



# RAJASTHAN TECHNICAL UNIVERSITY, KOTA

## Syllabus

3<sup>rd</sup> Year - V Semester: B.Tech. : Production and Industrial Engineering

### SPI3-01: MEASUREMENT AND METROLOGY

Credit: 2  
2L+0T+0P

Max. Marks: 100 (IA:30, ETE:70)  
End Term Exam: 3 Hours

UNIT	CONTENTS	CONTACT HOURS
I	Concept of measurement: General concept of measurement, Need for measurement, Generalized measuring system, Units, Standards, Sensitivity, Readability, Range of accuracy, Precision, Accuracy vs precision, Uncertainty.	4
	Repeatability and reproducibility, Errors in measurement, Types of error, Systematic and random error, Calibration, Interchangeability.	4
II	Linear and angular measurements: Linear measuring instruments: Vernier caliper, Micrometer, Slip gauges, Optical flat, Application of limit gauges;	4
	Comparators:- Mechanical comparators, Electrical comparator, Pneumatic comparator;	3
	Sine bar, Use of sine bar, Limitations of sine bars, Sources of error in sine bars, Bevel protractor, Applications of bevel protractor.	4
III	Form measurement: Introduction, Screw thread measurement, Thread gauges, Measurement of gears: Gear errors, Spur gear measurement, Parkinson gear tester.	4
	Surface finish measurement:-Introduction, Elements of surface texture, Analysis of surface finish, Methods of measuring surface finish, Straightness measurement, Flatness testing, Roundness measurements	4
IV	Machine tool metrology: Coordinate measuring machine (CMM):-Types of CMM, Features of CMM, Computer based inspection, Computer aided inspection using robots.	5
V	Measurement of force: Accelerometer, Load cells. Torque measurement: Torque measurement using strain gauges, Torque measurement using torsion bars, Measurement of power: Mechanical dynamometers,	4
	Measurement of flow: Variable area meters – rotameter, Hot wire anemometer, Pitot tube. Temperature measurement: Thermocouples (Thermo electric effects), Thermistors, Pyrometers	4
	<b>TOTAL</b>	<b>40</b>



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### 5PI4-02 : ADVANCED MANUFACTURING METHODS

Credit: 3  
3L+0T+0P

Max. Marks: 100 (IA:30, ETE:70)  
End Term Exam: 2 Hours

UNIT	CONTENTS	CONTACT HOURS
I	Introduction and classification of advanced machining process, Consideration in process selection, difference between traditional and non-traditional process, Hybrid process.	3
II	Abrasive finishing processes: AFM, MAF (for Plain and cylindrical surfaces).	4
III	Mechanical advanced machining process: Introduction, Mechanics of metal removal, process principle, Advantages, disadvantages and applications of AJM, WJC, USM.	8
IV	Thermo electric advanced machining process: Introduction, Principle, process parameters, advantages, disadvantages and applications about EDM, EDG,	7
	Laser Beam Machining – Principle of working, equipment, Material removal rate, Process parameters, performance characterization, Applications.	7
	Plasma Arc Machining – Principle of working, equipment, Material removal rate, Process parameters, performance characterization, Applications.	
V	Electrochemical and chemical advanced machining process: ECM, ECG, ESD, Chemical machining - Principle of working, equipment, Material removal rate, Process	6
	E-Manufacturing, Nanotechnology, Micromachining and High-speed Machining: basic principles, working, applications, advantages.	5
	<b>TOTAL</b>	<b>40</b>



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### 5PI4-03: THERMAL ENGINEERING

Credit: 3  
3L+0T+0P

Max. Marks: 100 (IA:30, ETE:70)  
End Term Exam: 2 Hours

Unit	Contents	Contact hours
I	Heat Transfer: Introduction, Fourier's law of conduction, Newton Rikhman equation, Stefan Boltzmann law, Overall heat transfer coefficient.	2
	Conduction: Three dimensional heat flow equation-Cartesian coordinates. One dimensional steady state conduction without heat generation, One dimensional flow through a plane wall, composite wall and tube, thick spherical shell, Critical insulation, Heat flow through fins. Convection: Dimensional analysis of forced and free convection, empirical relations Radiation: Introduction, Absorption, reflection and transmission, Monochromatic, total emissive power, view factor	6
II	Introduction of Internal and external combustion engine and their comparison, four stroke cycle S.I. and C.I. engine, two stroke engine, comparison of four stroke and two stroke engines, comparison of S.I. and C.I. engine.	5
	Classification of I.C. Engine, Valve timing diagram for S.I. and C.I. engines, effect of valve timing and engine speed on volumetric efficiency, reasons for ignition and injection advance, dual fuel.	3
III	Testing and Performance: Performance parameters, measurements of brake power, indicated power, friction power, fuel and air consumption, exhaust gas calorimeter, calculation of various performance parameter, heat balance sheet. Performance characteristics for S.I. and C.I. Engine with load and speed	4
	Heat exchanger: Types of Heat Exchanger, LMTD equation for parallel and counter flow Heat Exchanger and its applications. Effectiveness - NTU Method	4
IV	Refrigeration: Air refrigeration system, vapour compression	4
	Refrigerants, Refrigeration equipments, Reciprocating Air Compressor.	4
V	Air Conditioning: Properties of moist air, Psychrometric chart and its use, Elementary psychrometric processes. Comfort Air Conditioning.	8
	<b>TOTAL</b>	<b>40</b>



