CMR Institute of Technology, Bangalore			
Department: Mechanical Engineering			
Semester: 06	Sections: A &B		
Mechanics of Materials		10ME61	Lectures/week: 05
Course Instructor: Mr. Vijeesh M.V.			
Course duration: Feb 2017 – May 2017			

Lesson Plan

Lecture #	Chapter Title / Reference Literature	Topics	Portionscoverage%	
			Individual	Cumulative
01	UNIT 1: Computer Integrated Manufacturing Systems TB 1, TB 2	Introduction,	12.5%	12.5%
02		Automation definition, Types of automation		
03		CIM, Processing in manufacturing		
04		Production concepts		
05		Mathematical Models-Manufacturing lead time, production rate, components of operation time, capacity,		
06		Utilization and availability, Work-in-process, WIP ratio, TIP ratio		
07		Problems using mathematical model equations		
08		Problems using mathematical model equations		
09	UNIT 2: High Volume Production System TB 1, RB 2,	Introduction	12.5%	25%
		Automated flow line symbols, objectives,.		
10		Work part transport-continuous, Intermittent, synchronous, Pallet fixtures		
11		Transfer Mechanism-Linear-Walking beam, roller chain drive		
12		Rotary-rack and pinion, Rachet& Pawl, Geneva wheel,		
13		Buffer storage, control functions-sequence, safety, quality		
14		Automation for machining operation		
15	UNIT 3:	General terminology and analysis,	12.5%	37.5%
16		Analysis of Tranfer Line without storage		

17	Analysis Of Automated Flow Line & Line Balancing TB 1, RB 2	Upper bound approach, lower bound approach and problems,		
18		Analysis of Transfer lines with storage buffer, Effect of storage, buffer capacity with simple problems		
19		Partial automation-with numerical problems		
20		Flow lines with more than two stages		
		Manual Assembly lines, line balancing problem		
21	UNIT 4: Minimum Rational Work Element TB 1, RB 1	Work station process time, Cycle time	12.5%	50%
22		Precedence constraints and precedence diagram		
23		Balance delay methods of line balancing-largest Candidate rule		
24		Kilbridge and Westers method		
25		Ranked positional weight method		
26		Computerized line balancing.		
27	UNIT 5: Automated Assembly Systems TB 1, RB 2	Design for automated assembly systems, Types of automated assembly system	12.5%	62.5%
28		Parts feeding devices-elements of parts delivery system-hopper, part feeder		
29		Selectors, feedback, escapement and placement		
30		Analysis of multi-station assembly machine		
31		Analysis of single station assembly		
32		Automated Guided Vehicle System: Introduction		
33		Vehicle guidance and routing, System management,		
34		Quantitative analysis of AGV's with numerical problems and application		
35	UNIT 6: Computerized Manufacturing Planning System TB 1, RB 1	Introduction, Computer Aided Process Planning	12.5%	75%
36		Retrieval types of process planning		
37		Generative type of process planning		
38		Material requirement planning		
39		Fundamental concepts of MRP inputs to MRP		

40		Capacity planning		
41	UNIT 7: CNC Machining Centers TB 1, RB 1	Introduction to CNC	12.5%	87.5%
42		Elements of CNC		
43		CNC machining centers		
44		Part programming		
45		Fundamental steps involved in development of part programming for milling		
46		Fundamental steps involved in development of part programming for turning		
47	UNIT 8: Robotics TB 1, TB 2	Introduction to Robot configuration	12.5%	100%
48		Robot motion,		
49		Programming of Robots		
50		End effectors		
51		Robot sensors		
52		Robot applications		

Syllabus forInternal Assessment Tests(IAT)*

IAT #	Syllabus
IAT-1	Class # 01 – 20
IAT-2	Class # 21 - 40
IAT-3	Class # 41-52

*Seecalendarofeventsfor theschedulesof IATs.

Literature:

Book Type	Code	Author & Title	Publication info	
			Edition & Publisher	ISBN No.

