

## 5.1 Machine Element Design

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4 2 0

### 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

(08Periods)

##### 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 :

1.3.1 Properties of engineering materials: elasticity, plasticity, malleability, ductility, toughness, hardness and resilience. Fatigue, creep, tenacity, strength

1.3.2 Selection of materials, criterion of material selection, numbering systems for Cast Iron, steel, Aluminium alloys, IS/BS/ASTM standards for material specification

#### 2. Design Failure for static loading

(10 Periods)

2.1 Brittle and ductile behaviour of the materials, Various design failures under static loading, causes of failure

- Maximum principal stress theory.

- Maximum shear stress theory

- Distortion Energy theory

- Mohr's theory

- Road maps for the selection of static failure theory for ductile and brittle materials

2.2 Design for tensile, compressive and torsional loading

2.3 Design for combined torsion and bending

### **3. Design Equation for Impact loading (06Periods)**

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 (06 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 (10 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

5.5 Introduction to stepped shaft

### **6. Design of Key (06 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 (12 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).

7.1.2 Cotter Joint – Different parts of the joint, type of cotter joint –spigot and socket joint, gib and cotter joint, sleeve and cotter joint, Design of cotter 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 (06 Periods)**

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

## 9. Design of Screw, Nut, Bolt and Thread

(08 Periods)

- 9.1 Form of thread (ISO), Type of nut heads, type of threads and their nomenclature.
- 9.2 Nature of loads on nut and bolts, types of failure of nut and bolts.
- 9.3. Initial stresses due to screwing up, stresses due to combination of different loads.

### INSTRUCTIONAL STRATEGY

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

### REFERENCE BOOKS

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

### SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time allotted (Periods)	Marks Allotted (%)
1	8	10
2	10	20
3	6	05
4	6	05
5	10	20
6	6	10
7	12	10
8	6	10
9	8	10
<b>Total</b>	<b>72</b>	<b>100</b>

## 5.2 GARAGE EQUIPMENT

L T P  
Periods/week 5 0 0

### RATIONALE

Management of garages forms an important function of automobile technicians. To perform such functions, knowledge of service station equipment, tuning equipment, engine repair tools, electrical repair equipment and reconditioning and fabrication of equipment is very essential. Hence the subject.

### DETAILED CONTENTS

- 1. Hand Tools/Measuring Tools (13 periods)**  
Classification and Use of
  - Screw drivers
  - Spanners and wrenches
  - Pliers
  - Hammers
  - Chisels
  - Files
  - Hacksaw
  - Tools for tubes flaring
  - Taps and dies
  - Reamers
  - Feeler gauge
  - Cylinder dial gauge
  
- 2. General Equipment (13 periods)**  
Construction, working and application use of
  - Bench grinder
  - Air compressor
  - Hydraulic and electric hoists
  - High pressure washing equipment (Car washer)
  - Oil sprayers
  - Grease Guns-manual and bucket type, pneumatic
  - Tyre inflation gauge (Manual and Digital type automatic)
  - Fire extinguisher
  - Contents of First aid box
  
- 3. Turning and Testing Equipment (10 periods)**  
Construction, working and application use of
  - Vacuum Gauge
  - Compression Gauge (Pressure Gauge)
  - Distributor Tester cam (dwell) angle tester, r.p.m. tester.
  - Spark plug cleaner and tester
  - Ignition timing light
  - Fuel injector tester
  - Fuel consumption tester

4. **Engine Repair Tools/Measuring and Testing Equipment** (13 periods)  
Construction and use of
- Torque wrench, pneumatic wrench
  - Piston ring compressor, expander
  - Valve lifter and valve spring tester
  - Piston ring files, groove cleaner
  - Scrappers
  - Piston ring remover
  - Smokemeter
5. **Reconditioning/Testing Equipment for Chassis, Body** (10 periods)  
Construction, working and use of
- Brake Efficiency Tester (Chassis Dynamometer) or brake testing equipment
  - Jacks – mechanical, hydraulic, trolley type,
  - Creeper
  - Paint chamber
  - Paint Spray Gun
  - Paint Drying Equipment
  - Spring tester
6. **Special Tools** (10 periods)  
Construction and use of
- Ridge cutter
  - Crank shaft cutter
  - Tools for tubes flaring
  - Soldering tool
  - Nipple forming tool
  - Decarbonising kit
7. **Body Repair Tools Kit** (11 periods)  
Assorted hammers, assorted dollies, body spoons, sanders, pick tools, adjustable file, drip moulding pliers, assorted wrenches, assorted screw drivers, cold chisels, fender bleeding tool, sanders, power tools

