

Faculty of Engineering & Technology
KAKATIYA UNIVERSITY, WARANGAL-506009
Department of Mechanical Engineering

B. Tech. (ME) IV SEMISTER

Sl. No	Category / Code	Course Title	L	T	P	Credits
1	ME-221	Thermal Engineering	3	0	0	3
2	MC-220	Constitution of India	2	0	0	0
3	ME-222	Machine Tools & Metrology	3	0	0	3
4	ME-223	Design of Machine Elements-I	3	0	0	3
5	ME-224	Instrumentation and Control system	3	0	0	3
6	ME-225	Kinematics of Machinery	3	0	0	3
7	ME-226L	Thermal Engineering Lab- I	0	0	2	1
8	ME-227L	Machine Tools & Metrology Lab	0	0	3	1.5
9	ME-228L	Machine Drawing	0	0	4	2
		Total Contact Hours			26	19.5

Faculty of Engineering & Technology
 KAKATIYA UNIVERSITY, WARANGAL-506009
 Department of Mechanical Engineering

B. Tech. (ME) IV SEMESTER
ME-221
THERMAL ENGINEERING

Course code	PCC				
Category	Professional Core Course				
Course title	THERMAL ENGINEERING				
Scheme and Credits	L	T	P	Credits	Internal marks = 30
	3	0	-	3	External Marks = 70

UNIT-I

Reciprocating Air Compressors: Classification and applications. Ideal and actual P-V diagrams, work input and efficiency relations for single and multi stage compressors. Effect of clearance volume on work input and efficiency. Inter cooling and after cooling concepts.

UNIT-II

Internal Combustion Engines: Classification and applications. Working principles of four stroke and two stroke engines, Spark Ignition and Compression ignition engines. Deviation of actual cycles from Air Standard cycles. Performance parameters of I.C. Engines. Heat balance sheet of I. C. Engine. Overview of Engine supporting systems- Cooling Systems, Lubrication systems- Wet sump, Dry sump and Mist Systems. Working principles of S.I. Engine fuel systems- Carburetors, Battery and Magneto Ignition systems. Working principles of C.I. Engine fuel systems- Fuel pump and Fuel injector.

UNIT-III

I.C. Engine Combustion phenomena: Stages of combustion in S.I. Engines- Ignition delay, Flame front propagation and After burning. Abnormal combustion- Pre-ignition and Knocking. Factors affecting Knocking. Stages of combustion in C.I. Engines, Delay period, Period of Uncontrolled Combustion, Period of Controlled Combustion and after burning. Abnormal Combustion-Knocking. Factors affecting Knocking. Octane and Cetane rating of fuels. Design considerations for combustion chamber and cylinder head. Type of combustion chambers of S.I. engines and C.I. engines.

UNIT-IV

Steam Boilers: Classification and Working Principles. Water tube boilers- Babcock & Wilcox and Stirling boilers. Fire tube boilers- Cornish, Cochran, Locomotive and Lancashire boilers. High Pressure boilers / Supercritical boilers: La mont, Benson boiler, Loeffler boiler and Velox boiler. Boiler Mountings and Accessories: Working Principles of Water level indicator, Pressure gauge,

Steam stop valve, Feed check valve, Blow-off cock, Fusible plug, Safety valves, Economizers, Superheaters and Steam separator. Steam Condensers: Jet and Surface condensers, Principle of Operation and Applications.

UNIT-V

Steam power plant cycles: Carnot and Rankine cycles of operation and their efficiencies. Analysis of Rankine cycle with superheating, reheating and regeneration (Direct and Indirect types). Steam Nozzles: Flow of steam through convergent - divergent nozzles, velocity of steam flowing through the nozzle, mass of steam discharge through the nozzle, condition for maximum discharge, critical pressure ratio and nozzle efficiency. Super saturated expansion of steam through nozzles. General relationship between area, velocity and pressure in Nozzle flow.