Text Book	TB1	Automation, Production system & Computer Integrated manufacturingby M. P. Groover	Pearson Education, 2007	
Text Book	TB2	Principles of Computer Integrated Manufacturingby S. Kant Vajpayee	Prentice Hall India	
Reference Book	RB1	Computer Integrated Manufacturing by J. A. Rehg& Henry. W. Kraebber		
Reference Book	RB2	CAD, CAM by Ibrahim Zeid		

CMR Institute of Technology, Bangalore		
Department(s): Mechanical Engineering		
Semester: 06	Section(s):A & B	
Design of Machine Elements-II	10ME62	Lectures/week: 06
Course Instructor(s): Prof. Rajendra Prasad Reddy		
Session: Jan 2017 – May 2017		

Lesson Plan

Lecture #	Book & Sections	Topics	Portions coverage %	
			Individual	Cumulative
1-10	TB1: 1.2 TB1: 2.2-2.11	**1a) Curved Beams:** Difference between a curved beam and a straight beam, Derivation for a bending stress in a curved beam, Illustrative examples involving punch presses, crane hooks, S-link, closed rings and chain links **1b)Cylinders & Cylinder heads:** Lame's equations, compound cylinders, stresses due to different types of fits, cylinder heads, illustrative examples	16	16
11-19	TB1: 3.1-3.18	**2)Springs:** Helical springs –Shear stress induced and deflection, Design procedure, Concentric springs, leaf springs, laminated springs, semi elliptical leaf springs, illustrative examples	14	30
20-28	TB1:4.1-4.14,4.15-4.21.2	**4) spur & Helical Gears:** Spur Gears: Terminology, Tooth profiles, Interference in Involute gears, Design procedure, Helical Gears: Terminology, formative no.of teeth,Design procedure, Illustrative examples	14	44
29-37	TB1: 5.1-5.7,5.8-5.15	**5) Bevel and Worm Gears:** Bevel Gears: Terminology, Formative no. of teeth, Design procedure, Worm Gears: Terminology, Design procedure, Illustrative examoles	14	58
38-47	TB1: 6.1-6.6, 6.7-6.17	**6) Clutches and Brakes:** Single and multi plate clutches, cone clutch, Single and double shoe brakes, Band brake, simple and differential band brakes,Illustrative examples .	16	74
48-52	TB1:8.1-8.5	**2) Belts,Ropes and Chains:** Flat belts: length and cross section, selection of V-belts, ropes and chains for different applications .	08	82
53-60	TB1-7.1-7.18	**7) Lubrication and Bearings:** Lubricants, their properties, bearing modulus,co.eff of friction, min oil film thickness, heat generated, design procedure for Ball and Roller bearings, Illustrative exampl es	12	94
61-64	TB1: 8.1-8.5.8	**8) IC engine parts:** Design of piston, connecting rod and crank shaft, Illustrative examples	06	100

Syllabus for Internal Assessment Tests (IAT)*

IAT #	Syllabus
IAT-1	Class # 01 – 19
IAT-2	Class # 20 – 47
IAT-3	Class # 48 – 64

* See calendar of events for the schedules of IATs.

Literature:

Book Type	Code	Author & Title	Publication information	
			Edition // Publisher	ISB
Text Book	TB1	JBK Das Design of Machine Elements	I st edition,2013 Sapna Book House	9788128003066
Text Book	TB2	VB Bhandari Design of Machine Elements	5th edition, Tata McGraw-Hill	9780070681798
Reference	RB1	Hall,Halowenko Machine Design	5th edition, Tata McGraw-Hill	9780070634589
Reference	RB2	PC Sharma,Aggarwal Machine Design	12thedition,2012 Kataria & sons	

CMR Institute of Technology, Bangalore			
Department: Mechanical Engineering			
Semester: 6	Section: A& B		
Heat and Mass Transfer		10ME63	Lectures/week: 06
Course Instructor: Prof. Jitender Kumar Chaurasia			
Course duration: Feb 2017- June2017			

Class #	Book / Sections	Topic	Percentage of portion covered	
			Reference	Cumulative
Introductory Concepts and Definitions				
1-10	TB2	Modes of heat transfer: Basic laws governing conduction, convection, and radiation heat transfer; Overall heat transfer coefficient. Thermal contact resistance.	12 %	12 %
		Thermal conductivity; convective heat transfer coefficient; radiation heat transfer		
		Combined heat transfer mechanism. Boundary conditions of 1st, 2nd and 3rd kind		
		Conduction: Derivation of general three dimensional conduction equation in Cartesian coordinate, special cases, discussion on 3-D conduction in cylindrical and spherical coordinate systems (No derivation).		
		One dimensional conduction equations in rectangular, cylindrical and spherical coordinates for plane		
		Heat transfer through composite walls		
		Problems on basic conduction equations		
		Problems on steady state heat conduction		
		Problems on steady state heat conduction		
		Problems on steady state heat conduction		
Variable Thermal Conductivity				
11-19	TB1	Derivation for heat flow and temperature distribution in plane wall.	12 %	24 %
		Critical thickness of insulation without heat generation		
		Thermal resistance concept & its importance.		
		Heat transfer inextended surfaces of uniform cross-section without heat generation, Long fin,		

