

## 5.1 DYNAMICS OF MACHINES

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### RATIONALE

Diploma holder in Mechanical Engineering comes across many machines. He must have the knowledge of various mechanisms, power transmission devices, balancing of masses, vibrations etc. Hence this subject is offered.

### DETAILED CONTENTS

#### 1. Basic Concepts

(10Periods)

- 1.1 Definition of statics, dynamics, kinetics, and kinematics
- 1.2 Rigid body and resistant body.
- 1.3 Links, its classification, Kinematics chain and their types
- 1.4 Kinematics pairs and its classification.
- 1.5 Mechanism. Machine, Structure & Inversion
- 1.6 Degree of freedom, Types of joints
- 1.7 Constrained motion, and its classification.
- 1.8 Classification of mechanisms.
- 1.9 Four bar chain and its inversion
- 1.10 Single slider crank chain and its inversions.

#### 2. Flywheel

(12Periods)

- 2.1 Turning moment diagram plotting and its purpose
- 2.2 Turning moment diagram for single cylinder single acting steam engine
- 2.4 Fluctuation of energy & fluctuation of speed of Flywheel
- 2.5 Applications of fly wheel.
- 2.6 Types of fly wheels.
- 2.7 Mass and size calculations in different cases

### **3. Governors**

**(12Periods)**

3.1 Functions of governor

3.2 Classification of governors - elementary knowledge of porter governor, Watt governor, Proell governor, Porter governor

3.3 Terminology used in governors

3.4 Governor effort and power

3.5 Hunting, isochronism, stability, sensitiveness of a governor

3.7 **Simple problems** related to watt, porter and proell governor.

3.8 **applications of governors**

### **4. Cams**

**(12Periods)**

4.1 Definition of cam

4.2 Classification of cams

4.3 Followers and their classification

4.4 Applications of cam

4.5 Basic definition related to cams

4.6 Construction of displacement diagram of follower performing uniform velocity.

4.7 Construction of displacement diagram of follower performing SHM

4.8 Construction of displacement diagram of follower performing uniform acceleration and deceleration

4.9 Simple cam profile for uniform velocity, SHM and uniform acceleration and deceleration

### **5. Power Transmission Devices (Belt, Rope and Chain Drive)**

**(12Periods)**

5.1 Introduction.

5.2 Belt, Rope and Chain drives

5.3 Material for Belt, and Rope

5.4 Open and crossed belt drives, action of belt on pulleys, velocity ratio.

1. 5 Slip and Creep in belts,

5.7 Length of belt in case of open and cross belt

5.8 Ratio of tensions in case of flat and V belt

5.9 Power transmitted and maximum power transmitted by belt

5.10 Centrifugal force and its effect on belt tension

5.11 Initial tension and its effect on the transmission of maximum

5.12 Simple problems on power transmitted by belts and ropes

## **6. Gear Drive**

**(12 Periods)**

6.1 Functions of gear

6.2 Classification of gears and Gear material

6.3 Gear nomenclature

6.5 Simple, compound, reverted and epicyclic gear train

6.6 Horsepower transmitted by a gear train

6.7 Selection of gear trains- simple and epicyclic

## **7. Brakes and Dynamometers**

**(10 Periods)**

7.1 Introduction and Classification of brakes

7.2 Brief description of different types of Mechanical Brake such as block or shoe brake Simple and Differential band brake.

7.3 Definition and types of dynamometers, pony brake dynamometer, rope brake dynamometers, hydraulic dynamometer, belt transmission dynamometer.

## **8. Clutches**

**(08 Periods)**

8.1 Function of clutch

8.2 Classification of clutches

8.3 Principle of working of Single Disc clutch and Cone clutch with simple line diagram

8.4 Principle of working of Multi plate clutch and Centrifugal clutch

## **9. Balancing**

**(12 Periods)**

9.1 Need of balancing

9.2 Concept of static and dynamic balancing

9.3 Forces due to revolving masses

9.4 Balancing of single rotating mass by single mass in the same plane

9.5 Balancing of single rotating mass by two masses in the different plane

9.6 Concept of reference plane

9.7 Balancing of several masses rotating in same plane

9.8 Balancing of several masses rotating in different planes

## INSTRUCTIONAL STRATEGY

- Use teaching aids for classroom teaching.
- Give assignments for solving numerical problems.
- 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.
- Video films may be used to explain the working of mechanisms and machine components like clutch, governors, brake etc.