Text books:

1. R.K. Rajput, "*Thermal Engineering*", Laxmi Publications, 10th Edn. 2018
2. V. Ganesan, "*Internal Combustion Engines*", Tata McGraw Hill Publishing, 4th Edn, 2017

References Books:

1. P.L. Ballaney, " *Thermal Engineering: Engineering Thermodynamics & Energy Conversion Techniques*" Khanna Publishers, 19th Edn, 2005.
2. Richard Stone, "*Introduction to I.C. Engines*", Palgrave Mac Millan, 4th Edn., 2012

Faculty of Engineering & Technology
KAKATIYA UNIVERSITY, WARANGAL-506009
Department of Mechanical Engineering

B. Tech. (ME) IV SEMISTER
ME-226L
THERMAL ENGINEERING Lab-I

Course code	PCC				
Category	Professional Core Course				
Course title	<u>THERMAL ENGINEERING Lab-I</u>				
Scheme and Credits	L	T	P	Credits	Internal marks = 25
	0	0	2	1	External Marks = 50

LIST OF EXPERIMENTS:

1. To determine valve / port timing diagram of a diesel/ petrol engine
2. To conduct performance test on diesel engine
3. To conduct heat balance test on diesel engine
4. To conduct performance test on petrol engine
5. To conduct heat balance test on petrol engine
6. To determine the viscosities of lubricating oils
7. To determine the flash point and fire points of fuels
8. To conduct Performance test on VCR engine
9. To conduct Heat balance test on VCR engine
10. To conduct the Morse test on multi cylinder Petrol Engine.
11. To determine volumetric efficiency and mass flow rates of a two stage reciprocating air compressor.

Faculty of Engineering & Technology
 KAKATIYA UNIVERSITY, WARANGAL-506009
 Department of Mechanical Engineering

B. Tech. (ME) IV SEMISTER
MC 220
CONSTITUTION OF INDIA

Course code	MC				
Category	Mandatory Course				
Course title	CONSTITUTION OF INDIA				
Scheme and Credits	L	T	P	Credits	Internal marks =30
	2	0	0	0	External Marks = 70

- UNIT -1:**
1. Making of Indian Constitution - Constituent Assembly
 2. Historical Perspective of the Constitution of India
 3. Salient Features and characteristics of the Constitution of India

- UNIT -2:**
1. The Fundamental Rights
 2. The Fundamental Duties and their Legal Status
 3. The Directive Principles of State Policy – Their Importance and Implementation

- UNIT -3:**
1. Federal Structure and Distribution of Administrative, Legislative and Financial Powers between the Union and the States
 2. Parliamentary Form of Government in India – The Constitutional Powers and Status of the President of India
 3. Amendment of the Constitutional Provisions and Procedure

- UNIT -4:**
1. The Judiciary
 2. Constitutional and Legal Frame Work for Protection of Environmental in Global and National Level
 3. Corporate Social Responsibility (CSR) International and National Scenario.

Text books:

1. D.D. Basu: An Introduction of Indian Constitution
2. Greanvile Austin: The Indian Constitution
3. Paras Diwan: Studies on Environmental cases

References Books:

1. Khanna Justice.H.R: Making of India's Constitution, Eastern Book Companies.
2. Rajani Kothari: Indian Politics
3. Ghosh Pratap Kumar: The Constitution of India. How it has been Formed, World Press.
4. A.Agrawal (Ed): Legal Control of Environmental Pollution.

Faculty of Engineering & Technology
 KAKATIYA UNIVERSITY, WARANGAL-506009
 Department of Mechanical Engineering

B. Tech. (ME) IV SEMISTER
ME-222
MACHINE TOOLS & METROLOGY

Course code	PCC				
Category	Professional Core Course				
Course title	Machine Tools & Metrology				
Scheme and Credits	L	T	P	Credits	Internal marks = 30
	3	0	0	3	External Marks = 70

UNIT-I:

Metal cutting: Introduction, elements of cutting process – Geometry of single point tools. Chip formation and types of chips, chip breakers, mechanism of orthogonal cutting, merchant force diagram, cutting force, cutting speed, feed, depth of cut, tool life, coolant.

Engine lathe – Principle of working, types of lathe, specifications. Taper turning– Lathe attachments. Capstan and Turret lathe – Single spindle and multi-spindle automatic lathes – tool layouts.

UNIT-II:

Drilling and Boring Machines – Principles of working, specifications, types, operations performed; twist drill. Types of Boring machines and applications. Shaping, slotting and planning machines - Principles of working –machining time calculations.

UNIT-III:

Milling machines – Principles of working – Types of milling machines – Geometry of milling cutters – methods of indexing.

