

## 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.

### DETAILED CONTENTS THEORY

1. Simple Mechanisms (08 hrs)
  - 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 (16 hrs)
  - 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 (10 hrs)
  - 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 (12 hrs)
  - 4.1 Principal of governor
  - 4.2 Simple description and working of Watt, Porter and Hartnel governor (simple numericals based on watt governor)
  - 4.3 Hunting, isochronism, stability, sensitiveness of a governor

5. Balancing (08 hrs)

- 5.1 Concept 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 (10 hrs)

- 6.1 Concept of vibrations and its types - longitudinal, transverse and torsional vibrations (simple numericals)
- 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.

### RECOMMENDED BOOKS

- 1. Theory of Machines by D.R. Malhotra; Satya Prakashan, New Delhi.
- 2. Theory of Machines by V.P Singh; Dhanpat Rai and Sons, New Delhi.
- 3. Theory of Machines by Jagdish Lal; Metropolitan Publishers, New Delhi.
- 4. Theory of Machines by R.C. Jindal; North Publications.

### SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1	8	12
2	16	26
3	10	15
4	12	20
5	8	12
6	10	15
<b>Total</b>	<b>64</b>	<b>100</b>

## 5.2 REFRIGERATION AND AIR CONDITIONING

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### RATIONALE

The diploma holders of Mechanical Engineering are responsible for supervising and maintenance of RAC system. Moreover, RAC industry is expanding and employment opportunities in this field are good. For this purpose, the knowledge and skill covering basic principles of refrigeration and air conditioning is required to be imparted to the students.

### DETAILED CONTENTS

#### REFRIGERATION

1. Fundamentals of Refrigeration (06 hrs)  
Introduction to refrigeration, and air conditioning, meaning of refrigerating effect, units of refrigeration, COP, methods of refrigeration. Introduction to air refrigerator working on reversed carnot cycle.
2. Vapour Compression System (12 hrs)  
Introduction, principle, function, parts and necessity of vapour compression system, T-  $\phi$  and p- H charts, dry, wet and superheated compression. Effect of sub cooling, super heating, mass flow rate, entropy, enthalpy, work done, Refrigerating effect and COP. actual vapour compression system
3. Refrigerants (06 hrs)  
Functions, classification of refrigerants, properties of R - 717, R – 22, R–134 (a) and CO<sub>2</sub>. Properties of ideal refrigerant, selection of refrigerant
4. Vapour Absorption System (06 hrs)  
Introduction, principle and working of simple absorption system and domestic electrolyx refrigeration systems. Solar power refrigeration system, advantages and disadvantages of solar power refrigeration system over vapour compression system.
5. Refrigeration Equipment (14 hrs)
  - 5.1 Compressor - Function, various types of compressors
  - 5.2 Condenser - Function, various types of condensers
  - 5.3 Evaporator - Function, types of evaporators
  - 5.4 Expansion Valve - Function, various types such as capillary tube, thermostatic expansion valve, low side and high side float valves, application of various expansion valves
  - 5.5 Safety Devices-Thermostat, overload protector LP, HP cut out switch.

## **AIR CONDITIONING**

6. Psychrometry (08 hrs)  
Definition, importance, specific humidity, relative humidity, degree of saturation, DBT, WBT, DPT, sensible heat, latent heat, Total enthalpy of air. Psychrometry chart and various processes of psychrometry
7. Air-Conditioner (12 hrs)  
Study of window air-conditioning, split type air conditioning, concept of central air-condition, automobile air-conditioning

## **LIST OF PRACTICALS**

1. Identify various tools of refrigeration kit and practice in cutting, bending, flaring, swaging and brazing of tubes.
2. Study of thermostatic switch, LP/HP cut out overload protector filters, strainers and filter driers.
3. Identify various parts of a refrigerator and window air conditioner.
4. To find COP of Refrigeration system
5. To detect trouble/faults in a refrigerator/window type air conditioner
6. Charging of a refrigerator/window type air conditioner.
7. Study of cut section of single cylinder compressor
8. Visit to an ice plant, cold storage plant, central air conditioning plant

## **INSTRUCTIONAL STRATEGY**

1. Teachers should take the students to industry and explain the details of refrigeration and air-conditioning systems and their components.
2. While imparting instructions, focus should be on conceptual understanding.
3. Training slides of “Carrier Fundamentals of Refrigeration Air Conditioning” to be shown to students.

