



**UTTARAKHAND BOARD OF TECHNICAL EDUCATION**  
**JOINT ENTRANCE EXAMINATION AND TRAINING, RESEARCH DEVELOPMENT CELL, DEHRADUN**  
**STUDY AND EVALUATION SCHEME FOR DIPLOMA PROGRAMME**

**BRANCH NAME – MECHANICAL ENGINEERING**

**SEMESTER – V**

Subject Code	Subject	L	T	P	T O T	EVALUATION SCHEME						Total Marks	Credit Point
						Internal		External					
						Theory Max Marks	Practical Max Marks	Theory		Practical			
								Max Marks	Hrs.	Max Marks	Hrs.		
Period/Weeks													
145003	Dynamics of Machine	6	-	-	6	40	-	80	2.5	-	-	120	6
145004	Machine Design	6	2	-	8	40	-	80	2.5	-	-	120	6
145002	Production Management	6	-	-	6	40	-	80	2.5	-	-	120	6
145001	CNC Machine and Automation	6	-	6	12	40	40	80	2.5	50	3.0	210	7
145005	Maintenance Engineering*	6	-	6	12	40	25	80	2.5	25	3.0	170	7
145052	Industrial Exposure	-	-	-	-	-	25	-	-	-	-	25	1
145053	Industrial training	-	-	-	-	-	50	-	-	160	3.0	210	1
015054	General Proficiency#	-	-	4	4	-	25	-	-	-	-	25	1
	<b>Total</b>	<b>30</b>	<b>2</b>	<b>16</b>	<b>48</b>	<b>200</b>	<b>165</b>	<b>400</b>	<b>-</b>	<b>235</b>	<b>-</b>	<b>1000</b>	<b>35</b>

\* Common with diploma courses in 3rd Sem Mechanical (Production), Production, Mechanical (Automobile) and Automobile Engineering.

\*\* Common with diploma courses in 3rd Sem Mechanical (Production), Production Engineering.

# General Proficiency will comprise of various co-curricular activities like games, hobby clubs, seminars, declamation contests, extension lectures, NCC, NSS and cultural activities, elementary mathematics, GS & G.K etc.

**Note:** 1- Each period will be 50 minutes. 2- Each session will be of 16 weeks. 3- Effective teaching will be at least 12.5 weeks.

**Branch Code - 14**



**FIFTH SEMESTER  
MECHANICAL ENGINEERING**

L	T	P
6	-	-

Subject Code : 145003

### 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 (10 Periods)

- 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. Fly Wheel (10 Periods)

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

#### 3. Governors (12 Periods)

- 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
- 3.6 Simple problems related to watt, porter and proell governor.
- 3.7 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.
- 5.5 Slip and Creep in belts,
- 5.6 Length of belt in case of open and cross belt
- 5.7 Ratio of tensions in case of flat and V belt
- 5.8 Power transmitted and maximum power transmitted by belt
- 5.9 Centrifugal force and its effect on belt tension
- 5.10 Initial tension and its effect on the transmission of maximum
- 5.11 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
- 6.4 Simple, compound, reverted and epicyclic gear train
- 6.5 Horse power transmitted by a gear train
- 6.6 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, prony 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

(10 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

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. Mechanism and Machine Theory; JS Rao and Dukkupati; 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**

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

L	T	P
6	2	-

**Subject Code : 145004**

## **RATIONALE**

This course is designed for the diploma level students for Mechanical and Automobile engineering as first course in Machine Design. The contents of this subject are organised to understand the intricacies of different engineering design aspects. This will also help the students to enhance their imagination, innovative skill, adaptability to new situation and continued learning skills for problem solving.

## **DETAILED CONTENTS**

### **1. Introduction (20 Periods)**

- 1.1 Design – Definition, Type of design, necessity of design
  - 1.1.1 Comparison of designed and undesigned work
  - 1.1.2 Design procedure
  - 1.1.3 Practical examples related with design procedure
  - 1.1.4 Characteristics of a good designer
  - 1.1.5 Characteristics of environment required for a designer
- 1.2 Design terminology: stress, strain, factor of safety, factors affecting factor of safety, stress concentration, methods to reduce stress concentration, fatigue, endurance limit. General design considerations
- 1.3 Engineering materials and their mechanical properties : Properties of engineering materials: elasticity, plasticity, malleability, ductility, toughness, hardness and resilience. Fatigue, creep, tenacity, strength

### **2. Design Failure for static loading (20 Periods)**

- 2.1 Brittle and ductile behaviour of the materials, Various design failures under static loading, causes of failure
  - 1. Maximum principal stress theory.
  - 2. Maximum shear stress theory
  - 3. Distortion Energy theory
- 2.2 Design for tensile, compressive and torsional loading
- 2.3 Design for combined torsion and bending