Grinding – theory of grinding – classification of grinding machines. Types of abrasives, bonds. Selection of a grinding wheel. Lapping, honing and broaching machines, comparison and Constructional features, machining time calculations

UNIT-IV:

Limits, fits and tolerances- Unilateral and bilateral tolerance system, hole and shaft basis system. Interchange ability and selective assembly.

Limit Gauges: Taylor's principle, Design of GO and NO GO gauges Measurement of angles, Bevel protractor, Sine bar. Measurement of flat surfaces, straight edges, surface plates, optical flat and auto collimator.

UNIT-V:

Surface Roughness Measurement-Roughness, Waviness. CLA, RMS, Rz Values. Methods of measurement of

Surface finish- Talysurf. Screw thread measurement, Gear measurement; Machine Tool Alignment Tests on lathe, milling and drilling machines. Coordinate Measuring Machines: Types and Applications of CMM.

TEXT BOOKS:

1. Engineering Metrology by I C Gupta., Danpath Rai
2. Engineering Metrology by R.K. Jain, Khanna Publishers

References Books:

1. Principles of Machine Tools by Bhattacharya A and Sen.G.C, New Central Book Agency.
2. Production Technology by R.K. Jain and S.C. Gupta.

Faculty of Engineering & Technology
 KAKATIYA UNIVERSITY, WARANGAL-506009
 Department of Mechanical Engineering

B. Tech. (ME) IV SEMESTER
ME-223
DESIGN OF MACHINE ELEMENTS – I

Course code	PCC				
Category	Professional Core Course				
Course title	Design of Machine Elements I				
Scheme and Credits	L	T	P	Credits	Internal marks = 30
	3	0	-	3	External Marks = 70

NOTE:

Design Data books are not permitted in the Examinations. The design must not only satisfy strength criteria but also rigidity criteria.

UNIT-I

Introduction: General considerations in the design of Engineering Materials and their properties – selection – Manufacturing consideration in design. Tolerances and fits – BIS codes of steels.

Design for static strength: Simple stresses – Combined stresses – Torsional and Bending stresses – Impact stresses – Stress strain relation – Various theories of failure – Factor of safety – Design for strength and rigidity – preferred numbers. The concept of stiffness in tension, bending, torsion and combined situations.

UNIT – II:

Design for fatigue strength: Stress concentration – Theoretical stress Concentration factor – Fatigue stress concentration factor- Notch Sensitivity – Design for fluctuating stresses – Endurance limit – Estimation of Endurance strength – Gerber’s curve– Modified Goodman’s line– Soderbergs line.

Eccentric loading: Design of Machine Frames and Brackets under eccentric and flexural loads, Circular bars under axial, torsion and bending loads, equivalent bending and twisting moments.

UNIT – III:

Riveted, welded joints: Riveted joints- methods of failure of riveted joints-strength equations- efficiency of riveted joints-eccentrically loaded riveted joints.

Welded joints: Design of fillet welds-axial loads-circular fillet welds under bending, torsion. Welded joints under eccentric loading.

UNIT – IV:

Keys, cotters and knuckle joints: Design of keys-stresses in keys-cotter joints-spigot and socket, sleeve and cotter, gib and cotter joints-Knuckle joints.

Bolted joints: Design of bolts with pre-stresses – Design of joints under eccentric loading – locking devices – bolts of uniform strength.

UNIT – V:

Shafts: Design of solid and hollow shafts for strength and rigidity – Design of shafts for combined bending and axial loads – Shaft sizes – BIS code. Use of internal and external circlips, Gaskets and seals (stationary & rotary).

Shaft couplings: Rigid couplings – Muff, Split muff and Flange couplings. Flexible couplings – Flange coupling (Modified).

Mechanical springs: Stresses and deflections of helical springs-Extension-compression springs-springs for static and fatigue loading – natural frequency of helical springs-energy storage capacity-helical tension springs- co-axial springs.

TEXT BOOKS:

1. Machine Design by V. Bhandari, TMH Publishers

REFERENCE BOOKS:

1. Design of Machine Elements by V.M. Faires, Mcmillan Company New York

2. Mechanical Engineering Design by JE Shigley McGrawHill Publications

3. A Text book of Machine Design by RS Khurmi and Guptha, S. Chand & Co. New Delhi

4. Elements of Machine Design by Pandya & Shah, Chartor publications

Faculty of Engineering & Technology
 KAKATIYA UNIVERSITY, WARANGAL-506009
 Department of Mechanical Engineering

B. Tech. (ME) IV SEMESTER
ME-224
INSTRUMENTATION AND CONTROL SYSTEMS

Course code	PCC				
Category	Professional Core Course				
Course title	Instrumentation and Control Systems				
Scheme and Credits	L	T	P	Credits	Internal marks = 30
	3	0	-	3	External Marks = 70

UNIT-I:

Definition – Basic principles of measurement – Measurement systems, generalized configuration and functional description of measuring instruments –examples. Static and Dynamic performance characteristics – sources of errors, Classification and elimination of errors.