## RECOMMENDED BOOKS

1. Refrigeration and Air Conditioning by Domkundwar; Dhanpat Rai and Sons, Delhi.
2. Refrigeration and Air Conditioning by CP Arora; Tata McGraw Hill, New Delhi.
3. Refrigeration and Air Conditioning by R.S Khurmi and J.K. Gupta; S Chand and Company Limited, New Delhi.

## SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1	06	10
2	12	20
3	06	10
4	06	10
5	14	20
6	08	12
7	12	18
<b>Total</b>	<b>64</b>	<b>100</b>

### 5.3 EMPLOYABILITY SKILLS – I

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#### RATIONALE

The present day world requires professionals who are not only well qualified and competent but also possess good communication skills. Our diploma students not only need to possess subject related knowledge but also soft skills to get good jobs or to rise steadily at their work place. The objective of this subject is to prepare students for employability in job market and survive in cut throat competition among professionals.

#### DETAILED CONTENTS\

1. Writing skills (08 hrs)
  - i) Official and business correspondence
  - ii) Job application - covering letter and resume
  - iii) Report writing - key features and kinds
2. Oral Communication Skills (20 hrs)
  - i) Giving advice
  - ii) Making comparisons
  - iii) Agreeing and disagreeing
  - iv) Taking turns in conversation
  - v) Fixing and cancelling appointments
3. Generic Skills (04 hrs)
  - i) Stress management
  - ii) Time management
  - iii) Negotiations and conflict resolution
  - iv) Team work and leadership qualities

## 5.4 ENVIRONMENTAL EDUCATION

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### RATIONALE

A diploma holder must have knowledge of different types of pollution caused due to industries and constructional activities so that he may help in balancing the eco system and controlling pollution by pollution control measures. He should also be aware of environmental laws related to the control of pollution.

### DETAILED CONTENTS

1. Definition, Scope and Importance of Environmental Education (02 hrs)
2. Basics of ecology, biodiversity, eco system and sustainable development (03 hrs)
3. Sources of pollution - natural and manmade, causes, effects and control measures of pollution (air, water, noise, soil, radioactive and nuclear) and their units of measurement (12 hrs)
4. Solid waste management – Causes, effects and control measures of urban and industrial waste (06 hrs)
5. Mining and deforestation – Causes, effects and control measures (04 hrs)
6. Environmental Legislation - Water (prevention and control of pollution) Act 1974, Air (Prevention and Control of Pollution) Act 1981 and Environmental Protection Act 1986, Role and Function of State Pollution Control Board, Environmental Impact Assessment (EIA) (10 hrs)
7. Role of Non-conventional Energy Resources (Solar Energy, Wind Energy, Bio Energy, Hydro Energy) (04 hrs)
8. Current Issues in Environmental Pollution – Global Warming, Green House Effect, Depletion of Ozone Layer, Recycling of Material, Environmental Ethics, Rain Water Harvesting, Maintenance of Groundwater, Acid Rain, Carbon Credits. (07 hrs)

### INSTRUCTIONAL STRATEGY

In addition, different activities pertaining to Environmental Education like expert lectures, seminar and awareness camps etc. may also be organized.

## RECOMMENDED BOOKS

1. Environmental and Pollution Awareness by Sharma BR; Satya Prakashan, New Delhi.
2. Environmental Protection Law and Policy in India by Thakur Kailash; Deep and Deep Publications, New Delhi.
3. Environmental Engineering and Management by Suresh K Dhamija; SK Kataria and Sons, New Delhi.
4. Environmental Science by Deswal and Deswal; Dhanpat Rai and Co. (P) Ltd. Delhi.
5. Engineering Chemistry by Jain and Jain; Dhanpat Rai and Co. (P) Ltd. Delhi.
6. Environmental Studies by Erach Bharucha; UGC University Press
7. Basic Environmental Engineering by R.C. Gaur; New Age International Publishers, New Delhi.

## SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted for Lectures (Periods)	Marks Allotted (%)
1	02	04
2	03	06
3	12	24
4	06	12
5	04	10
6	10	20
7	04	10
8	07	14
<b>Total</b>	<b>48</b>	<b>100</b>



## 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.

### DETAILED CONTENTS

1. Introduction (06 hrs)  
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 (06 Hrs)  
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, management of a tool room.
3. System Devices (12 Hrs)  
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 (08 Hrs)  
Introduction to Part programming, Basic concepts of part programming, NC words, part programming formats, simple programming for rational components, part programming using coned cycles, subroutines and do loops, tool off sets, cutter radius compensation and tool wear compensation.
5. Problems in CNC Machines (04 Hrs)  
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 (06 Hrs)

Concept of automation, emerging trends in automation, automatic assembly. Overview of FMS, Group technology, CAD/CAM and CIM.

7. Robot Technology (06 hrs)

Introduction to robot technology, basic robot motion and its applications

### **LIST OF PRACTICALS**

1. Study of constructional detail of CNC lathe.
2. Study of constructional detail of CNC milling machine.
3. Study the constructional details and working of Automatic tool changer and Multiple pallets
4. 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.
5. Develop a part programme for the following milling operation and make the job on CNC milling
  - Plain milling
  - Slot milling
  - Contouring
  - Pocket milling
6. Preparation of work instructions for machine operator
7. Preparation of preventive maintenance schedule for CNC machine.
8. Demonstration through industrial visit for awareness of actual working of FMS in production.

### **INSTRUCTIONAL STRATEGY**

This is highly practice-based course. Efforts should be made to develop programming skills amongst the students. During practice work, it should be ensured that students get opportunity to individually perform practical tasks.

## RECOMMENDED BOOKS

1. CNC Machines – Programming and Applications by M Adithan and BS Pabla; New Age International (P) Ltd., Delhi.
2. CNC Machines by M.S. Sehrawat and J.S. Narang; Dhanpat Rai and Co., New Delhi.
3. Computer Aided Manufacturing by Rao, Kundra and Tiwari; Tata Mc Graw Hill, New Delhi.
4. CNC Machine by Bharaj; Satya Publications, New Delhi.

## SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1	06	12
2	06	12
3	12	26
4	08	18
5	04	08
6	06	12
7	06	12
<b>Total</b>	<b>48</b>	<b>100</b>

## 5.6 WORKSHOP 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.

### DETAILED CONTENTS

1. Milling (12 hrs)
  - 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.
  
- 2 Grinding (12 hrs)
  - 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

3. Gear Manufacturing and Finishing Processes (02 hrs)
  - 3.1 Gear hobbing
  - 3.2 Gear shaping
  
4. Modern Machining Processes (08 hrs)
  - 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. Metallic Coating Processes (02 hrs)
  - 5.1 Metal spraying – Wire process, powder process, applications
  - 5.2 Powder coating
  
6. Metal Finishing Processes (12 hrs)
  - 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

## **INSTRUCTIONAL STRATEGY**

1. Teachers should lay special emphasis in making the students conversant with concepts, principles, procedures and practices related to various manufacturing processes.
2. Focus should be laid in preparing jobs using various machines/equipment in the workshop.
3. Use of audio-visual aids/video films should be made to show specialized operations.

## RECOMMENDED BOOKS

1. Manufacturing Technology by Rao; Tata McGraw Hill Publishers, New Delhi.
2. Workshop Technology Vol. I, II, III by Chapman; Standard Publishers Distributors, New Delhi.
3. Production Technology by HMT; Tata McGraw Publishers, New Delhi.
4. Production Engineering and Science by Pandey and Singh; Standard Publishers Distributors, New Delhi.
5. Modern Machining Processes by Pandey; Tata McGraw Publishers, New Delhi.
6. A Text Book of Production Engineering by P.C. Sharma; S. Chand and Company Ltd., New Delhi.
7. Workshop Technology Vol-III, by R.P. Dhiman, Ishan Publications Jalandhar

## SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1	12	25
2	12	25
3	02	05
4	08	15
5	02	05
6	12	25
<b>Total</b>	<b>48</b>	<b>100</b>

## 5.7 WORKSHOP PRACTICE - III

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### **RATIONALE**

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**

#### **Advance Turning Shop**

1. Exercise of boring with the help of boring bar
2. Exercises on internal turning on lathe machine
3. Exercises on internal threading on lathe machine
4. Exercises on external turning on lathe machine
5. Resharpener of single point cutting tool with given geometry

#### **Machine Shop**

1. Produce a rectangular slot on one face with a sharper
2. Produce a rectangular block using a milling machine with a side and face cutter
3. Prepare a slot on one face using milling machine
4. Job on grinding machine using a surface grinder
5. Prepare a job on cylindrical grinding machine.
6. Exercise on milling machine with the help of a form cutter
7. Exercise on milling machine to produce a spur gear
8. Grinding a drill-bit on tool and cutter grinder
9. Exercise on dressing a grinding wheel

## 5.8 COMPUTER AIDED DRAFTING

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### RATIONALE

Computer aided drafting these days is extensively being used in the industry. This subject has been added to enable a diploma holder to make drawings using computer software and take prints/plots.

### PRACTICE WORK

1. Introduction to AutoCAD : Starting up, practice on – how to create a new drawing file, setting drawing limits & saving a file, drawing lines in different ways using absolute co-ordinates, user co-ordinates, WCS, UCS, drawing circles, drawing arcs, drawing ellipses. Drawing polygons, drawings splines. Drawing polylines, using window, zoom commands.
2. Practice on Edit commands such as erase, copy, mirror, array, offset, rotate, oops, undo, redo, scale, stretch, trim, break, extend, chamfer, fillet, O snap command
3. Practice on Text commands: editing text, text size, text styles, change properties commands.
4. Practice on Layer Commands: creating layer, freeze, layer on/off colour assigning, current layer, load line type, lock & unlock layer, move from one layer to other.
5. Practice on Hatching, Hatch pattern selection.
6. Practice on Dimensioning, linear dimensioning, angular dimensioning radius/.diameter dimensioning O-snap command, aligned dimensioning, editing of dimensioning, tolerances in dimensioning.
7. Practice on print/plot commands. Export/import commands.
8. Practice on making complete drawings of components by doing following exercises:
  - a) Detail and assembly drawing of the following using AUTOCAD (2D) (4 sheets)
    - Plummer Block
    - Wall Bracket
    - Stepped pulley, V-belt pulley
    - Flanged coupling
    - Machine tool Holder (Three views)
    - Screw jack or knuckle joint



- b) Isometric Drawing by CAD using Auto CAD (one sheet)

Drawings of following on computer:

- Cone
- Cylinder
- Isometric view of objects

9. Modelling (02 sheets)

3D modelling, Transformations, scaling, rotation, translation

10. Creating Chamfer and Fillet

Practice on surface modeling, create part file, practice on assembly of parts, creating assembly view, orthographic views, section view ( Practice on different views, practice on data transfer)

11. Introduction to Other Softwares;

(Pro Engineer/CATIA / Inventor/Unigraphics/Solid Work: Salient features.

## **INSTRUCTIONAL STRATEGY**

1. Teachers should show model or realia of the component/part whose drawing is to be made.
2. Emphasis should be given on cleanliness, dimensioning, & layout of sheet.
3. Teachers should ensure use of IS codes related to drawing.

## **RECOMMENDED BOOKS**

1. Engineering Drawing with AutoCAD 2000 by T. Jeyapooran; Vikas Publishing House, Delhi.
2. AutoCAD for Engineering Drawing Made Easy by P. Nageswara Rao; Tata McGraw Hill, New Delhi.
3. AutoCAD 2000 for you by Umesh Shettigar and Abdul Khader; Janatha Publishers, Udupi.
4. Auto CAD 2000 by Ajit Singh, TMH, New Delhi.