

5.1 THEORY OF MACHINES

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RATIONALE

A diploma holder in this course is required to assist in the design and development of prototype and other components. For this, it is essential that he is made conversant with the principles related to design of components and machine and application of these principles for designing. The aim of the subject is to develop knowledge and skills about various aspects related to design of machine components.

NOTE: - Weightage of each topic for external examination is given in the brackets

DETAILED CONTENTS

1. **Simple Mechanisms** (10%)
 - 1.1 Introduction to link, kinematic pair, lower and higher pair, kinematic chain, mechanism, inversions.
 - 1.2 Different types of mechanisms (with examples)
2. **Power Transmission** (25%)
 - 2.1 Introduction to Belt and Rope drives
 - 2.2 Types of belt drives and types of pulleys
 - 2.3 Concept of velocity ratio, slip and creep; crowning of pulleys (simple numericals)
 - 2.4 Flat and V belt drive: Ratio of driving tensions, power transmitted, centrifugal tension, and condition for maximum horse power (simple numericals)
 - 2.5 Different types of chains and their terminology
 - 2.6 Gear terminology, types of gears and their applications; simple and compound gear trains; power transmitted by simple spur gear
3. **Flywheel** (20%)
 - 3.1 Principle and applications of flywheel
 - 3.2 Turning - moment diagram of flywheel for different engines
 - 3.3 Fluctuation of speed and fluctuation of energy - Concept only
 - 3.4 Coefficient of fluctuation of speed and coefficient of fluctuation of energy
 - 3.5 Simple numerical problems on fluctuation of speed and fluctuation of energy
4. **Governor** (15%)
 - 4.1 Principle of governor
 - 4.2 Simple description and working of Watt, Porter and Hartnell governor (simple numericals based on watt governor)
 - 4.3 Hunting, isochronism, stability, sensitiveness of a governor
5. **Balancing** (15%)
 - 5.1 Principle of balancing
 - 5.2 Introduction to balancing of rotating masses (simple numericals).

5.3 Simple problems related to several masses rotating in different planes.

6. Vibrations

- 6.1 Concept of vibrations and its types - longitudinal, transverse and torsional vibrations (simple numericals) (15%)
- 6.2 Damping of vibrations
- 6.3 Causes of vibrations in machines, their harmful effects and remedies

INSTRUCTIONAL STRATEGY

1. Use teaching aids for classroom teaching
2. Give assignments for solving numerical problems
3. Arrange industry visits to augment explaining use of various machine components like belt, rope, chain, gear drives, action due to unbalanced masses, brake clutch, governors, fly wheels, cams and gear drives
4. Video films may be used to explain the working of mechanisms and machine components like clutch, governors, brake etc.

5.2 REFRIGERATION AND AIR CONDITIONING

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RATIONALE

Diploma holders in mechanical engineering are responsible for supervising production and maintenance of refrigeration and air conditioning systems. For this purpose, knowledge and skills covering principles of refrigeration and air conditioning, various refrigeration and air conditioning system, psychometric are required to be imparted to them. Hence this subject.

Note: Weightage of each topic for external examination is given in the brackets.

DETAILED CONTENTS

1. **Principles of refrigeration** (10%)
 - 1.1 Meaning
 - 1.2 Refrigeration Methods
 - 1.3 Units of refrigeration
 - 1.4 Reversed Carnot cycle.
 - 1.5 Heat pump
 - 1.6 Coefficient of performance
 - 1.7 Rating of refrigeration machines.
2. **Refrigeration Systems** (20%)
 - 2.1 Air Refrigeration cycle-application and its limitations.
 - 2.2 Vapour Compression Cycle.
 - 2.1.1 Effect of sub-cooling and super heating
 - 2.1.2 Departure of actual vapour compression cycle from theoretical cycle
 - 2.1.3 Effect of varying condensing and suction temperature on coefficient of performance.
 - 2.1.4 Simple mathematical calculation with pressure enthalpy charts.
 - 2.3 Vapour absorption cycle
 - 2.4 Actual Vapour absorption cycle and application
3. **Refrigerants** (10%)
 - 3.1 Important properties of a refrigerant.
 - 3.2 Nomenclature of refrigerants.
 - 3.3 Properties and application of commonly used refrigerants such as R-134(a), R22, CO₂, NH₃ and refrigerant mixture.
 - 3.4 Concept of Ozone Depletion Potential (ODP), Global Warming Potential (GWP)
4. **Refrigeration System, Components and Controls** (10%)
 - 4.1 Function, type, specification and constructional details of components such as compressor, condenser, expansion valve (capillary tube, thermostatic

expansion valve, low side and high side float valve), evaporator, oil separator, accumulator, header.