		Short fin with insulated tip and without insulated tip and fin connected between two heat sources		
		Fin efficiency and effectiveness.		
		Numerical problems on variable thermal conductivity		
		Problems on critical thickness of insulation		
		Problems on fins		
One-Dimensional Transient Conduction				
20-25	TB1	Conduction in solids with negligible internal temperature gradient (Lumped system analysis),	12 %	36%
		Use of Transient temperature charts (Heisler's charts) for transient conduction inslab, long cylinder and sphere;		
		Use of transient temperature charts for transient conduction in semi-infinite solids		
		Numerical Problems infinite solids.		
		Numerical Problems infinite solids...		
		Numerical Problems semi-infinite solids		
Concepts and Basic Relations In Boundary Layers				
26-35	TB2	Flow over a body velocity boundary layer; critical Reynolds number; general expression for local heat transfer coefficient;	14 %	50%
		General expressions for drag coefficient and drag force; thermal boundary layer		
		Average heat transfer coefficient; Nusselt number.		
		Flow inside a duct- velocity boundary layer, hydrodynamic entrance length and hydro dynamically developed flow; flow through tubes (internalflow discussion only).		
		Numericals based on empirical relation given in data handbook		
		Numericals		
		Free Or Natural Convection: Application of dimensional analysis for free convection-physical significance of Grashoff number;		
		Use of correlations of free convection in vertical, horizontal and inclined flat plates, vertical and horizontal cylinders and spheres		
		Numerical problems.		
		Numerical problems		
Forced Convection				
		Applications of dimensional analysis for forced convection. Physical significance of Reynolds, Prandtl, Nusselt and Stanton numbers.		

36-41	RB1	Use of various correlations for hydro dynamically and thermallydeveloped flows inside a duct	12 %	62%
		Use of correlations for flow over a flat plate, over a cylinder and sphere.		
		Numerical problems.		
		Numerical problems.		
		Numerical problems.		
Heat Exchangers				
42-48	RB3	Classification and description of heat exchangers;	12 %	74%
		overall heat transfer coefficient, fouling and fouling factor;		
		Analysis of heat exchangers using LMTD method		
		Analysis of heat exchangers using Effectiveness-NTU method		
		Numerical problems.		
		Numerical problems.		
		Numerical problems.		
Condensation And Boiling				
49-55	RB4	Types of condensation (discussion only) Nusselt's theory for laminar condensation on a vertical flat surface;	12 %	86%
		Use of correlations for condensation on vertical flat surfaces, horizontal tube and horizontal tube banks;		
		Reynolds number for condensate flow;		
		Regimes of pool boiling, pool boilingcorrelations.		
		Numerical problems on condensation		
		Numerical problems on boiling		
		Mass transfer definition and terms used in mass transfer analysis, Ficks First law of diffusion (no numericals).		
Radiation Heat Transfer				
56-63	RB2	Thermal radiation; definitions of various terms used in radiation heat transfer;	14 %	100%
		Stefan-Boltzman law, Kirchoff's law, Planck's law and Wein's displacement law.		
		Radiation heat exchange betweentwo parallel infinite black surfaces, between two parallel infinite gray surfaces;		
		Effect of radiation shield; intensity of radiation		

		and solid angle; Lambert's law;		
		Radiation heat exchange between two finite surfacesconfiguration factor or view factor.		
		Numerical problems.		
		Numerical problems.		
		Numerical problems.		