### **3. Design Equation for Impact loading (12 Periods)**

Examples of impact loading, stress and deflection due to impact load, selection of impact factor for minor, medium and heavy shock load

#### **4. Design for Cyclic loading**

**(10 Periods)**

Types of cyclic loading, failure of parts due to cyclic loading, design strength for cyclic loading, design equation for simple cyclic loading

#### **5. Design of Shaft**

**(20 Periods)**

5.1 Type of shaft, shaft materials, Type of loading on shaft, standard sizes of shaft available

5.2 Design of shaft subjected to torsion on the basis of:

- Strength criterion
- Rigidity criterion

5.3 Design of shaft subjected to bending

5.4 Design of shaft subjected to combined torsion and bending

#### **6. Design of Key**

**(10 Periods)**

6.1 Types of key, materials of key, functions of key

6.2 Failure of key (by Shearing and Crushing).

6.3 Design of key (Determination of key dimension)

6.4 Effect of keyway on shaft strength. (Figures and problems).

#### **7. Design of Joints**

**(20 Periods)**

Types of joints - Temporary and Permanent, utility of joints

7.1 Temporary Joint:

7.1.1 Knuckle Joints – Different parts of the joint, material used for the joint, type of knuckle Joint, design of the knuckle joint. (Figures and problems).

7.2 Permanent Joint: Welding symbols, standards and materials having high weldability.

7.2.1 Welded Joint - Type of welded joint, strength of parallel and transverse fillet welds.

7.2.2 Strength of combined parallel and transverse weld.

7.2.3 Axially loaded welded joints.

7.2.4 Riveted Joints. : Rivet materials, Rivet heads, leak proofing of riveted joint – caulking and fullering.

7.2.5 Different modes of rivet joint failure.

7.2.6 Design of riveted joint – Lap and butt, single and multi riveted joint

#### **8. Design of Flange Coupling**

**(16 Periods)**

Necessity of a coupling, advantages of a coupling, types of couplings, design of flange coupling. (both protected type and unprotected type) loads.



## INSTRUCTIONAL STRATEGY

- Use models of machine parts/components.
- Presentation should be arranged for various topics.

## REFERENCE BOOKS

- Machine Design- Fundamentals and Practices, by P C Gope, PHI Learning Pvt Limited, New Delhi. 2012
- Machine Design by R.S. Khurmi and JK Gupta; Eurasia Publishing House (Pvt.) Limited, New Delhi.
- Machine Design by Sharma and Agrawal; Katson Publishing House, Ludhiana.

## SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Periods)	Marks Allotted (%)
1	20	10
2	20	20
3	12	10
4	10	10
5	20	20
6	10	10
7	20	10
8	16	10
<b>Total</b>	<b>128</b>	<b>100</b>

L	T	P
6	-	-

**Subject Code : 145002**

### **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.

## 7. Estimation and Costing

(13 Periods)

Introduction, purpose/functions of estimating, costing concept, ladder and elements of cost, difference between estimation and costing. Over heads and their types, estimation of material cost, estimation of cost for machining processes, numerical problems.

## 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

1. Industrial Engineering by O.P. Khanna; Dhanpat Rai and Sons, New Delhi.
2. Industrial Engineering by S.C. Sharma; Khanna Publisher.
3. Industrial Engineering and Management by T.R. Banga.
4. Elements of work study by Suresh Dalela.
5. Production Management by Jain and Aggarwal.

## SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Periods)	Marks Allotted (%)
1	12	10
2	13	15
3	16	15
4	13	15
5	16	15
6	13	15
7	13	15
<b>Total</b>	<b>96</b>	<b>100</b>

<b>L</b>	<b>T</b>	<b>P</b>
<b>6</b>	<b>-</b>	<b>6</b>

**Subject Code : 145001**

### **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.

### **1. Automation**

**(08Periods)**

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.

### **2. Introduction of NC Machines-**

**(10 periods)**

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)

### **3. NC Part Programming & Common Problems in CNC Machines (20 Periods)**

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.

### **4. System Devices**

**(24 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 its types.

## 5. Computer Integrated Manufacturing system

(14 Periods)

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

## 6. Robotics and Intelligent Manufacturing

(20Periods)

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

#### NC Grinder:

1. Perform a basic surface grind to achieve a smooth, flat finish on a workpiece.
2. Grind a complex shape with precision using NC Programming.
3. Grind multiple steps or levels on a single workpiece to specified dimensions.
4. Achieve parallel and perpendicular surfaces on a workpiece with precise measurements Using NC Grinder.

#### CNC Lathe:

1. Create a CNC Lathe program to machine a simple cylindrical part with OD Turning Step Turning and facing operations.
2. Program and execute external and internal thread cutting operations.
3. Program and execute internal and external taper turning operations.
4. Generate G-code for the CNC lathe part using CAM software and simulate the machining process.