- 4.2 Various controls – Solenoid valve, thermostat, low pressure /high pressure cut out, safety switch.

5. **Psychrometry** (20%)

- 5.1 Various terms –Dry and wet bulb temperature, saturation, dew point, adiabatic saturation, temperature, relative humidity, absolute humidity, humidity ratio.

- 5.2 Psychrometric chart and its uses.

- 5.3 Psychrometric processes – sensible heating and sensible cooling, humidification and dehumidification, cooling and dehumidification, heating and humidification, and their representation on psychrometric chart.

- 5.4 Simple problems.

6. **Air-conditioning** (5%)

- 6.1 Introduction

- 6.2 Metabolism in human body

- 6.3 Human comfort

- 6.4 Applications of air-conditioning

7. **Heat Load** (10%)

- 7.1 Various types of loads

- 7.2 Sensible and latent heat load

- 7.3 Load calculations

8. **Air-conditioning System** (10%)

- 8.1 Study of window air conditioner

- 8.2 Study of split air conditioner

- 8.3 Concept of Central air-conditioning system

- 8.4 Round the year air conditioning system

- 8.5 Air distribution systems, concept of filter, damper, fan, blower, air register and diffuser.

9. **Miscellaneous Topics** (5%)

- 9.1 Evaporative cooling with example of Desert cooler

- 9.2 Water Chillers and their applications

- 9.3 Green Building Concept

- 9.4 Building Rating

LIST OF PRACTICALS

1. Practice in

- i) Tube cutting

- ii) Tube Flaring

- iii) Tube bending

- iv) Tube joining

2. Study of Domestic refrigerator.

3. Study of water cooler

4. Study and sketch window type room air-conditioner
 5. Testing of a refrigeration unit to find out:
 - (i) Refrigeration capacity, (ii) Power input, (iii) C.O.P.
 6. (i) Charging refrigerant in an open as well as hermetically sealed units.
(ii) Physical detection of leakage of refrigerant by various methods.
 7. Study of experiment ice plant
 8. Visit to an Ice Plant and cold storage.
 9. Visit to a central air-conditioning plant.
 10. Study and sketch of Compressor, Expansion Valve, Solenoid valve, thermostat, H.P.-
L.P. switch, oil safety switch, service manifolds and valves, strainers, Driers.
 11. Determination of psychrometric properties of air by sling psychrometer and fan type
hygrometer and compare the results with ideal type hygrometer.
 12. Determination of bypass factor of cooling coil.
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5.3 INSPECTION AND QUALITY CONTROL

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RATIONALE

Diploma holders in this course are required to measure and inspect for ensuring quality of product. For this purpose, knowledge and skills about standards of measurement, limits, fits and tolerances, types of inspection and various measuring instruments, SQC & quality standards are necessary.

Note: Weightage of each topic for external examination is given in the brackets.

1. **Introduction to Quality** (15%)
Meaning of Quality. Quality Characteristics. Dimensions of Quality – Quality of Design, Quality of Conformance and Quality of Performance. Concept of Variables and Attributes. Quality Assurance. Quality related costs – Prevention Cost, Appraisal Cost, Internal and External Failure Costs. Tools for Quality Improvement – Flow Charts, Cause and Effect Diagram, Check Sheet, Histograms, Scatter Diagrams, Pareto Analysis and Control Chart
2. **Some Philosophies and their Impact on Quality** (5 %)
Deming's Wheel. Juran's Quality Trilogy, Crosby's Absolutes of Quality Management. Taguchi's Quality Loss Function
3. **Statistical Foundation** (10%)
Concept of Random Variable. Measures of Central Tendency and Dispersion. Sampling Process.- Advantages and Disadvantages. Basics of Probability Theory. Probability Distributions – Normal Distribution, Binomial Distribution and Poisson Distribution along with their respective tables.
4. **Statistical Quality Control** (25%)
Meaning and importance of SQC. Inherent and Assignable sources of Quality Variations. Control Charts for Variables - \bar{X} and R charts. Control Charts for Attributes – p, np and c charts. Process Capability Analysis – Determination of Statistical Tolerance Limits. Different possibilities of statistically capable and incapable process. Process Capability Indices – C_p and C_{pk}
5. **Acceptance Sampling** (20%)
Concept of Acceptance Sampling and comparison with 100% inspection. Different types of Sampling Plans. Operating Characteristic (OC) Curve – Importance and Significance. Concept of Producer's Risk and Consumer's Risk. Concepts of AQL, AOQL, IQL and LTPD.
6. **Total Quality Management** (20%)
6.1 Principles of TQM: Customer Focus, Commitment by Top Management, Continuous Improvement, Quality Circles, Employee Empowerment, Principle of JIDOKA.

