosa Publishing House, 1997

MATHEMATICAL MODELS OF PHYSICAL SYSTEMS (9)

Introduction to control systems, differential equations of physical systems, dynamics of robotic mechanism, transfer functions, block diagram algebra, signal flow graphs.

FEEDBACK CHARACTERISTICS OF CONTROL SYSTEMS AND COMPONENTS (9)

Feed back and non feedback systems, reduction of parameter variations, control over system dynamics, control of the effects of disturbance signals, linearizing effect, regenerative feedback.. Linear approximation on non-linear systems, stepper motors, hydraulic systems, pneumatic systems.

TIME RESPONSE ANALYSIS AND STABILITY IN TIME DOMAIN (9)

Standard test signals, time response of first-order systems, time response of second-order systems, steady-state errors and error constraints, effect of adding a zero to a system, design specifications of second-order systems, design considerations for higher-order system, performance indices, robotic control systems, state variable analysis, approximation of higher-order systems by lower order systems, concept of stability, necessary conditions, Routh stability criterion, relative stability analysis

FREQUENCY RESPONSE ANALYSIS AND STABILITY IN FREQUENCY DOMAIN**(9)**

Correlation between time and frequency response, polar plots, bode plots, all-pass and minimum-phase systems, experimental determination of transfer functions, log-magnitude versus phase plots, Nyquist stability criterion, assessment of relative stability, closed loop frequency response, sensitivity analysis.

INTRODUCTION TO DESIGN AND STATE VARIABLE ANALYSIS (9)

Preliminary considerations, realization of basic compensators, cascade compensation in time domain and frequency domain, feedback compensation, robust control system design. Concepts of state, state variables and state model, state models for linear-continuous-time systems, state variables and linear discrete-time systems, solutions of state equations, concepts of controllability and observability, pole placement by state feedback.

TOTAL: 45**REFERENCES:**

- 1 Nagrath I J, and Gopal M, "Control Systems Engineering" New Age International Publishers, Fourth edition, 2005.
- 2 Okata K, "Modern Control Engineering" Pearson/Prentice hall of India Pvt. Ltd., New Delhi, 1997.
- 3 Gopal M, "Control Systems-Principles and design" Tata McGraw Hill Co. Ltd., 2nd Edition, 002.
- 4 Norman S Nise, " Control System Engineering" John Wiley & Sons Inc., 2001.
- 5 Sergey Edward Lyshevski, "Control Systems-Theory with Engineering Applications" Springer-Verlag, New York Inc., 2002.
- 6 Stainslaw H Zak, "Systems and Control" Oxford University Press Inc., 2003.

INTRODUCTION

(9)

Fundamentals of designing automobiles-performance of automobiles, general layout of the automobile Design conditions-loading conditions, maximum moments in automobile transmission, forced vibrations of sprung mass with random disturbance, fatigue resistance analysis procedure.

CLUTCH

(9)

Introduction-design diagrams of clutch, calculation of critical parameters of clutches, design calculation of standard elements of friction clutches, torsional vibration dampers, clutch control drives.

TRANSMISSION

(9)

Determining main parameters of transmission, gear shift mechanisms, main gear, differential, differential housings, axle shafts, fear box, auxiliary gear box, transfer case, planetary gears, kinematics of universal joints, design of universal joint and propeller shaft, location determination of universal joint and propeller shaft.

SUSPENSION AND STEERING SYSTEM

(9)

Oscillation and smoothness of ride, elastic characteristics of ride, elastic elements of suspension, shock absorbers. Fundamentals of designing and calculating steering control linkage, steering gears, hydraulic booster.

BRAKES

(9)

Pressure distribution along shoe length, determining braking torque, design of drum and disk brakes, fundamentals of designing brake force regulators, antilocking system.

TOTAL: 45**REFERENCES:**

- 1 Lukin P Gasparyants G and Rodionov V, "Automobile Chassis Design and Calculations", Mir Publishers, 1989.
- 2 Heinz Heisier, "Vehicle and Engine technology" SAE, New York, 1999.
- 3 Gillespie T D, "Fundamentals of Vehicle Dynamics" SAE Inc., New York, 1992
- 4 Schwaller A E, "Motor Automotive Technology" Third Edition, Delman Publishers, New York.