Syllabus for Internal Assessment Tests (IAT)*:

IAT #	Syllabus
IAT-1	Class # 01 – 19
IAT-2	Class # 20 - 41
IAT-3	Class # 42 - 63

*** See calendar of events EVEN-2016-17 for the schedules of IATs.**

Literature:

Book Type	Code	Author & Title	Publication information	
			Edition & Publisher	ISBN #
Text Book	TB1	Tirumaleshwar, Heat & Mass transfer	Pearson education. 2006	9788177585193
Text Book	TB2	Ozisik, Heat transfer-A basic approach	Tata McGraw Hill 2002	9780070479821.
Reference	RB1	Yunus A- Cengel Heat transfer, a practical approach	Tata Mc Graw Hill	9780077366643
Reference	RB2	Kreith Principles of heat transfer	Thomas Learning 2001	9780849397516
Reference	RB3	Frenk P. Incropera andDavid P. Dewitt, Fundamentals of heat and mass transfer	John Wiley and son's.	0471457280
Reference	RB4	P.K. Nag, Heat transfer	Tata McGraw Hill 2002.	9780070702530

CMR Institute of Technology, Bangalore			
Department: Mechanical Engineering			
Semester: 06	Sections : A & B		
Finite Element Methods		10ME64	Lectures/week: 06
Course Instructor: Mr. Prashant S. Hatti			
Course duration: Feb 2017–June 2017			

Lesson Plan

Lecture #	Book & Sections	Topics	Portions coverage %	
			Individual	Cumulative
1-8	TB 2 : 1.1 – 1.6	**Introduction:** Equilibrium equations in elasticity subjected to body force, traction forces, and stress-strain relations for plane stress and plane strains. General description of Finite Element Method, Application and limitations. Types of elements based on geometry. Node numbering, Half band width.	12.5	12.5
9-18	TB 1: 3.8, 2.2	**Solution of 1-D Bars:** Solutions of bars and stepped bars for displacements, reactions and stresses by using penalty approach and elimination approach. Guass-elimination technique	12.5	12.5
19-28	TB1 : 4.1 – 4.6	**Trusses:** Stiffness matrix of Truss element. Numerical problems	12.5	12.5
29-36	B 1 : 8.1 – 8.5	**Beams:** Hermite shape functions for beam element, Derivation of stiffness matrix. Numerical problems of beams carrying concentrated, UDL and linearly varying loads.	12.5	12.5

37-44	TB 2: 5.1 – 5.9	**Basic Procedure:** Euler - Lagrange equation for bar, beam (cantilever / simply supported fixed) Principle of virtual work, principle of minimum potential energy, Raleigh's Ritz method. Direct approach for stiffness matrix formulation of bar element. Galerkin's method.	12.5	12.5
45-52	TB 1: 5.1 – 5.4 ,	**Interpolation Models:** Interpolation polynomials-Linear, quadratic and cubic. Simplex complex and multiplex elements. 2D PASCAL's triangle. CST elements-Shape functions and Nodal load vector, Strain displacement matrix and Jacobian for triangular and rectangular element.	12.5	12.5
53-58	RB 2 : 13.1 – 13.8, TB 2: 4.1 – 4.9	**Higher Order Elements:** Langrange's interpolation, Higher order one dimensional elements-Quadratic and cubic element and their shape functions. Shape function of 2-D quadrilateral element-linear, quadric element Isoparametric, Sub parametric and Super parametric elements. Numerical integration : 1, 2 and 3 gauge point for 1D and 2D cases	12.5	12.5
58-62	TB 2 : 13.1 – 13.5, 14.1 – 14.5	**Heat Transfer:** Steady state heat transfer, 1D heat conduction governing equations. Functional approach for heat conduction. Galerkin's approach for heat conduction. 1D heat transfer in thin fins.	12.5	12.5

Syllabus for Internal Assessment Tests (IAT)*

IAT #	Syllabus
IAT-1	Class # 01 – 28
IAT-2	Class # 29 – 52
IAT-3	Class # 53 - 62

Literature:

Book Type	Code	Author & Title	Publication information	
			Edition // Publisher	ISBN
Text Book	TB1	T.R.Chandrupatla, A.D Belegunde	3rd Edition, PHI	0-13-061591-9
Text Book	TB2	S.S. Rao, "Finite Element Method in Engineering "	4th Edition, Elsevier	0-7056-7828-3
Reference	RB1	S M Murigendrappa, "Fundamentals of Finite Element method"	2nd Edition, Interline Publishing	81-7296-098-0
Reference	RB2	S. S. Bhavikatti "Finite Element Analysis"	1st Edition, New Age International Publishers	81-224-1589-X