Measurement of Displacement: Theory and construction of various transducers to measure displacement – Piezoelectric, Inductive, capacitance, resistance, ionization and Photo electric transducers, Calibration procedures.

UNIT-II:

Measurement of Temperature: Various Principles of measurement-Classification: Expansion Type: Bimetallic Strip- Liquid in glass Thermometer; Electrical Resistance Type: Thermistor, Thermocouple, RTD; Radiation

Pyrometry: Optical Pyrometer; Changes in Chemical Phase: Fusible Indicators and Liquid crystals. Measurement of Pressure: Different principles used- Classification: Manometers, Dead weight pressure gauge. Tester (Piston gauge), Bourdon pressure gauges, Bulk modulus pressure gauges; Bellows – Diaphragm gauges. Low-pressure measurement – Thermal conductivity gauges, ionization pressure gauges, Mcleod pressure gauge.

UNIT-III:

Measurement of Level: Direct methods – Indirect methods – Capacitive, Radioactive, Ultrasonic, Magnetic, Cryogenic Fuel level indicators – Bubbler level indicators.

Flow measurement: Rotameter, magnetic, Ultrasonic, Turbine flow meter, Hot – wire anemometer, Laser Doppler Anemometer (LDA).

Measurement of Speed: Mechanical Tachometers, Electrical tachometers, Non- contact type- Stroboscope

Measurement of Acceleration and Vibration: Different simple instruments – Principles of Seismic instruments –Vibrometer and accelerometer using this principle- Piezo electric accelerometer.

UNIT-IV:

Stress-Strain measurements: Various types of stress and strain measurements –Selection and installation of metallic strain gauges- electrical strain gauge – gauge factor – method of usage of resistance strain gauge for bending compressive and tensile strains – Temperature compensation techniques, Use of strain gauges for measuring torque, Strain gauge Rosettes.

Measurement of Humidity: Moisture content of gases, Sling Psychrometer, Absorption Psychrometer, Dew pointmeter.

UNIT-V:

Measurement of Force, Torque And Power- Elastic force meters, load cells, Torsion meters, Dynamometers.

Elements of Control Systems: Introduction, Importance – Classification – Open and closed systems Servomechanisms– Examples with block diagrams–Temperature, speed & position control systems.

TEXT BOOKS:

1. Principles of Industrial Instrumentation & Control Systems by Alavala, Cengage Learning
2. Instrumentation, Measurement & Analysis by B.C.Nakra & K.K.Choudhary, TMH
3. Mechanical Measurements & Controls by D.S. Kumar

REFERENCE BOOKS:

1. Measurement Systems: Applications & design by E.O. Doebelin, TMH
2. Experimental Methods for Engineers by Holman
3. Mechanical and Industrial Measurements by R.K. Jain, Khanna Publishers.
4. Mechanical Measurements by Sirohi and Radhakrishna, New Age International.

Faculty of Engineering & Technology
 KAKATIYA UNIVERSITY, WARANGAL-506009
 Department of Mechanical Engineering

B. Tech. (ME) IV SEMISTER
ME-225
KINEMATICS OF MACHINERY

Course code	PCC				
Category	Professional Core Course				
Course title	Kinematics of Machinery				
Scheme and Credits	L	T	P	Credits	Internal marks = 30
	3	0	-	3	External Marks = 70

UNIT – I:

Mechanisms: Elements or Links – Classification – Rigid Link, flexible and fluid link – Types of kinematics pairs –sliding, turning, rolling, screw and spherical pairs – lower and higher pairs – closed and open pairs – constrained motion – completely, partially or successfully and incompletely constrained .

Mechanism and Machines: Mobility of Mechanisms: Grublers criterion, classification of machines – kinematics chain – inversions of mechanism – inversions of quadric cycle chain, single and double slider crank chains, Mechanical Advantage, Intermittent motion Mechanism, Ratchet & Paul Generca Mechanicsm.