- 6.2 Quality Audit: Quality Audit Practices, Lead Assessor and Certification
- 6.3 Six Sigma: Statistical meaning of six sigma. System Improvement Methodology. DMAIC Cycle. Yellow Belt, Green Belt and Black Belt Certification.

7. **ISO 9000 and other Quality Standards** (5%)
Concept of Quality Standards. ISO 9000 and 14000 standards. Necessity of ISO Certification. Other Quality Standards.

List of Practical:

1. Calculation of mean and standard deviation of the quality characteristic for a given set of components.
2. Construction of \bar{X} and R chart of the quality characteristic of a given set of components
3. Construction of p chart of the quality characteristic of a given set of components
4. Construction of np chart of the quality characteristic of a given set of components
5. Construction of c chart of the quality characteristic of a given set of components
6. Construction of OC curve for a given single sampling plan.

RATIONALE

Diploma holders in mechanical engineering are responsible for controlling production and quality of the product on the shop floor as well as be responsible for production, planning and control. He is also required to supervise erection, installation and maintenance of equipment including material handling and undertake work study for better utilization of resources. He is also required to lead a team of workers and motivate them towards realization of organizational objectives. For this purpose, knowledge and skills about these topics need to be imparted to them. This subject aims at development of competencies to prepare material. Equipment and production control schedules and maintain required quality levels. In addition, it will also help in developing skills in erection, installation and testing of equipment.

Note: Weightage of each topic for external examination is given in the brackets.

DETAILED CONTENTS

1. **Management Science** 10 %
Introduction to Management – Definitions and Characteristics of Management. Leadership - Styles,, Functions and Qualities of a Leader, Manager as a Team Leader. Levels of Management. Managerial Skills – Technical, Conceptual and Human Relation skills. Scientific Management Theory (as given by F. W. Taylor). Principles of Management (as given by Henry Fayol). Functions of Management – Planning, Organizing, Directing, Controlling and Staffing. Systems Approach to Management
2. **Organization** 10 %
Introduction to Organization. The Process of Organizing. Principles of Organization. Organization Structures – Line, Functional, Line and Staff and Project Organization. Methods of Departmentalization - By Function, Process, Product and Geography. Forms of Business Ownership – Proprietorship, Partnership, Private and Public Enterprises, Cooperative Societies
3. **Productivity** 10 %
Introduction to Productivity. Types of Productivity Measurement – Concept of Aggregate Productivity. Factors affecting Productivity. Methods of Improving Productivity. Job Evaluation – different methods of Job Evaluation. Wages – Types of Wage Plans. Incentive Schemes. Merit Rating
4. **Work Study** 25 %
Introduction to Work Study. Method Study – Basic Procedure and Steps involved. Information Collection and recording Techniques in Method Study- Process Chart Symbols, Operation process Chart, Flow Process Chart, Two Handed Process

Chart, Multiple Activity Chart, Flow Process Chart, String Diagram and Travel Chart. Critical Examination. Micromotion Study – use of THERBLIGS. SIMO (Simultaneous Motion) Chart Cyclograph and Chrono Cyclo Graph. Principles of Motion Economy. Work Measurement – Basic Procedure. Techniques in Work Measurement - Time Study, calculation of Standard Time and different Allowances given. Work Sampling (basic calculation) Predetermined Motion Time System (PMTS) Standard Data and its usage. Performance Rating. Concept of Ergonomics

10 %

5. Managerial Economics

Law of Demand and Supply. Types of Industrial Assets – Current, Fixed and Intangible Assets and Investments. Liabilities of an industrial organization. Concept of Balance Sheet. Components of Costing. Concept of Depreciation .Concept of Break Even Point

10 %

6. Industrial Psychology

Introduction to Psychology. Scope of Industrial Psychology. Motivation - Maslow's Hierarchy of Needs. Human Relations and its importance in Industry. Industrial Relations – Causes of Industrial Disputes. Process of Collective bargaining – Trade Unionism. Workers Participation in Management. Salient features of Industrial Legislations like Factories Act, ESI Act, Boilers Act, Payment of Wages Act, Minimum Wages Act, Workmen Compensation Act and Apprenticeship Act