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### 5PI4-04: DESIGN OF MACHINE ELEMENTS

Credit: 3  
3L+0T+0P

Max. Marks: 100 (IA:30, ETE:70)  
End Term Exam: 2 Hours

UNIT	CONTENTS	CONTACT HOURS
I	Design Criteria: Strength, Stiffness, aesthetics, ergonomics Design for Manufacturing: Design consideration for cast, forged and machined parts. Design for Assembly: Introduction, Limits, fits and tolerances, Interchangeability, standardization. Materials: Selection of material from properties and economic aspects. Mechanical Properties and IS coding of various materials.	7
II	Design for Strength: Modes of failure, Allowable stresses, factor of safety. Stress concentration: causes and mitigation.	4
	Design of Members subjected to direct stress: Cotter joints. Couplings: Design of muff coupling, flanged couplings: rigid and flexible	5
III	Design of Members in Bending: Levers and laminated springs. Design for stiffness: Introduction, Specific cases of beam design on the basis of maximum deflection. Deflection by double integration method	7
IV	Design of Threaded fasteners: Bolt of uniform strength, Preloading of bolts: Effect of initial tension and applied loads, Eccentric loading	5
	Power screws like lead screw, screw jack	3
V	Fatigue Considerations in Design: Variable load, loading pattern, endurance stresses, Influence of size, surface finish, notch sensitivity and stress concentration.	3
	Goodman line, Soderberg line, Design of machine members subjected to combined, steady and alternating stresses.	4
	Design for finite life, Design of Shafts under Variable Stresses	2
	<b>Total</b>	<b>40</b>



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### 5PI4-05: QUALITY MANAGEMENT

**Credit: 2**  
**2L+0T+0P**

**Max. Marks: 100 (IA:30, ETE:70)**  
**End Term Exam: 3 Hours**

UNIT	CONTENTS	Contact Hours
I	Introduction: Objective, scope and outcome of the course. Introduction to Quality Management: Quality – Concept, Different Definitions and Dimensions, Inspection, Quality Control, Quality Assurance and Quality Management, Quality as Wining Strategy, Views of different Quality Gurus, Quality Cost.	7
II	Process Quality Improvement: Introduction to process quality, Graphical and statistical techniques for process Quality Improvement, Graphical tools for data representation, 7QC tools, Sampling, sampling distribution, and hypothesis Testing, Regression, control charts, process capability analysis, Measurement system analysis, Analysis of Variance(ANOVA), Design and analysis of experiment (DOE), Acceptance sampling pan, TQM	9
III	Leadership, Lean and JIT Q Quality Philosophy, Benchmarking, Process failure mode and effect analysis (PFMEA), Service Quality, Six sigma for process Improvement, ISO 9001, ISO 14000 and QS 9000, Quality audit, Quality Circles.	9
IV	Product Quality Improvement: Quality Function Deployment, Robust Design and Taguchi Method	8
V	Design Failure Mode and Effect Analysis, Product Reliability Analysis, Six sigma in product development	7
	<b>Total</b>	<b>40</b>