INTRODUCTION

(8)

Design Principles, workable systems, optimal systems, matching of system components, economic analysis , depreciation, gradient present worth factor.

MATHEMATICAL MODELING

(9)

Equation fitting, nomography, empirical equation, regression analysis, different modes of mathematical models, selection, computer programmes for models.

MODELLING THERMAL EQUIPMENTS

(9)

Modelling heat exchangers, evaporators, condensers, absorption and rectification columns, compressor, pumps, simulation studies, information flow diagram, solution procedures.

SYSTEMS OPTIMIZATION

(10)

Objective function formulation, constraint equations, mathematical formulation, Calculas method, dynamic programming, geometric programming, linear programming methods, solution procedures.

DYNAMIC BEHAVIOUR OF THERMAL SYSTEM

(9)

Steady state simulation, Laplace transformation, feedback control loops, stability analysis, non-linearities.

TOTAL: 45**REFERENCES:**

- 1 Stoecker W F, "Design of Thermal Systems" McGraw Hill, 1980.
- 2 Kapur J N, "Mathematical Modelling" Wiley eastern Ltd., New York, 1989.
- 3 Stoecker W F, "Refrigeration and Air-Conditioning" TMH, 1985.
- 4 Fanger P O, "Thermal Comfort" McGraw Hill, USA 1972.
- 5 McQuiston F C and Parker T D, " Heating, Ventilating and Air conditioning, Analysis and design" John Wiley and Sons, USA.

Selection of Plastics

(9)

Mechanical Properties- Material Selection for Strength – Degradation - Wear Resistance and Frictional Properties- Special Properties - Processing - Costs. Mechanical Behavior of Plastics- Short term tests -Long term testing -Design Methods for Plastics using deformation data -Pseudo-Elastic design method for plastics-Thermal stresses and Strains- - Time Temperature Superposition - Fracture behavior - Creep behavior - Impact behavior.

Design of Injection Molded Parts

(9)

Manufacturing Considerations -Mold Filling Considerations -Weld line-Shrinkage and Warpage - Cooling and Solidification-Structural design Considerations-Structural Members-Design for Stiffness - Processing Limitations in Product Design.

Introduction to Mould Design

(9)

Types of moulds and dies for various processing methods - Mould and Die Design Concept and Materials. Injection Mould Design - Basics of mould construction - Methodical Mould Design - Design of Feed System, Ejection System - Venting - Design of Cooling system - Mould alignment concepts and Demoulding Techniques.

Compression and Transfer Mould Design

(9)

Basics of mould construction - Mould design -Positive moulds- Positive moulds with Lands- Multi cavity moulds with individual, common Loading Chamber - Moulds with a slide core - Split cavity moulds, Heat losses and energy requirement.

Blow Mould Design

(9)

Materials Selection, Mould Cooling, Clamping Force, Venting, Pinch-off, Head die design, Parison Diameter Calculation, Wall Thickness, Vertical-load strength, Blow ratio, Base pushup, Neck and Shoulder Design, Thread and beads, Bottom Design. Extrusion Die Design - Die geometry, Die Design, Materials and Classification.

TOTAL : 45**REFERENCES**

- 1 P.S.Cracknell and R.W Dyson, Handbook of Thermoplastics - Injection Mould Design, Chapman & Hall, 1993.
- 2 Laszlo Sors and Imre Balazs, Design of Plastics Moulds and Dies, Elsevier, Amsterdam, 1989.
- 3 R.G.W.Pye, Injection Mould Design, SPE Publication, 2000.
- 4 R J Crawford, Plastics Engineering, Butterworth-Heinemann, Oxford, 1999
- 5 Edward Miller(Ed), Plastics Product Design Handbook Part A –Materials and Components, Marcel Dekker, 1981.
- 6 R.A Malloy, Plastic Part Design for Injection Molding An Introduction, Hanser, 1997
- 7 N. Rao, K O'Brien, Design Data for Plastics Engineers, Hanser, New York, 1998

1. ENTERPRISE RESOURCE PLANNING**10**

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

2. TECHNOLOGY AND ARCHITECTURE**10**

Client/Server architecture – Technology choices – Internet direction – Evaluation framework – CRM – CRM pricing – chain safety – Evaluation framework.