5 %

7. Human Resource Management

Importance of Human Resources in an Industry. Aims and objectives of Human Resource Management. Staff Development - Development of Human Resource Policy in an organization. Manpower Planning – Steps involved. Training – Identification of Training Need, Training Strategies and Methods

5 %

8. Industrial Safety

Importance of Industrial safety. Causes of Accidents. Safety Awareness and Safety Drills. Safety Devices. Safety Councils and their roles

10 %

9. Entrepreneurship Development

Concept of Entrepreneurship. Need for Entrepreneurship Development. Introduction to Micro, Small and Medium Enterprises (MSME). Entrepreneurial Characteristics – Risk Taking ability. Assessment of Feasibility of the business. – Technical, Economical, Financial, Managerial and Social Feasibilities. Direct and Indirect Taxes. Concept of Cash Flows – NPV and IRR methods. Project Report

5 %

10. Professional and Business Ethics

Professional Ethics. Business Ethics. Human Values for Indian Managers. Role of Professional Bodies. Corporate Social Responsibility

5.5 CNC MACHINES AND AUTOMATION

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RATIONALE

Diploma holders are required to supervise and handle specialized machines and equipment like CNC machines. For this purpose, knowledge and skills about NC machines, part programming in NC machines and tooling for CNC machines are required to be imparted for enabling them to perform above functions. This subject aims at development of knowledge and skills about CNC machines, tools, equipment and use of high tech machines for increased productivity and quality.

Note: Weightage of each topic for external examination is given in the brackets.

DETAILED CONTENTS

- 1. Introduction (12%)**
Introduction to NC, CNC & DNC, their advantages, disadvantages and applications. Basic components of CNC machines, Machine Control Unit, input devices, selection of components to be machined on CNC machines, Axis identification
- 2. Construction and Tooling (12%)**
Design features, specification of CNC machines, use of slideways, balls, rollers and coatings, motor and leadscrew, swarf removal, safety and guarding devices, various cutting tools for CNC machines, Concept of CNC tool holder, different pallet systems and automatic tool changer system.
- 3. System Devices (26%)**
Control System; Open Loop and Closed Loop System, Concept of Actuators, Transducers and Sensors, Tachometer, LVDT, opto-interrupters, potentiometers for linear and angular position, encoder and decoder and axis drives
- 4. Part Programming (18%)**
Introduction to Part programming, Basic concepts of part programming, NC words, part programming formats, simple programming for rational components, part programming using canned cycles, subroutines and do loops, tool off sets, cutter radius compensation and tool wear compensation.
- 5. Problems in CNC Machines (8%)**
Common problems in CNC machines related to mechanical, electrical and pneumatic, electronic components. Study of common problems and remedies, use of on-time fault finding diagnosis tools in CNC machines.
- 6. Automation and NC system (12%)**
Concept of automation, emerging trends in automation, automatic assembly. Overview of FMS, Group technology, CAD/CAM and CIM.

7. **Robot Technology** (12%)
Introduction to robotics, basic robot motion and its applications

LIST OF PRACTICALS (CNC MACHINES AND AUTOMATION)

1. Study of constructional detail of CNC lathe.
2. Study of constructional detail of CNC milling machine.
3. Develop a part programme for following lathe operations and make the job on CNC lathe.
 - Plain turning and facing operation
 - Taper turning operation
 - Circular interpolation.
4. Develop a part programme for the following milling operation and make the job on CNC milling
 - Plain milling
 - Slot milling
 - Contouring
 - Pocket milling
5. Preparation of work instructions for machine operator
6. Preparation of preventive maintenance schedule for CNC machine.
7. Demonstration through industrial visit for awareness of actual working of FMS in production.

5.6 MANUFACTURING TECHNOLOGY - III

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RATIONALE

Diploma holders are responsible for supervising production processes to achieve production targets and for optimal utilization of resources. For this purpose, knowledge about various machining processes and modern machining methods is required to be imparted. Hence the subject of workshop technology.

Note: Weightage of each topic for external examination is given in the brackets.