## RECOMMENDED BOOKS

1. Mechanism and Machine Theory; JS Rao and Dukkipati; Wiley Eastern, New Delhi.
2. Theory of Mechanism and Machine; A Ghosh and AK Malik, East West Press (Pvt.) Ltd., New Delhi.
3. Theory of Machines; SS Rattan: Tata McGraw Hill, New Delhi.
4. Theory of Machines by RS Khurmi and JK Gupta; S.Chand and Company Ltd., New Delhi.
5. Theory of Machines and Mechanisms by PL Ballaney; Khanna Publishers, New Delhi.

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## SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted ( Periods )	Marks Allotted (%)
1	09	10
2	12	12
3	12	12
4	12	12
5	12	12
6	12	12
7	06	10
8	06	08
9	15	12
<b>Total</b>	<b>96</b>	<b>100</b>

## 5.2 POWER PLANT ENGINEERING

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### RATIONALE

A diploma holder in mechanical engineering is supposed to manage the power generating plant. In Uttarakhand state, hydropower potential is supposed to be very large. Therefore, he must have relevant knowledge and skills about various power plants e.g. steam power plant, nuclear power plant, hydro power plant, diesel engine power plant and gas turbine power plant. Hence this subject is offered.

### DETAILED CONTENTS

#### 1. Introduction

(08 Periods)

Sources of energy fuels, flowing stream of water, solar rays, wind, terrestrial heat, ocean tides and waves Concept of power station, central and industrial power station, captive power station, classification of power station with respect to prime mover steam, IC engine, gas turbine and hydro power station, scope in Uttaranchal state

#### 2. Steam Power Plant

(12 Periods)

2.1 Parameters of power cycle- thermal efficiency, work ratio, specific steam Consumption Rankine cycle flow diagram, representation on thermodynamic planes, thermal efficiency, effect on change of condenser pressure, boiler pressure, degree of super heat on thermal efficiency Reheat cycle, simple regenerative cycle, STEAM GENERATOR – FUNCTIONS, CLASSIFICATION & SELECTION (No numerical)

#### 2.2 Steam prime movers

Concept of a prime mover, steam turbine- advantages as a prime mover, principle elements of a steam turbine .Governing of steam turbines- classification of steam turbines Starting and stopping procedures for turbines, precautions during running Performance of steam turbine, Thermal efficiency, efficiency ratio, mechanical efficiency, steam rate (No numerical)

### **2.3 Steam Condensing Equipment**

Functions of condensers, classification, surface condenser components and their functions Condenser auxiliaries- hot well, condensate pump, vacuum pump, air ejector, circulating pump, atmospheric relief valve Requirement of a good condensing system Cooling towers-purpose and types

### **3. Nuclear Power Plant**

**(12 Periods)**

Atomic structure of matter, nomenclature, atomic nuclear reactions- fission, fusion, mass defect, binding energy, chain reaction, types of nuclear materials, fissile and fertile materials Nuclear reactors-elements and functions of different reactors, **(DIFFERENT TYPES OF REACTORS VIZ. BWR, PWR, FBR)**, advantages and disadvantages and Comparison of nuclear power station with a steam power station Health hazards, safety precautions

### **4. Diesel Engine Power Plant**

**(10 Periods)**

Advantages and disadvantages of diesel engine. Essential elements of diesel power plant. Fuel injection system performance, testing of diesel engine power plant

### **5. Gas Turbine Power Plant**

**(10 Periods)**

Brayton cycle- schematic diagram, thermal efficiency. Advantages of gas turbines over diesel engines. Classification of gas turbines, advantages and disadvantages methods of improving thermal efficiency, Important parts and their functions, Essential auxiliaries and controls for gas turbine power plant. Fuel for gas turbines

### **6. Hydro Power**

**(12 Periods)**

Advantages, basic elements, dams, head works, water turbines, classification of water turbines, speed and pressure control, plant auxiliaries, plant operation, potential in Uttarakhand state, detailed working

### **INSTRUCTIONAL STRATEGY**

Treatment of the subject will be subjected to analysis and examples. One visit to Power plant station is compulsory.