3. ERP SYSTEM PACKAGES**10**

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

4. ORACLE**7**

Overview – Architecture – AIM – applications – Oracle SCM. SAP: Overview – Architecture – applications -Before and after Y2k – critical issues – Training on various modules of IBCS ERP Package-Oracle ERP and MAXIMO, including ERP on the NET

5. ERP PROCUREMENT ISSUES**8**

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

Total 45**REFERENCES:**

- 1 Sadagopan. S , ERP-A Managerial Perspective, Tata McGraw Hill, 1999.
- 2 Jose Antonio Fernandez, The SAP R/3 Handbook, Tata McGraw Hill, 1998.
- 3 Vinod Kumar Crag and N.K.Venkitakrishnan, Enterprise Resource Planning – Concepts and Practice, Prentice Hall of India, 1998.
- 4 ERPWARE, ERP Implementation Framework, Garg & Venkitakrishnan, Prentice Hall, 1999.
- 5 Thomas E Vollmann and Bery Whybark, Manufacturing and Control Systems, Galgotia Publications, 1998.

1. INTRODUCTION**5**

Review of fundamentals of kinematics – mobility analysis – formation of one D.O.F. multi loop kinematic chains, Network formula – Gross motion concepts.

2. KINEMATIC ANALYSIS**5**

Displacement , Velocity and acceleration analysis of simple mechanisms, instant centres kinematic analysis of complex mechanisms , Goodman analysis , auxiliary point method.

3. PATH CURVATURE THEORY**6**

Inflection point and inflection circles. Euler – Savary equation, Bobilliers constructions , Hartmann’s construction, the cubic of stationary curvature or Burmester’s circle point and center point curves for four infinitesimally close positions of the moving plane.

4. SYNTHESIS OF MECHANISMS**15**

Type synthesis – Number synthesis – Associated Linkage Concept. Dimensional synthesis – function generation, path generation, motion generation. Graphical methods. Cognate linkages -Coupler curve synthesis, design of six-bar mechanisms. Algebraic methods. Application of instant center in linkage design. Cam Mechanisms – determination of optimum size of Cams.

5. DYNAMICS OF MECHANISMS AND SPATIAL MECHANISMS AND ROBOTICS**14**

Static force analysis with friction – Inertia force analysis – combined static and inertia force analysis, shaking force, Kinetostatic analysis. Introduction to force and moment balancing of linkages.

Kinematic Analysis of Spatial RSSR mechanism – Denavit – Hartenberg Parameters. Forward and inverse Kinematics of Robotic Manipulators.

Study and use of Mechanism using Simulation Soft-ware packages.

L : 45**T : 15****Total 60****REFERENCES:**

1. Uicker, J.J, Pennock G.R. and Shigley, J.E., “Theory of Machines and Mechanisms”, Oxford University Press, NY, 2003.
2. Amitabha Ghosh and Asok Kumar Mallik, “Theory of Mechanism and Machines”, EWLP, Delhi, 1999.
3. Sandor G.N., and Erdman A.G., “Advanced Mechanism Design Analysis and Synthesis”, Prentice Hall, 1984.
4. Norton R.L., “Design of Machinery”, McGraw Hill, 1999.
5. Kenneth J, Waldron, Gary L. Kinzel, “Kinematics, Dynamics and Design of Machinery”, John Wiley-sons, 1999.

1. 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.

2. FACTORS INFLUENCING FORM DESIGN**10**

Influence of materials on form design - form design of grey iron, malleable iron, steel and aluminium castings - form design of welded members, forgings.

3. COMPONENT DESIGN - MACHINING CONSIDERATION**9**

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.