#### VMC (Vertical Machining Center):

1. Setup and perform basic CNC Milling operations using milling cutters.
2. Program and execute basic milling operations on a workpiece.
3. Develop 2-D CNC program of Standard Geometrical Shapes ( Square, Rectangular , Triangular , Circular using CNC VMC–Manual Part Programme
4. Develop 3-D CNC Programme of 3 D shapes using CNC VMC / CAM Software
5. Set up tool holders and tooling stations on a VMC, considering tool length offsets and tool change sequence.

#### EDM (Wire Cut Machine):

##### Study of EDM Machine:

- Understand the working principle of the EDM (Wire Cut) machine.
- Identify the key components and their functions.
- Observe a demonstration of the wire cut process.

**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**

Topic No.	Time allotted (Periods)	Marks Allotted (%)
1	8	10
2	10	10
3	20	20
4	24	25
5	14	15
6	20	20
<b>Total</b>	<b>96</b>	<b>100</b>

L	T	P
6	-	6

**Subject Code : 145005**

## **RATIONALE**

A diploma engineer comes across installation, maintenance, testing of various machines and equipment in industries. The layout of different machines, their foundation is in an important phenomenon of an industry. He should know the various methods of testing and maintenance. This subject will enable diploma holders to deal with such aspects.

## **DETAILED CONTENTS**

- 1. Introduction (09 Periods)**
  - 1.1 Necessity and advantages of testing, repair and maintenance
  - 1.2 Economic aspects, manpower planning and materials management
  - 1.3 Fits and tolerances – common fits and tolerances used for various machine Parts
- 2. Erection and Commissioning of Machines (Installation) (15 Periods)**
  - 2.1 Location, layout and positioning of machines
  - 2.2 Foundation – types of foundation, foundation plan, erection and leveling, grouting, vibration damping, vibration isolation – methods of isolation, anti vibration mounts.
- 3. Testing of Machines (15 Periods)**
  - 3.1 Testing equipment – dial gauge, mandrel, spirit level, straight edge, autocollimator
  - 3.2 Testing methods – geometrical/alignment test, performance test, testing under load, run test, vibrations, noise
- 4. Lubrication Systems (25 Periods)**
  - 4.1 Lubrication methods and periodical lubrication chart for various machines (daily, weekly, monthly )
  - 4.2 Handling and storage of lubricants
  - 4.3 Lubricants conditioning and disposal
  - 4.4 Lubricant needed for specific components such as gears, bearings, and chains

4.5 Purpose and procedure of changing oil periodically (like gear box oil)

**5. Repairing (12 Periods)**

5.1 Common parts which are prone to failure, reasons of failure

5.2 Repair schedule

5.3 Parts that commonly need repair such as belts, couplings, nuts, and bolts

**6. Maintenance (20 Periods)**

6.1 Definition, advantages, limitations and types of maintenance viz. preventive, breakdown, predictive

6.2 Organization of maintenance

6.3 Introduction to computerized maintenance record

6.4 ISO standards for maintenance documentation

6.5 Introduction to machine history card – purpose and advantages

6.6 Preparation of yearly plan for preventive maintenance

6.7 Need of frequently needed spare parts inventory

**LIST OF PRACTICALS**

1. Preparation of prevention maintenance check.
2. Condition monitoring by non destructive testing.
3. Case study on trouble free maintenance.
4. Project on maintenance of utility equipment like compressors, pumps, driers, valves (actuator type valves).
5. Equipment/machine leveling and alignment.
6. Maintenance of material handling equipment – pulley blocks, hand operated cranes, fork lifts, hydraulic jacks, mobile cranes, winches.
7. Use of lubrication equipment like oil gun, grease gun.
8. Removing old lubricant, cleaning and replenishing the machine with fresh lubricant.
9. Case study on computerized maintenance schedule.
10. Reconditioning of machine parts.
11. Replacing gear.
12. Replacing bearings (all types).
13. Practically making different types of fits.



## INSTRUCTIONAL STRATEGY

1. Lay greater emphasis on practical aspects of maintenance.
2. Make use of transparencies, video films and CD's.
3. Expose the students to real life situation.
4. Promote continued learning through properly planned assignments.
5. Demonstrate sample of all types of gear and bearings.

## RECOMMENDED BOOKS

1. Industrial Maintenance by HP Garg; S. Chand and Company, Delhi.
2. Plant Maintenance Engineering by RK Jain; Khanna Publishers, Delhi.
3. Installation, Servicing and Maintenance by SN Bhattacharya; S Chand and Company, Delhi.
4. Maintenance Engineering and Management by RC Mishra and K Pathak; Prentice Hall of India Pvt. Ltd., New Delhi.

## SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time allotted (Periods)	Marks Allotted (%)
1	9	10
2	15	15
3	15	15
4	25	25
5	12	15
6	20	20
<b>Total</b>	<b>96</b>	<b>100</b>