#### **INSTRUCTIONAL STRATEGY**

Teacher should make use of audio visual aids to show features of chassis, body and transmission. Demonstration should be made in the automobile shop to explain various aspects of garage equipment.

## RECOMMENDED BOOKS

1. Automotive Mechanics by WH Crouse and Donald Anglin; Tata McGraw Hill Publishing Co. Ltd., Delhi
2. Auto Mechanics Fundamentals by MW Stockel, Goodheart Wilcox Publishers
3. Automobile Engineering Vol. I and II by Dr. Kirpal Singh; Standard Publishers, Delhi
4. Garage Equipment by G.S. Aulakh, Eagle Prakashan, Jalandhar
5. Garage Equipment by Raj Kumar, Ishan Publication, Jalandhar

## SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Periods allotted (Period)	Marks Allotted (%)
1	13	15
2	13	15
3	10	10
4	13	15
5	10	15
6	10	15
7	11	15
<b>Total</b>	<b>80</b>	<b>100</b>

## 5.3 EARTH MOVING EQUIPMENT

L T P  
Periods/week 5 0 0

### RATIONALE

A diploma holder in Automobile Engineering has to deal with repair and maintenance of heavy earthmoving vehicles. The subject provides basic understanding of such special vehicles

### DETAILED CONTENTS

- 1. Earth Moving Equipment (36 periods)**  
Function, classification, constructional features and applications of the following earth moving machinery: Excavator, scrapper, ripper, dragline, grader, shovel, trailer, loader, dozer. Equipment used - drill, ripper, crusher, feeder, compressor, snow remover. Tractor types. Difference in each type of engine used, features of clutch, power transmission, track chains, sprockets, springs and blades.  
Working principal and design considerations of different systems involved like power system, transmission system, final drive, lubrication system, electrical system, braking system, steering system and pneumatic and hydraulic control circuits of earth moving equipment
- 2. Hoisting Equipment (14 periods)**  
Description of hoist winch, part lines, hoisting chains, slings, fork-lift truck, cranes (hand operated type electric overhead travelling type), Jacks (hydraulic, mechanical), bucket elevators. Factors affecting the selection of hoisting equipment
- 3. Rollers (10 periods)**  
Types of rollers, type of engines used for rollers. Chassis, power transmission, steering, braking and other features
- 4. Pneumatic Equipment (12 periods)**  
Function and salient features of pneumatic tools-rock drill, hammer, chipper. Air operated grease gun and spray gun
- 5. Calculation of hire charges for various types of earth moving equipment (08 period)**

### INSTRUCTIONAL STRATEGY

Visits to construction sites should be organized for better understanding of concepts and principles. It is important to make use of audio-visual aids/video films to support the instructional material

## RECOMMENDED BOOKS

1. Construction Equipment & its planning & applications by Mahesh Varma, Metropolitan Book Company, New Delhi
2. Hand Book of Earth Moving Machinery by Central Water and Power Commission
3. Construction Equipment Operation and Maintenance by Y Pokras and M Tushnyakov, Mir Publishers, Moscow
4. Heavy Construction Planning Equipment & Methods by Jagman Singh, Oxford & IBH Publishing Co., New Delhi
5. Construction Equipment Operation and Maintenance by Y Pokras and M Tushnyakov, Mir Publishers, Moscow

## SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time allotted (Period)	Marks Allotted (%)
1	36	45
2	14	20
3	10	10
4	12	15
5	08	10
<b>Total</b>	<b>80</b>	<b>100</b>



## 5.4 Operations Management

L T P  
6 0 0

**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)

Operations management defined, history of development, functions of OM, scope & applications of OM, 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. Overheads 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>

## 5.5 FAULT DIAGNOSIS AND DRIVING PRACTICES

**L T P**  
**Periods/week 0 0 12**

### RATIONALE

Now, as the students have learnt about the engines, chassis, body, transmission, auto electrical and electronics systems and garage equipments, they should be able to test the various automotive parts and accessories as well as diagnosis the various problems relating to them. So emphasis is given to familiarize and practice about fault diagnosis and testing.