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### 5PI5-11: NON DESTRUCTIVE EVALUATION AND TESTING

**Credit: 3**  
**3L+0T+0P**

**Max. Marks: 100 (IA:30, ETE:70)**  
**End Term Exam: 3 Hours**

UNIT	CONTENTS	CONTACT HOURS
<b>I</b>	Introduction: An Overview, Factors influencing the Reliability of NDE, Defects in materials, Defects in composites. NDT methods used for evaluation of materials and composites.	<b>3</b>
	Visual Inspection: Basic Principle and Applications.	<b>2</b>
	Liquid Penetrant Testing: Principle, Procedure and Test Parameters, Materials, Limitations and Applications.	<b>3</b>
<b>II</b>	Radiographic Inspection: Principles of X – ray radiography, equipment, Absorption, Scattering, X-ray film processing, General radiographic procedures, Reading and Interpretation of Radiographs, Industrial radiographic practice, Limitations and Applications, Welding defects detection. Gamma ray radiography.	<b>8</b>
<b>III</b>	Ultrasonic Testing: Principle of wave propagation, Ultrasonic equipment, Variables affecting an ultrasound test, Basic methods: Pulse Echo and Through Transmission, Types of scanning.	<b>5</b>
	Applications of UT: Testing of products, Welding Inspection, Tube Inspection, Thickness Measurement, Elastic Constant Determination, Ultrasonic testing of composites.	<b>3</b>
<b>IV</b>	Magnetic Particle Inspection: Methods of generating magnetic field, Demagnetization of materials, Magnetic particle test: Principle, Test Equipment and Procedure, Interpretation and evaluation.	<b>5</b>
	Introduction to Acoustic Emission Testing and Thermography.	<b>3</b>
<b>V</b>	Eddy Current Testing: Principle of eddy current, Factors affecting eddy currents, Test system and test arrangement, Standardization and calibration, Application and effectiveness.	<b>5</b>
	Comparison and Selection of NDT Methods, Codes and Standards	<b>3</b>
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### 5PI5-12: COMPUTER AIDED DESIGN AND GRAPHICS

**Credit: 3**  
**3L+0T+0P**

**Max. Marks: 100 (IA:30, ETE:70)**  
**End Term Exam: 3 Hours**

UNIT	CONTENTS	CONTACT HOURS
<b>I</b>	Overview of Computer Graphics: Picture representation, Coordinate Systems, Raster Scan Display, DDA for line generation and Bresenham's algorithm for line and circle generation; Graphics standards: GKS, IGES, STEP, DXF..	<b>4</b>
	Parametric representation of plane curves: line, circle, ellipse, parabola and hyperbola.	<b>4</b>
<b>II</b>	Parametric representation of Space Curves: Cubic spline curve, Bezier Curve and B Spline Curves. Blending of Curves.	<b>5</b>
	Parametric representation of Surfaces: HermiteBicubic surfaces, Bezier surfaces and B-spline surfaces.	<b>5</b>
<b>III</b>	Solid Representation: B-rep. and CSG. Comparison between three types of models.	<b>5</b>
<b>IV</b>	Two and Three Dimensional Transformation of Geometric Models: Translation, Scaling Reflection, Rotation and Shearing, Homogeneous Representation, Combined Transformation.	<b>4</b>
	Projection of Geometric models: Parallel and Perspective Projection.	<b>5</b>
<b>V</b>	Clipping: Point clipping, Line clipping, Cohen- Sutherland algorithm etc., Viewing transformation.	<b>4</b>
	Hidden line and surface removal: Techniques and Algorithms. Coloring and Shading.	<b>4</b>
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### SPI5-13: AUTOMOBILE ENGINEERING

Credit: 3  
3L+0T+0P

Max. Marks: 100 (IA:30, ETE:70)  
End Term Exam: 3 Hours

UNIT	CONTENTS	CONTACT HOURS
I	Frame & Body: Layout of chassis, types of chassis frames and bodies, their constructional features and materials.	3
	Clutches: single plate, multi-plate, cone clutch, semi centrifugal electromagnetic, vacuum and hydraulic clutches. Fluid coupling. Brakes: Classification and function; Mechanical, hydraulic, vacuum air and self engineering brakes; Brake shoes and lining materials.	5
II	Gear Boxes: Sliding mesh, constant mesh, synchromesh and epicyclic gear boxes, Automatic transmission system; Hydraulic torque converter	4
	Drives: Overdrive, Propeller shaft, Universal joints, Differential; Rear axle drives. Hotchkiss and torque tube drives; Rear axle types; Front wheel and All wheel drive.	4
III	Wheels and Tyres: Tyre types, Tyre construction; Tyre inflation pressure, Tyre wear and their causes; Re-treading of the tyre,	2
	Steering system: steering gear boxes, Steering linkages, Steering mechanism, Under and Over steering. Steering Geometry, Effect of camber, caster, king pin inclination, toe in and toe out; Power steering; Integral and linkage types	3
	Suspension system: objective and requirements, Suspension spring, front and rear suspension systems, Independent suspension system Shock absorbers.	3
IV	Automotive Electrical System: Battery construction, Charging and testing, battery types, Starting and Battery Charging System: Starter motor construction, types of drive, Alternator construction, regulation and rectification.	4
	Ignition System: Magneto and coil ignition systems, System components and requirements, Automotive lighting: Wiring systems Electrical instruments; head lamp, electric horn, fuel level indicator.	4
V	Automotive Air Conditioning: Introduction, Loads, Air conditioning system Components, Refrigerants, Fault Diagnosis.	4
	Automotive Safety: Safety requirements, Safety Devices, Air bags, belts, radio ranging, NVS (Night Vision System) GPS (Global Positioning System)	4
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### 5PI3-21: METROLOGY LAB