4. COMPONENT DESIGN - CASTING CONSIDERATION**9**

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

5. DESIGN FOR THE ENVIRONMENT**9**

Introduction – Environmental objectives – Global issues – Regional and local issues – Basic DFE methods – Design guide lines – Example application – Lifecycle assessment – Basic method – AT&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**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, Hartz 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. Allen By. B, Design for the Environment Angle Wood Cliff, Prentice Hall. Reason Pub., 1996.
- 7 Kevien Otto and Kristin Wood, Product Design. Pearson Publication, 2004.

1. INTRODUCTION**5**

General Characteristics of mechanical elements, adequate and optimum design, principles of optimization, formulation of objective function, design constraints – Classification of optimization problem.

2. UNCONSTRAINED OPTIMIZATION**8**

Single variable and multivariable optimization, Techniques of unconstrained minimization – Golden section, pattern and gradient search methods – Interpolation methods.

3. CONSTRAINED OPTIMIZATION**12**

Optimization with equality and inequality constraints - Indirect methods using penalty functions, Lagrange multipliers; Geometric programming- Constrained, mixed inequality and unconstrained minimization; Genetic algorithms.

4. STATIC APPLICATIONS**10**

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

5. DYNAMIC APPLICATIONS**10**

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

L : 45 T : 15 Total 60**REFERENCES**

1. Singiresu S.Rao., "Engineering Optimization Theory and Practice", New Age International (P) Limited, Publishers 1996.
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", Barmen, Addison-Wesley, New York, 1989.
5. Saravanan.R, "Manufacturing optimization through intelligent techniques", Taylor and Francis Publications, CRC Press, 2006.

1. Surfaces, Friction and Wear**9**

Topography of surfaces – Surfaces features – Experimental Determinations of surface structure – Chemical analysis of surface – surface effects in Tribology – Analysis of surface roughness – measurement of surface roughness. Friction – Mechanism of friction, measuring friction, equations and models of friction – Friction properties of metallic and non metallic materials, friction in extreme conditions. Wear – Types, mechanism, mapping, measurements, wear resistance materials – surface treatment, surface modifications and surface coatings. Computer Simulations of friction, lubrication and wear.

2. Lubrication Theory**9**

Lubricants – selection criteria – lubrication regimes – Hydrodynamic, elasto and plasto hydrodynamic lubrication, basic equations, Reynold's equation, energy equation, boundary lubrication, boundary lubricating films and its properties. Hydrostatic lubrication – Gas lubrication

3. Design of Fluid Film Bearings**9**

Dynamic analysis of hydrodynamic bearing performance, thrust and journal bearings– full, partial, fixed and pivoted – mass flow rate, friction, power loss, heat and temperature difference, dynamic loads, oil film thickness, stiffness of squeeze film and dynamic co-efficient – hydrostatic bearing design.

4. Industrial Components and Systems**9**

Slider bearings – self acting finite bearings, failure modes, materials rolling element bearings – Types, contact mechanics, bearing internal load distribution, lubrication – Bearing geometry and kinematics, load ratings and life prediction, torque calculation, temperature analysis, endurance testing and failure analysis.

5. Space and Automotive Tribology**9**

Introduction – Mechanism, components, liquid and solid lubricants, accelerated testing and life testing of space mechanism. Principles of Aerospace eccentric bearing test mechanism. Engine Tribology –importance, lubrication regimes, engine bearings, wheel bearings, tire. Mechanics of load transfer – contact area and normal pressure distribution, brakes, effects of service on engine oil properties. Tribology in manufacturing – macro and micro tribology of MEMS materials. Technologies for machinery diagnosis and prognosis.

L : 45**T : 15****Total 60****REFERENCES**

1. Cameron, A. "Basic Lubrication Theory", Ellis Herward Ltd., UK, 1981.
2. Hulling, J. (Editor) – "Principles of Tribology", MacMillan, 1984.
3. Williams, J.A. "Engineering Tribology", Oxford University Press, 1994.
4. Neale, M.J. "Tribology Handbook", Butterworth Heinemann, 1995.
5. Bharat Bhushan, "Modern Tribology Handbook" Vol. – I & II.