The student will visit to different power plant station and prepare a report. The Evaluation of internal and external marks will be based on report as well as viva-voice.

**RECOMMENDED BOOKS**

1. A course in Power Plant Engineering by S. Domkundwar & Arora; Dhanpat Rai and sons
2. Power Plant Engineering by G.B.S Narang
3. Power plant engineering by G.R. Nagpal; S.K. Khanna Publishers, Delhi

**SUGGESTED DISTRIBUTION OF MARKS**

<b>Topic No.</b>	<b>Time allotted (Period)</b>	<b>Marks Allotted (%)</b>
1	08	10
2	12	30
3	12	20
4	10	10
5	10	10
6	12	20
<b>Total</b>	<b>64</b>	<b>100</b>

## 5.3 Production Management

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**Rationale:** After studying the subject of production management, the students will be able to know the basics of production planning and control, industrial engineering, and estimation and costing. This will enable them to understand and handle production environment effectively.

### 1. Introduction (12 Periods)

Production management defined, history of development, functions of PM, scope & applications of PM, advantages- disadvantages.

### 2. Production and Productivity (13 Periods)

Production, production functions, productivity, factors affecting productivity, measurement of productivity, causes of decrease in productivity, difference between production and productivity.

### 3. Plant Location, Layout and Material Handling (16 Periods)

Plant location, factors affecting plant location, concept of plant layout, types of layout, their characteristics, factors affecting plant layout, work station design, factors considered while designing a work station, introduction, need and objective of material handling, factors considered while selecting a material handling device, safety concept of material handling equipment.

### 4. Work Study (13 Periods)

Definition and scope of work study; areas of application of work study in industry, Role of work study in improving productivity, Objectives, needs and methods of method study, information collection, recording techniques, process symbols, charts and diagrams, critical examination, development, installation and maintenance of improved methods, work measurement objectives, needs and methods of work measurement, time study, various allowances, calculation of time, work sampling, standard data and its use. Application of engineered time standards and work sampling, Ergonomics, concept and advantages.

### 5. Production Planning and Control (16 Periods)

Introduction, objectives and components (functions) of P.P.C, Advantages of production planning and Production Control, stages of P.P.C, process planning, routing, scheduling, dispatching and follow up, routing purpose, route sheets, scheduling – purpose, machine loading chart, Gantt chart, dispatching – purpose, and procedure, follow up – purpose and procedure. Production Control in job order, batch type and continuous type of productions. Difference between these controls.

### 6. Inspection and Quality Control (13 Periods)

Definitions, types of inspection and procedure, Quality, Quality control, Statistical quality control, Process capability, Control charts for variables - X and R chart, control chart, for fraction defectives (P chart), control chart for number of defects (C chart), Concept of ISO 9000, ISO 14000 and TQM, Quality Circles.

### **INSTRUCTIONAL STRATEGY**

Teacher should put emphasis on giving practical problems related to plant location and plant layout. Students should be taken to industrial units to give an exposure of production environment, plant layout and material handling. Live problems may be given to students to carry out case studies in teams under the guidance of teacher.

### **RECOMMENDED BOOKS**

6. Industrial Engineering by O.P. Khanna; Dhanpat Rai and Sons, New Delhi.
7. Industrial Engineering by S.C. Sharma; Khanna Publisher.
8. Industrial Engineering and Management by T.R. Banga.
9. Elements of work study by Suresh Dalela.
10. Production Management by Jain and Aggarwal.