CMR Institute of Technology, Bangalore			
Department: Mechanical Engineering			
Semester: 06	Sections: A & B		
Mechatronics & Microprocessor		10ME65	Lectures/week: 05
Course Instructor: Mr. Venkatesh Naik			
Course duration: 13 Feb, 2017 – 24 May 2017			

Lecture#	Book & Sections	Topic	Portions coverage in %	
			Reference	Cumulative
1-6	TB1:1.1-1.7 RB1:1.1.1-1.1.112	**1) Introduction to Mechatronic Systems**: Measurement and control systems, their elements and functions, Microprocessor based controllers.	12.5	12.5
7-13	TB1:2.1-2.12 RB1:2.1-2.30	**2) Review of Transducers and Sensors:** Definition and classification of transducers. Definition and classification of sensors. Principle of working and applications of light sensors, proximity sensors and Hall effect sensors.	12.5	25
14-20	TB1:9.1-9.7 RB1:4.3-4.3.10	**3) Electrical Actuation Systems:** Electrical systems, Mechanical switches, solid-state switches, solenoids, DC & AC motors, Stepper motors and their merits and demerits.	12.5	37.5
21-22	TB1:18.1-18.6	**5. a) Introduction to Microprocessors:** Evolution of Microprocessor, Organization of Microprocessors (Preliminary concepts), basic concepts of Programming of microprocessors.	12.5	50
23-27	TB1:18.6-18.8	**5.b) Review of concepts** - Boolean algebra, Logic Gates and Gate Networks, Binary & Decimal number systems, memory representation of positive and Negative integers, maximum and minimum integers. Conversion of real, numbers, floating point notation, representation of floating point numbers, accuracy and range in floating point representation, overflow and underflow, addition of floating point numbers, character representation.		

28-34	TB1:18.6-18.8	**6) Logic Function:** Data word representation. Basic elements of control systems 8085A processor architecture terminology such as CPU, memory and address, ALU, assembler data registers, Fetch cycle, write cycle, state, bus, interrupts. Micro Controllers. Difference between microprocessor and micro controllers. Requirements for control and their implementation in microcontrollers. Classification of micro controllers.	12.5	62.5
35-39	TB1:19.1-19.6	**7) Organization & Programming of Microprocessors:** Introduction to organization of INTEL 8085-Data and Address buses, Instruction set of 8085, programming the 8085, assembly language programming.	12.5	75
40-44	TB1:19.1-19.6	**8) Central Processing Unit of Microprocessors:** Introduction, timing and control unit basic concepts, Instruction and data flow, system timing, examples of INTEL 8085 and INTEL 4004 register organization.	12.5	87.5
45-52	TB1:3.1-3.6 4.1-4.6	**4) Signal Conditioning:** Introduction to signal conditioning. The operational amplifier, Protection, Filtering, Wheatstone bridge, Digital signals, multiplexers, Data acquisition, Introduction to Digital system. Processing Pulse-modulation.	12.5	100

Syllabus forInternal Assessment Tests(IAT)*

IAT #	Syllabus
IAT1	1-19
IAT2	20-39
IAT3	40-52

*Seecalendarofeventsfor theschedulesof IATs.

Literature:

Book Type	Code	Author & Title	Publication info	
			Edition&Publisher	ISBN #
Text Book	TB1	Mechatronics, W.Bolton, Longman,	2nd, Pearson Publications, 2007.	978-81-317-3253-3
Text Book	TB2	Mechatronics Principles & applications, Godfrey C. Onwubolu	Elsevier. 2011	978-0-7506-6379-3
References	RB1	Mechatronics, R. K. Rajput	Third edition,	81-219-2859-1

CMR Institute of Technology, Bangalore			
Department: Mechanical Engineering			
Semester: 06	Section: A & B		
Non Traditional Machining		10ME665	Lectures/week: 05
Course Instructor: Mr. Trishul.M.A			
Course duration: 13 February 2017 – 24 May 2017			