UNIT – II:

Kinematics: Velocity and acceleration – Motion of link in machine – Determination of Velocity and acceleration –Graphical method – Application of relative velocity method.

Plane motion of body: Instantaneous center of rotation- centrodes and axodes– Three centers in line theorem –Graphical determination of instantaneous center, determination of angular velocity of points and links by instantaneous center method.

Kliens construction - Coriolis acceleration - determination of Coriolis component of acceleration

Analysis of Mechanisms: Analysis of slider crank chain for displacement- velocity and acceleration of slider –Acceleration diagram for a given mechanism.

UNIT – III:

Straight-line motion mechanisms: Exact and approximate copied and generated types –Peaucellier - Hart - Scott Russel– Grasshopper – Watt -Tchebicheffs and Robert Mechanism -

Pantographs Steering gears: Conditions for correct steering – Davis Steering gear, Ackerman’s steering gear.

Hooke’s Joint: Single and double Hooke’s joint –velocity ratio – application – problems.

UNIT – IV:

Cams: Definitions of cam and followers – their uses – Types of followers and cams – Terminology – Types of follower motion - Uniform velocity, Simple harmonic motion and uniform acceleration and retardation. Maximum velocity and maximum acceleration during outward and return strokes in the above 3 cases.

Analysis of motion of followers: Tangent cam with Roller follower – circular arc cam with straight, concave and convex flanks.

UNIT – V:

Higher pair: Friction wheels and toothed gears – types – law of gearing, condition for constant velocity ratio for transmission of motion – velocity of sliding. Forms of teeth, cycloidal and involutes profiles – phenomena of interferences – Methods of interference. Condition for minimum number of teeth to avoid interference – expressions for arc of contact and path of contact of Pinion & Gear and Pinion & Rack Arrangements– Introduction to Helical –Bevel and worm gearing

Gear Trains: Introduction: Types – Simple – compound and reverted gear trains –Epicyclic gear train. Methods of finding train value or velocity ratio of Epicyclic gear trains. Selection of gear box - Differential gear for an automobile

TEXT BOOKS:

1. Theory of Machines by S.S.Rattan, Tata McGraw Hill Publishers.
2. Kinematics & Dynamics Of machinerybyNorton, TMH

REFERENCE BOOKS:

1. Theory of Machines by Thomas Bevan, CBS
2. Theory of Machines by Sadhu Singh, Pearson.
3. Theory of Machines by Shigley, Oxford
4. Mechanism and Machine Theory by JS Rao and RV Duggipati, New Age
5. Theory of Machines by R.K. Bansal, LakshmiPublications.

Faculty of Engineering & Technology
 KAKATIYA UNIVERSITY, WARANGAL-506009
 Department of Mechanical Engineering

B. Tech. (ME) IV SEMISTER
ME-227L
MACHINE TOOLS & METROLOGY LAB

Course code	PCC				
Category	Professional Core Course				
Course title	Machine Tools & Metrology Lab				
Scheme and Credits	L	T	P	Credits	Internal marks = 25
	0	0	3	1.5	External Marks = 50

MACHINE TOOLS LAB

1. Study of general purpose machines - Lathe, Drilling machine, Milling machine, Shaper, Planning machine, slotting machine, Cylindrical Grinder, surface grinder and tool and cutter grinder.
2. Step turning, taper turning (swelling compound rest), grooving on lathe machine.
3. Taper turning by taper turning attachment.
4. Thread cutting and knurling using lathe machine.
5. Make a hole using lathe machine.
6. Drilling and Tapping using Radial drilling machine.
7. Cutting 'V' groove using shaping machine.
8. Cutting slots on circular shaft using slotting machine.
9. Cutting key ways using milling machines.
10. Surface Grinding using surface grinding machine.
11. Setting tool angles using tool & cutter grinder.
12. Cutting grooves/Plain surface using planning machine.
13. Cylindrical grinding by cylindrical grinding machine.

METROLOGY LAB

1. Measurement of lengths, heights, diameters by vernier caliper and micrometer etc.
2. Measurement of bores by internal micrometer and dial bore indicator.
3. Use of gear teeth vernier caliper and checking the chordal addendum and chordal height of spur gear.
4. Machine tool - alignment test on the lathe.
5. Measurement of screw thread and cutting tool profiles using Tool maker's microscope.
6. Angle and taper measurements by Bevel protractor and Sine bar.
7. Measurement of effective diameter of screw thread by two wire / three wire method.
8. Measurement of surface roughness.