### **SUGGESTED DISTRIBUTION OF MARKS**

<b>Topic No.</b>	<b>Time Allotted (Periods)</b>	<b>Marks Allotted (%)</b>
1.	16	10
2.	16	15
3.	16	15
4.	16	15
5.	16	15
6.	16	15
<b>Total</b>	<b>96</b>	<b>100</b>

## 5.4 CNC MACHINES AND AUTOMATION

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**Rationale:** Computer-aided manufacturing is the use of computer software to control machine tools and related machinery in the manufacturing of work pieces. NC and CAM may also refer to the use of a computer to assist in all operations of a manufacturing plant, including planning, management, transportation and storage.

**Course objective :**Its primary purpose is to create a faster production process and components and tooling with more precise dimensions and material consistency, which in some cases, uses only the required amount of raw material (thus minimizing waste), while simultaneously reducing energy consumption.

**Syllabus:**

**UNIT-1: (08Periods)**

**Automation**

Introduction to CAM, Automated Manufacturing system, Need of automation, Basic elements of automation, Levels of automation, Automation Strategies, Advantages & disadvantages of automation, Historical development and future trends.

**(INTRODUCTION) of NC Machines-**

Fundamental of Numerical Control, elements of NC machine tools, classification of NC machine tools, **Axis orientation system of NC Machines.** Advantages, suitability and limitations of NC machine tools, Application of NC system, **DNC & BTR (behind tape reader), BINARY NUMBER SYSTEM (ADDITION & SUBTRACTION)**

**UNIT-2: (12 Periods)**

**NC Part Programming & Common Problems in CNC Machines**

Part programming and basic concepts of part programming, NC words, part programming formats, simple programming for rotational components, Common problems in mechanical, electrical, pneumatic, electronic and PC components of CNC machines.

### **UNIT-3: System Devices**

**(12 Periods)**

Introduction to DC motors, stepping motors, SLIDE WAYS, PALLETS, TOOL MAGAZINES, SWARF REMOVAL SYSTEM.

#### **Control of NC Systems**

Open and closed loops, Control of point to point systems, Incremental open loop control, Incremental close loop, Absolute close loop, Control loop in contouring systems, Adaptive control and it's types.

### **UNIT-4: Computer Integrated Manufacturing system**

**(08 Periods)**

Group Technology, Flexible Manufacturing System, CIM, CAD/CAM, Computer aided process planning-Retrieval and Generative, Computer aided Inspection.

### **UNIT-5: Robotics and Intelligent Manufacturing**

**(08Periods)**

Types and generations of Robots, Structure and operation of Robot, Robot applications, Economics, Robot programming methods.

Introduction to Artificial Intelligence for Intelligent manufacturing.

#### **List of Practical**

4. To study the basic feature and operation of NC, CNC machine & Study the constructional details of CNC lathe , working of following ,tool changer and tool setter ,Multiple pallets , Safety devices.
5. To demonstrate how to program (using the computer-assisted method) and machine a simple part on the CNC lathe and Develop part programmes for following lathe operations:
  - Plain turning and facing operations
  - Taper turning operations (internal and external)
  - Thread cutting operations (internal and external)

1. To operate a CNC milling machine and become familiar with set-up, procedures and data flow.
2. To use AutoCAD to define a series of closed 2-D polygons that form initials, or other artistic creations, within a 150 x 100 mm border. To run the output data file through the Auto LISP program called “digitize.lsp”.

**Text Books:**

1. Numerical Control and Computer aided Manufacturing, By Kundra, Rao and Tewari.
2. Automation, Production Systems and Computer Integrated Manufacturing by Mikell P.Groover.
3. Computer Aided Manufacturing by Kundra and Rao.
4. Computer control of manufacturing systems by Koren.
5. NC Machine Tools by S.J. Martin.
6. NC Machines by Koren.
7. CAD/CAM by Groover.