Lesson Plan

# Class	Chapter Title/ Reference Literature	Topic Covered	Percentage of portion covered	
			Reference	Cumulative
1-3	**Introduction** TB1: 2.1 to 2.11	History, Classification, comparison between conventional and Non-conventional machining process selection.	12.5%	12.5%
04-13	**Ultrasonic Machining (Usm)** TB1: 3.1 to 3.8	Introduction, equipment, tool materials & tool size, abrasive slurry, cutting tool system design:- Effect of parameter: Effect of amplitude and frequency and vibration, Effect of abrasive grain diameter, effect of applied static load, effect of slurry, tool & work material, USM process characteristics: Material removal rate, tool wear, Accuracy, surface finish, applications, advantages & Disadvantages of USM.	12.5%	25%
14- 23	**Laser Beam Machining (Lbm) Electron Beam Machining (Ebm)** TB1: 4.1 to 4.8	**Laser Beam Machining (Lbm):** Introduction, equipment of LBM mechanism of metal removal, LBM parameters, Process characteristics, Applications, Advantages & **limitations. Electron Beam Machining (Ebm):** Principles, equipment, operations, applications, advantages and limitation of EBM.	12.5%	37.5%

24-33	**Abrasive Jet Machining (AJM)** TB1 : 6.1 to 6.6 & 7.1 TO 7.4	Introduction, Equipment, Variables in **AJM**: Carrier Gas, Type of abrasive, size of abrasive grain, velocity of the abrasive jet, mean number. abrasive particles per unit volume of the carrier gas, work material, stand off distance (SOD), nozzle design, shape of cut. Process characteristics-Material removal rate, Nozzle wear, Accuracy & surface finish. Applications, advantages & Disadvantages of AJM. Water Jet Machining: Principal, Equipment, Operation, Application, Advantages and limitations of water Jet machinery.	12.5%	50%
34-43	**Electrical Discharge Machining (Edm)** TB1: 12.1 to 12.13	Introduction, mechanism of metal removal, dielectric fluid, spark generator, EDM tools (electrodes) Electrode feed control, Electrode manufacture, Electrode wear, EDM tool design, choice of machining operation, electrode material selection, under sizing and length of electrode, machining time. Flushing; pressure flushing, suction flushing, side flushing, pulsed flushing synchronized with electrode movement, EDM process characteristics: metal removal rate, accuracy, surface finish, Heat Affected Zone. Machine tool selection, Application, EDM accessories / applications, electrical discharge grinding, Traveling wire EDM.	12.5%	62.5%

44-48	**Chemical Machining (Chm)** TB1: 13.1 to 13.15	Introduction, elements of process, chemical blanking process : Preparation of work piece, preparation of masters, masking with photo resists, etching for blanking, accuracy of chemical blanking, applications of chemical blanking, chemical milling (contour machining): process steps –masking, Etching, process characteristics of CHM: material removal rate, accuracy, surface finish, Hydrogen embrittlement, advantages & application of CHM.	12.5%	75%
49-56	**Plasma Arc Machining (Pam)** TB1: 14.1 to 14.14	Introduction, equipment, non-thermal generation of plasma, selection of gas, Mechanism of metal removal, PAM parameters, process characteristics. Safety precautions, Applications, Advantages and limitations.	12.5%	87.5%
57-62	**Electrochemical Machining (ECM)** TB1: 15.1 to 15.16	Introduction, study of ECM machine, elements of ECM process : Cathode tool, Anode work piece, source of DC power, Electrolyte, chemistry of the process, ECM Process characteristics – Material removal rate, Accuracy, surface finish, ECM Tooling: ECM tooling technique & example, Tool & insulation materials, Tool size Electrolyte flow arrangement, Handling of slug, Economics of ECM, Applications such as Electrochemical turning, Electrochemical Grinding, Electrochemical Honing, deburring, Advantages, Limitations.	12.5%	100%

Syllabus for Internal Assessment Tests (IAT)*

Sessional #	Syllabus
T1	Class # 01 – 35
T2	Class # 36 - 56

* See calendar of events for the schedules of IATs.

LITERATURE:

Book Type	Code	Author & Title	Publication info	
			Edition & Publisher	ISBN #
Text Book	TB1	**Modern machining process, Pandey and Shan**	Tata McGraw-Hill Education	0070965536, 9780070965539
Text Book	TB2	**New Technology, Bhattacharya 2000**	2nd edition, Pearson	978-81-317-5919-6
References	RB1	**Non Conventional machining**	Narosa Publishing House Pvt.Ltd	978-81-7319-138-1
References	RB2	**Manufacturing technology**, P N RAO	Tata McGraw-Hill Education	978-0-07-008769-9