Credit: 1  
0L+0T+2P

Max. Marks: 100 (IA:60, ETE:40)

SN	NAME OF EXPERIMENT
1	Study of various measuring tools like dial gauge, micrometer, vernier caliper and telescopic gauges.
2	Measurement of angle and width of a V-groove by using bevel protector..
3	To measure a gap by using slip gauges
4	Measurement of angle by using sine bar.
5	Study and use of surface roughness instrument (Taylor Hobson make) Inspection of various elements of screw thread by Tool makers microscope and optical projector.
6	Measurement of gear tooth thickness by using gear tooth vernier caliper.
7	To check accuracy of gear profile with the help of profile projector.
8	To determine the effective diameter of external thread by using three-wire method.
9	To measure flatness and surface defects in the given test piece with the help of monochromatic check light and optical flat.
10	To plot the composite errors of a given set of gears using composite gear tester.
11	Measurement of coating thickness on electroplated part and paint coating on steel and non-ferrous material using coating thickness gauge.
12	Study and use of hardness tester for rubber and plastics.
13	To check the accuracy of a ground, machined and lapped surface - (a) Flat surface (b) Cylindrical surface.
14	To compare & access the method of small-bore measurement with the aid of spheres.



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### 5PI4-22: MACHINE DESIGN PRACTICE

**Credit: 1**  
**0L+0T+2P**

**Max. Marks: 100 (IA:60, ETE:40)**

SN	NAME OF EXPERIMENT
	Problems on:
1	Selecting fit and assigning tolerances, Examples of Production considerations
2	Cotter joints
3	Torque: Keyed joints and shaft couplings
4	Design of screw fastening, Preloaded bolts,
5	Bending: Beams, Levers, laminated springs.
6	Power screws, lead screw design
7	Fatigue loading.



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### SPI4-23: THERMAL ENGINEERING LAB

**Credit: 1**  
**0L+0T+2P**

**Max. Marks: 100 (IA:60, ETE:40)**

SN	NAME OF EXPERIMENT
1	Comparative study of a) Four stroke diesel and petrol engines. b) Two stroke petrol and diesel engines
2	Studies of fuel supply systems of diesel and petrol engines.
3	Study of cooling, lubrication and ignition system in diesel and petrol engines.
4	To study various types of Boilers and to study Boiler mounting and accessories.
5	To study various types of Dynamometers.
6	To study Multi Stage Air Compressors.
7	To find the BHP, Thermal efficiency of four stroke diesel engine.
8	Study of Brakes, Clutches, and Transmission System.
9	To prepare a comparison sheet of various automobiles (4 Wheeler and 2 Wheeler).
10	Study of parallel flow and counter flow heat exchanger.
11	Load test on Petrol Engine and Diesel engine.
12	Determination of conductivity of insulating powder.
13	Determination of effectiveness of parallel and counter flow heat exchanger.



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### SPI4-24: QUALITY CONTROL LAB

**Credit: 1**  
**0L+0T+2P**

**Max. Marks: 100 (IA:60, ETE:40)**

SN	NAME OF EXPERIMENT
1	Case study on X bar charts and process capability analysis
2	PChart: (a) Verify the Binomial Distribution of the number of defective balls by treating the balls with a red colour to be defective. (b) Plot a P-chart by taking a sample of $n=20$ and establish control limits
3	To plot C-chart using given experimental setup
4	Operating Characteristics Curve: (a) Plot the operating characteristics curve for single sampling attribute plan for $n = 20 ; c = 1 , 2 , 3$ Designate the red ball to defective. (b) Compare the actual O.C. curve with theoretical O.C. curve using approximation for the nature of distribution
5	Distribution Verification: (a) Verification of Normal Distribution. (b) To find the distribution of numbered cardboard chips by random drawing one at a time with replacement. Make 25 subgroups in size 5 and 10 find the type of distribution of sample average in each case. Comment on your observations
6	Verification of Poisson distribution
7	Central Limit Theorem: (a) To show that a sample means for a normal universe follow a normal distribution. (b) To show that the sample means for a non normal universe also follow a normal Distribution.