**Reference Books:**

1. Numerical Control Machine Tool by Y. Koren and Joseph Ben Uri.
2. Computer Aided Design and Manufacture by Groover and Zimmer, PHI.
3. Technology of Computer aided Design and Manufacturing by Kumar and Jha, Dhanpat Rai and Sons
4. CNC Machines –Programming and Applications by M Adithan and BS Pabla, New Age International (P) Ltd., Delhi.
5. Computer Aided Manufacturing by Rao, Kundra and Tiwari; Tata McGraw Hill, New Delhi.
6. Numerical Control of Machines Tools by Yorem Korem and IB Uri, Khanna Publishers, New Delhi.

## INSTRUCTIONAL STRATEGY

This is a 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.

### SUGGESTED DISTRIBUTION OF MARKS

<b>Unit No.</b>	<b>Time allotted (Periods)</b>	<b>Marks Allotted (%)</b>
1	08	10
2	12	35
3	12	35
4	08	10
5	08	10
<b>Total</b>	<b>48</b>	<b>100</b>

## 5.5 Refrigeration and Air Conditioning

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### 1. Fundamentals of Refrigeration

20 Period

Introduction to refrigeration and air conditioning, units of refrigeration, meaning of refrigerating effect, compressor work, condenser work and COP, difference between COP and efficiency, methods of refrigeration, natural system and artificial system of refrigeration (Simple numerical problems)

### 2. Vapour Compression System

15 Period

Principle, function, parts and necessity of vapour compression system, T- $\phi$  and p-H charts, dry, wet and superheated compression. Sub cooling, super heating (No numerical problems)

### 3. Refrigerants

15 Period

Functions, various classification of refrigerants, properties of R - 717, R - 22, R-134 (a), CO<sub>2</sub>, R - 11, R - 12, R - 502, Properties of ideal refrigerant, selection of refrigerant

### 4. Vapour Absorption System

20 Period

Introduction, principle, NH<sub>3</sub> absorption system, lithium bromide absorption system, advantages and disadvantages of Vapour absorption system over vapour compression refrigeration system (No numerical problems)

### 5. Refrigeration Equipment

10 Period

5.1 Compressors: Function, various types of compressors

5.2 Condensers: Function, various types of condensers, essential requirements of a condenser

5.3 Evaporators: Function, DX and flooded evaporator, advantages and disadvantages, other types of evaporators

### 6. Psychrometry

08 Period

Definition, importance, specific humidity, relative humidity, degree of saturation, DBT, WBT, DPT, humid heat, latent heat, relationship amongst them.

### 7. Applied Psychrometry

08 Period

Psychrometric chart, various lines, psychrometric process, by pass factor, room sensible heat factor, effective room sensible heat factor, ADP, room DPT, supply air condition. (Simple numerical problems)

### LIST OF PRACTICALS

- To plot p-h diagram for vapour compression refrigeration system using refrigeration test rig
- To plot p-h diagram for vapour compression refrigeration system using air conditioner test rig
- Study of vapour absorption refrigeration
- To study rotary compressor

- To find relative humidity using psychrometer

### INSTRUCTIONAL STRATEGY

1. Models of various components/ parts should be demonstrated to develop comprehension amongst students
2. Industrial visit to thermal power plant and roadways/ private automobile workshop should be arranged
  1. Video films for demonstration of working of IC engines, jet propulsion and gas turbine should be shown.

### RECOMMENDED BOOKS

2. Elements of heat engines by Pandey and Shah; Charotar Publishing house, Anand
3. Thermal Engineering by PL.Ballaney; Khanna Publishers, New Delhi.
4. Engineering Thermodynamics by Francis F Huang; McMillan Publishing company, Delhi.
5. Engineering Thermodynamics by CP Arora; Tata Mc Graw Hill Publishers, New Delhi.
6. Thermal engineering by RK Purohit; Standard publishers Distributors, New Delhi.
7. Refrigeration and air conditioning by Domkundwar; Dhanpat Rai & sons, Delhi.
8. Refrigeration and air conditioning by CP Arora , Tata McGraw Hill , New Delhi.
9. 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 (Period)	Marks Allotted (%)
1.	20	20
2.	15	10
3.	15	15
4.	20	15
5.	10	15
6.	08	15
7.	08	10
<b>Total</b>	<b>96</b>	<b>100</b>