UNIT - I ELASTICITY**(8)**

Stress – Strain relation and General equation of elasticity in cartesian, polar and spherical coordinates- differential equation of equilibrium – compatibility – boundary conditions, representations of three dimensional stress of a tension – generalized Hooke's law – St.Venant's principle – Plane strain, plane stress – Airy's stress function. Location of shear centre for various sections – shear flow.

UNIT - II UNSYMMETRICAL BENDING**(10)**

Stresses and deflection in beams subjected to unsymmetrical loading – Kern of a section. Curved flexural members - circumferential and radial stresses – deflection and radial curved beam with re-restrained ends – closed ring subjected to concentrated load and uniform load – chain link and crane hooks.

UNIT - III THICK CYLINDERS AND ROTATING DISKS**(10)**

Thick walled cylinder subjected to internal and external pressures – Shrink fit joints – Stresses due to rotation – Radial and tangential stresses in solid disc and ring of uniform thickness and varying thickness – allowable speed. – Rotating shafts and cylinders.

UNIT - IV TORSION OF NON CIRCULAR SECTIONS**(8)**

Torsion of rectangular cross section – St.Venant Theory – elastic membrane analogy – Prandtl's stress function – Torsional stresses in hollow thin walled tubes.

UNIT - V STRESSES IN FLAT PLATES**(9)**

Stresses in circular and rectangular plates due to various types of loading and end conditions – Buckling of plates. Theory of contact stresses – methods of computing contact stresses – deflection of bodies in point and line contact – applications.

L : 45**T : 15****Total 60****Reference Books**

1. Arthur P.Boresi and Richard J.Schmidt, "Advanced Mechanics of Materials",John, Willey & Sons, Inc., 2003.
2. Arthur P.Boresi and Omar M.Siseborttom, "Advanced Mechanics of Materials",John, Willey International Education, 1985.
3. Robert,D.Cook, Wareen.C.Yound, "Advanced Mechanics of Materials", Macmillon Publishers Company, 1985.
4. Srinath.L.S., Advanced Mechanics of Solids, Tata McGraw Hill PublishingCompany Limited, 2003
5. KrishnaRaju, N., Gururaja,D.R., Advanced Mechanics of Solids and Structures,Narosa Publishing House, 1997.
6. U.C.Jindal, "Advanced Topics of Strength of materials", Galgotia Publications, First edition, 1997.

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(Use of approved data book is permitted)

1. FLEXIBLE HOISTING APPLIANCES 9

Type, selection and applications of material handling equipments, choice of material handling equipment – hoisting equipment – components and theory of hoisting equipment – chain and ropes – selection of ropes, pulleys, pulley systems, sprockets and drums.

2. LOAD HANDLING EQUIPMENTS AND BRAKES 9

Forged standard hooks – forged Ramshorn hooks – solid triangular eye hooks – crane grabs, electric lifting magnetic – grabbing attachments for loose materials. arresting gear – brakes: shoe, band and cone types – elements of shoe brakes – thermal calculation in shoe brakes.

3. SURFACE AND OVERHEAD TRANSPORTATION EQUIPMENTS 9

Hand operated trucks – powered trucks – tractors – electronically controlled tractors - hand truck on rails – industrial railroad equipments: locomotives - winches – capstans – turntables – monorail conveyors – pipe rail systems – flat bar monorails. Rail traveling mechanism, cantilever and monorail cranes, cogwheel drive, monocable tramways- reversible tramways.

4. ELEVATING EQUIPMENTS 9

Continuous-motion vertical conveyors – reciprocating-motion vertical conveyors – stackers – work levelers and tail gates – industrial lifts – passenger lifts – freight elevators – mast type elevators – vertical skip hoist elevators, bucket elevators: design, loading and bucket arrangements.