Faculty of Engineering & Technology
 KAKATIYA UNIVERSITY, WARANGAL-506009
 Department of Mechanical Engineering

B. Tech. (ME) IV SEMESTER
ME-228L
MACHINE DRAWING

Course code	PCC				
Category	Professional Core Course				
Course title	Machine Drawing				
Scheme and Credits	L	T	P	Credits	Internal marks = 30
	-	-	4	2	External Marks = 70

The following contents are to be drawn using conventional method

UNIT-I

Standard Drawing Practices: Format of drawing sheet, title block, conventions of drawing lines and dimensions. conventional representation of materials and parts (Screwed joint, Welded joints, Springs, Gears, machine tool elements). Abbreviated indication of standard parts in assembly drawings. First and third angle projections, conventions for sectional views, views of simple machine elements from the given pictorial and orthographic views.

UNIT II

Machine Elements: sketching of the following standard machine elements Screwed Fastenings: Screw thread nomenclature, thread series, designation, thread profiles, multi start threads, representation of threads, bolted joints, studded joint, eye bolt.

Keys, Cotters and Pin Joints: Introduction, saddle keys, sunk keys, cotter joint with sleeve, cotter joint with socket and Spigot ends, cotter joint with a Gib and knuckle joint.

Shaft Couplings: Rigid couplings, flexible couplings, disengaging couplings and non-aligned couplings.

Riveted Joints: Introduction, classification of riveted joints, terminology of riveted joints, rivet heads.

Welded Joints: Introduction, types of welded joints, representation of welds on drawings.

UNIT-III

Assembly Drawings:

Assembly drawings from given details of component drawings and working description of the assembly. Ability to supply additional views. The exercises will be drawings of typical machine parts, assemblies e.g., Connecting rod, Eccentric, Cross head, Machine vice, pipe vice, Screw jack, Plummer block, Pedestal Bearing, Tail stock, Gate valve, Universal coupling, Geneva cam etc. These are only examples and actual exercise or examination may include any assembly.

Limits and fits: Introduction, fundamental deviations for Hole based and Shaft based systems, alpha numeric designation of limits & fits. Types of Fits. Form and positional tolerances. Conventional practices of indicating limits and fits, geometrical form and position tolerances, surface finish and surface treatments requirements. Study of Examples involving selection of fits and calculation of limits. Suggestion of suitable fits for mating parts.

The following contents are to be drawn using software package

UNIT-IV

Sectional views Creating solid models of complex machine parts and creating sectional views

Assembly drawing: Lathe tool post, Connecting rod, Eccentric, Cross head, Machine vice, pipe vice, Screw jack, Plummer block, Pedestal Bearing, Tail stock, Gate valve, Universal coupling, Geneva cam.

UNIT - V

Manufacturing drawing: Representation of limits fits and tolerances for mating parts. Use any four parts of above assembly drawings and prepare manufacturing drawing with dimensional and geometric tolerances.

Pattern of Exam: Internals: Conventional and CAD Software Externals: Conventional N.B. Tolerance charts to be provided in the examination Hall for calculation of limits.

TEXT BOOKS:

1. Siddeshwar N, Kannaiah P and Sastry VVS, "*Machine Drawing*", Tata McGraw Hill Publishing Co. Ltd., 5th Edition, 1994.
2. Bhatt N.D, "*Machine Drawing*", Charotar Publishing House, Anand, New Delhi, 28th Edition, 1993.

REFERENCE BOOKS:

1. Narayan K.L, Kannaiah P, Venkat Reddy K, "*Machine Drawing*", New Age International (P) Ltd., 2nd Edition, 1999.
2. K. C. John, "*Text book of Machine Drawing*", PHI Learning, 2010.
3. P. Narsimha Reddy, T.A. Janardhan Reddy, C.S. Rao, "*Production Drawing Practice*", High Tech Publishers, 2001.

4. R.K. Jain, *Engineering Metrology*, Khanna Publishers, 8th Ed. 1985.
5. K.L. Narayana, P. Kannayya and K. Venkat Reddy, *Production Drawing*, New Age International (p) Ltd. Revised edition, 1997.
6. The Solid Works software manual