### DETAILED CONTENTS

1. Basic electrical checks – Battery connections, electrical bulbs and units, circuit protection devices and wiring connections
2. Testing of battery – Specific gravity test, high rate discharge test, open circuit voltage test, charging of battery
3. Testing and setting of ignition timing, cam angle
4. Testing of field winding of alternator and armature of starter motor for open circuit, short circuit and earthing
5. Engine testing and finding out fuel consumption
6. Diagnosing battery ignition system
7. Diagnosing and rectifying high oil consumption
8. Diagnosing and rectifying high fuel consumption
9. Diagnosing and rectifying engine noises and knocks
10. Diagnosing and rectifying engine starting troubles
11. Diagnosing and rectifying engine running faults
12. Diagnosing and rectifying engine overhauling
13. Measuring of bore for wear, ovality and taperness
14. Inspection of crankshaft – bearing replacement and setting of journal bearings, crank pin bearings and crank shaft bearings, measuring bearing clearances by gauges
15. Demonstration of body repair techniques

### RECOMMENDED BOOKS

1. Automobile Engineering by Dr. Kirpal Singh; Standard Publisher, Delhi
2. Automobile Engineering by Sh. R. B Gupta; Satya Prakashan, New Delhi
3. Maintenance and Repair of Motor Vehicle by H.O Geneva; Dialogue, R-686, New Rajinder Nagar, New Delhi
4. Automotive Mechanics by William H. Crouse, Tata McGraw Hill, Delhi
5. Auto Mechanics – Theory and Service by W.J Dekryger, ET Hall

## 5.6 CAD IN AUTOMOBILE ENGINEERING

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Periods/week	0	0	12

### RATIONALE

Competency in computer aided drafting is essential for diploma holders in Automobile Engineering. Hence this subject is required.

### DETAILED CONTENTS

#### 1. Introduction to AutoCAD

- 1.1 Introduction to AutoCAD. Setting the drawing environment: Limits, Grid, Snap, Axis, Units, Ortho, Co- Ordinates ON, OFF Units and Color
- 1.2 2D Drawing entities - Point - Line - Arc - circle, Ellipse, Polygon, and Trace. Object Selection using Object Snap (OSNAP)
- 1.3 Editing commands: Selection of entities by different methods - copy, Move, Scale, Rotate, Fillet, Chamfer, Mirror, Array-Polar, Rectangular. Measure, Divide, and Erase. Drawing Display Methods: Zoom, Pan, and View
- 1.4 Drawing Display Methods – Zoom, Pan, and View
- 1.5 Adding Texts and Dimensions: Text, Dimension-linear, continued, angular
- 1.6 Pedit commands. Working on multiple layers, Layer concepts in Auto CAD -Various options with layer command - Hatch command - Creating line types, library and user made library
- 1.7 Preparing the schematic drawing of a workshop building in one layer, the blocks of machines in another Layer and Electrical connection on another layer

#### 2. Drawing of 2D views of following automotive components using AutoCAD (Any Six sheets)

- V – belt pulley
- Stepped cone pulley
- Ball bearing
- Sectional front view of screw jack
- Spur gear
- Poppet valve
- Wheel cylinder (sketch)
- Valve tappet
- Piston
- Semi-elliptic leaf spring
- Internal expanding shoes brake (sketch)

#### 3. Introduction to 3D features of AutoCAD

### **INSTRUCTIONAL STATREGY**

1. Teachers should demonstrate use of AutoCAD, while teaching..
2. Emphasis should be given on dimensioning and layout of sheet.
3. Teacher should ensure use of IS Codes related to drawing.

### **RECOMMENDED BOOKS**

1. AutoCAD by Shyam Tickoo, Dream Tech. Publication, Delhi
2. Computer Aided Drafting – Auto CAD; ISTE Nomogram, Delhi