5. CONVEYING EQUIPMENTS 9

Belt conveyors - chain conveyors – apron conveyors – escalators – flight conveyors – roller conveyors - oscillating conveyors. design of belt conveyors, screw conveyors and pneumatic conveyors.

Total: 45

REFERENCES

1. Rudenko. N., Materials Handling Equipment – MIR Publishers, 1969
2. Spivakovsky. A.O and Dyachkov. V.K., Conveying Machines, Volume I and II, MIR Publishers, 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, 2003
6. Lingaiah. K. and Narayana Iyengar, Machine Design Data Hand Book, Vol. 1 & 2, Suma Publishers, 1983
7. Chowdary.R.B and Tagore.G.R.N.– Materials Handling Equipment –Khanna Publishers, 1996

1. INTRODUCTION**8**

Definition – Need – General Characteristics, Applications. Fibers – Glass, Carbon, Ceramic and Aramid fibers. Matrices – Polymer, Graphite, Ceramic and Metal Matrices – Characteristics of fibers and matrices. Fiber surface treatments, Fillers and additives, Fiber content, density and void content.

2. MECHANICS**12**

Rule of mixture -volume and mass fractions – density - void content, Evaluation of four elastic moduli based on strength of materials approach and Semi-Empirical model-Longitudinal Young's modulus-transverse Young's modulus–major Poisson's ratio-In-plane shear modulus, Ultimate strengths of a unidirectional lamina. Characteristics of Fiber-reinforced lamina–laminates–lamination theory, Interlaminar stresses

3. PERFORMANCE**5**

Static Mechanical Properties – Fatigue and Impact Properties – Environmental effects – Long term properties, Fracture Behavior and Damage Tolerance.

4. MANUFACTURING**8**

Bag Moulding – Compression Moulding – Pultrusion – Filament Winding – Other Manufacturing Processes – Quality Inspection methods. Processing of MMC –diffusion bonding – stir casting – squeeze casting.

5. DESIGN**12**

Failure Predictions, Laminate Design Consideration-design criteria-design allowables -design guidelines, Joint design-Bolted and Bonded Joints, Design Examples-Design of a tension member – design of a compression member – design of a beam-design of a torsional member, Application of FEM for design and analysis of laminated composites.

Total: 45**REFERENCES:**

1. Mallick, P.K., "Fiber Reinforced Composites: Materials, Manufacturing and Design", Marcel Dekker Inc, 1993.
2. Autar K. Kaw, "Mechanics of Composite Materials" CRC Press, 2006
3. Agarwal, B.D., and Broutman L.J., "Analysis and Performance of Fiber Composites", John Wiley and Sons, New York, 1990.
4. Ronald Gibson, "Principles of Composite Material Mechanics", Tata McGraw Hill, 1994.
5. Chawla K.K., "Composite materials", Springer – Verlag, 1987

1. OIL HYDRAULIC SYSTEMS AND HYDRAULIC ACTUATORS	5
Hydraulic Power Generators – Selection and specification of pumps, pump characteristics- Determination of volumetric, mechanical and overall efficiencies of positive displacement pumps. Linear and Rotary Actuators – selection, specification and characteristics.	
2. CONTROL AND REGULATION ELEMENTS	12
Pressure - direction and flow control valves - relief valves, non-return and safety valves - actuation systems. Electrical control solenoid valves, relays, Electro hydraulic servo valves.	
3. HYDRAULIC CIRCUITS	5
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.	
4. PNEUMATIC SYSTEMS AND CIRCUITS	16
Pneumatic fundamentals - control elements, position and pressure sensing - logic circuits - switching circuits - fringe conditions modules and these integration - sequential circuits - cascade methods - mapping methods - step counter method - compound circuit design - combination circuit design.	
5. INSTALLATION, MAINTENANCE AND SPECIAL CIRCUITS	7
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

REFERENCES:

1. Bolton. W., "Pneumatic and Hydraulic Systems ", Butterworth –Heinemann, 1997.
2. Antony Esposito, "Fluid Power with Applications", Prentice Hall, 1980.
3. Dudleyt, A. Pease and John J. Pippenger, Industrial Hydraulics, Tata MGrav Hill Prentice Hall, 1985.
4. Andrew Parr, "Hydraulic and Pneumatics" (HB), Jaico Publishing House, 2004.
5. Majumdar, S.R., Oil Hydraulic Systems, Principles and Maintenance, Tata MGrav Hill Prentice Hall, 2001.