DETAILED CONTENTS

1. **Milling** (25%)
 - 1.1 Specification and working principle of milling machine
 - 1.2 Classification, brief description and applications of milling machine
 - 1.3 Main parts of column and knee type milling machine
 - 1.4 Milling machine accessories and attachment – Arbors, adaptors, collets, vices, circular table, indexing head and tail stock, vertical milling attachment
 - 1.5 Milling methods - up milling and down milling
 - 1.6 Identification of different milling cutters and work mandrels
 - 1.7 Work holding devices
 - 1.8 Milling operations – face milling, angular milling, form milling, straddle milling and gang milling.
 - 1.9 Cutting parameters
 - 1.10 Indexing on dividing heads, plain and universal dividing heads.
 - 1.11 Indexing methods: direct, Plain or simple, compound, differential and angular indexing, numerical problems on indexing. (20%)
2. **Grinding**
 - 2.1 Purpose of grinding
 - 2.2 Various elements of grinding wheel – Abrasive, Grade, structure, Bond
 - 2.3 Common wheel shapes and types of wheel – built up wheels, mounted wheels and diamond wheels. Specification of grinding wheels as per BIS.
 - 2.4 Truing, dressing, balancing and mounting of wheel.
 - 2.5 Grinding methods – Surface grinding, cylindrical grinding and centreless grinding.
 - 2.6 Grinding machine – Cylindrical grinder, surface grinder, internal grinder, centreless grinder, tool and cutter grinder.
 - 2.7 Selection of grinding wheel (5%)
3. **Gear Manufacturing and Finishing Processes**
 - 3.1 Gear hobbing
 - 3.2 Gear shaping

4. **Modern Machining Processes** (20%)
- 4.1 Mechanical Process - Ultrasonic machining (USM): Introduction, principle, process, advantages and limitations, applications
 - 4.2 Electro Chemical Processes - Electro chemical machining (ECM) - Fundamental principle, process, applications, Electro chemical Grinding (ECG) - Fundamental principle, process, application
 - 4.3 Electrical Discharge Machining (EDM) - Introduction, basic EDM circuit, Principle, metal removing rate, dielectric fluid, applications
 - 4.4 Laser beam machining (LBM) - Introduction, machining process and applications
 - 4.5 Electro beam machining (EBM)- Introduction, principle, process and applications
5. **Presses and press tools** (10%)
- 5.1 Types of presses, their applications, types of press operations.
 - 5.2 Types of dies
 - 5.3 Types of die sets
 - 5.4 Punches
 - 5.5 Pads
 - 5.6 Die clearance
 - 5.7 Stripper plates
 - 5.8 Stops
 - 5.9 Pilots
6. **Metal Finishing Processes** (20%)
- 6.1 Purpose of finishing surfaces.
 - 6.2 Surface roughness-Definition and units
 - 6.3 Honing Process, its applications
 - 6.4 Description of hones.
 - 6.5 Brief idea of honing machines.
 - 6.6 Lapping process, its applications.
 - 6.7 Description of lapping compounds and tools.
 - 6.8 Brief idea of lapping machines.
 - 6.9 Super finishing process, its applications.
 - 6.10 Polishing
 - 6.11 Buffing
 - 6.12 Concept of electroplating, galvanizing, powder coating

5.7 WORKSHOP PRACTICE - V

RATIONALE:

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Workshop Practice is included in the curriculum to provide practice on use of different tools and various manufacturing practices. The other objectives of this subject are to develop awareness about safety at work place and ability to work in a team.

DETAILED CONTENTS

General introduction to tools, equipments & machinery used in advance turning shop, machine shop, grinding shop, press & sheet metal shop along with safety precautions.

ADVANCE TURNING SHOP

1. Exercises on external turning of various types on lathe.
2. Exercise of boring with the help of boring bar on lathe.
3. Exercises on internal threading on lathe.

MACHINE SHOP

1. Produce a rectangular block using a Milling Machine with a side and face cutter
2. Prepare a 'V'- slot on a face using Milling Machine
3. Exercise on Milling Machine with the help of a form cutter

GRINDING SHOP

1. Prepare a Job on surface grinding machine
2. Prepare a job on cylindrical grinding machine.
3. Exercise on dressing a grinding wheel.

PRESS & SHEET METAL SHOP

1. Exercise in presswork on sheet metal components using a fly press.
2. Exercises in cold working operations on sheet metal cutting, punching, bending, embossing, coining and blanking by using Power Press.
3. Exercises involving use of dies in fabrication of sheet metal parts by power press

ADVANCE FITTING SHOP

1. Radius fitting in mild steel
2. Pipe threading with die

Note:

- * An experts may be invited from an industry to deliver expert lecturer.
- ** Relevant industrial visit may be planned.
- *** Making a record of exercises/ job completed by the students is a part of the Work for internal evaluation.