1. INTRODUCTION**3**

Introduction to PDM-present market constraints-need for collaboration - internet and developments in server-client computing.

2. COMPONENTS OF PDM**9**

Components of a typical PDM setup-hardware and software-document management-creation and viewing of documents-creating parts-versions and version control of parts and documents-case studies.

3.CONFIGURATION MANAGEMENT**5**

Base lines-product structure-configuration management-case studies.

4. PROJECTS AND ROLES**12**

Creation of projects and roles-life cycle of a product- life cycle management-automating information flow-work flows- creation of work flow templates-life cycle-work flow integration-case studies.

5. CHANGE MANAGEMENT**6**

Change issue- change request- change investigation- change proposal - change activity - case studies.

6. GENERIC PRODUCTS AND VARIANTS**10**

Data Management Systems for FEA data - Product configurator - comparison between sales configuration and product configurator-generic product modeling in configuration modeler-use of order generator for variant creation-registering of variants in product register-case studies.

Total: 45**REFERENCES**

1. Kevin Otto, Kristin Wood, "Product Design", Pearson, 2001.
2. Daniel Amor, "The E-Business Revolution", Prentice-Hall, 2000.
3. David Bed worth. Mark Henderson & Phillip Wolfe. "Computer Integrated Design and Manufacturing ". McGraw Hill Inc...1991.
4. Terry Quatrain. "Visual Modeling with Rational Rose and UML ". Addison Wesley...1998.
5. Wind-Chill R5.0Reference Manuals...2000.

1. INTRODUCTION**4**

Need for the compression in product development, History of RP systems, Survey of applications, Growth of RP industry, classification of RP systems.

2. STEREOLITHOGRAPHY SYSTEMS**8**

Principle, Process parameters, Process details, Data preparation, Data files and Machine details, Applications.

SELECTIVE LASER SINTERING - Types of machines, Principle of operation, Process parameters, Data preparation for SLS, Applications.

3. FUSION DEPOSITION MODELING**6**

Principle, Process parameters, Path generation, Applications. **SOLID GROUND CURING:** Principle of operation, Machine details, Applications.

4. LAMINATED OBJECT MANUFACTURING**8**

Principle of operation, LOM materials, Process details, Applications. **CONCEPT MODELERS** - Principle, Thermo jet printer, Sander's model market, 3-D printer, Genisys Xs printer, JP system 5, Object Quadra System. **LASER ENGINEERED NET SHAPING (LENS)** – principle – applications.

5. RAPID TOOLING**7**

Indirect Rapid Tooling - Silicone rubber tooling, Aluminum filled epoxy tooling, Spray metal tooling, etc. Direct Rapid Tooling - Direct AIM, Quick cast process, Copper polyamide, Rapid Tool, DMILS, ProMetal, Sand casting tooling, Laminate tooling, soft tooling vs hard tooling.

6. SOFTWARE FOR RAPID PROTOTYPING**12**

STL files, Overview of Solid view, Magics, mimics, magics communicator, etc. Internet based softwares, Collaboration tools. **RAPID MANUFACTURING PROCESS OPTIMIZATION** - Factors influencing accuracy, Data preparation errors, Part building errors, Errors in finishing, Influence of part build orientation. **ALLIED PROCESSES** - Vacuum Casting, Surface Digitizing, Surface Generation from point cloud, Surface modification, data transfer to solid models.

Total: 45**REFERENCES**

1. Paul. F. Jacobs, "Stereo lithography and other RP & M Technologies", SME, NY, 1996.
2. Pham. D. T. & Dimov. S. S., "Rapid Manufacturing", Verlag, London, 2001.
3. Terry Wohlers, "Wohlers Report 2006", Wohlers Associates, 2006.