

AUTO SHOP AND GARAGE PRACTICE

CODE MA 301

L T P
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RATIONALE

This subject imparts the practical skill and knowledge related to vehicle repair and maintenance to the students. Practicals such as overhauling of different vehicle systems are kept in this subject. practicals related to special auto machines, engine reconditioning F.I. Pump calibration etc. are included in this subject. So that students gain knowledge to start their own work.

CONTENTS (PRACTICALS)

1. Study of layout of Auto shop and Garage.
2. Study and operations of the auto shop equipment.
3. Study and uses of vehicle tools.
4. Prepare measurement sheet for cylinder, piston, connecting rod and crank shaft.
5. Cylinder Liner removing and fitting, Boring the cylinder by boring machine and Lapping and honing of the cylinder.
6. Repairing of cylinder head, Refinishing of cylinder head by surface grinder and Testing for leakage.
7. Repairing of cylinder block surface, Boring of main journal, cam shaft journal by line boring machine.
8. Checking of twist and bend with the help of connecting rod alignment machine and rectifying the defects.
9. Inspection of crank shaft for bend, taper and ovality of main journal and crank pins, Grinding of crank shaft by crank shaft grinder.
10. Overhauling and testing of F.I. pump with the help of F.I. pump calibration machine.
11. Complete overhauling and Testing of injector.
12. Servicing of vehicles.
13. Inspection of brake drum, Turning of brake drum by brake drum turning machine and Complete overhaul of braking system (L.T.V. & H.T.V).
14. Complete overhaul of suspension system - (Two wheeler, L.T.V. & H.T.V).
15. Complete overhaul of clutch system (Two wheeler. L.T.V. & H.T.V).
16. Complete overhaul of gear box (Two wheeler, L.T.V. & H.T.V).
17. Complete overhaul of Propeller shaft "U" joints and Centre bearing.
18. Complete overhaul of Differential (L.T.V. & H.T.V).
19. Complete overhaul of steering system (L.T.V. & H.T.V).
20. Complete tune up of Engine by tuning equipment.
21. Driving practice of two wheeler, L.T. V & H.T. V.
22. Repairing. Servicing and testing of Radiator.

Note - Visit to Nearby Auto Workshop for conducting those practical which are not feasible in institute.

REFERENCE BOOKS :

1. Car Maintenance & Repair W. Judge
2. Diesel Fault Tracing & Maintenance Repair Staton Abbey

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PROCESSES IN MANUFACTURING

CODE MA 302
ME 302

L T P
2 -- 2

RATIONALE

Manufacturing processes are developing very fast with rapid changes in technology. This subject will provide insight to the students regarding metal forming methods, newer machining processes, jigs and fixtures. These processes are needed for modern and mass production processes. In order to create interest in the subject theory should be supplemented by visit to industries where new manufacturing processes are being used.

CONTENTS

1. Metal Forming Process :

- 1.1 Forging
 - 1.1.1 Forging process, open die forging, closed die forging (drop forging)
 - 1.1.2 Press forging, upset forging, Swaging, up setters, roll forging
 - 1.1.3 Cold and hot forging, forging defects and their remedies
- 1.2 Rolling
 - 1.2.1 Elementary theory of rolling, types of rolling mills
 - 1.2.2 Roll passes, rolling defects and remedies
- 1.3 Press forming
 - 1.3.1 Types of presses, working, selection of press dies, die material.
 - 1.3.2 Press operations - shearing piercing, trimming, punching, Notching, shaving, guering or rubber forming, embossing, stamping
 - 1.3.3 Deep Drawing
- 1.4 Extrusion
 - 1.4.1 Types of extrusion - Hot and Cold, Direct and Indirect
- 1.5 Drawing
 - 1.5.1 Pipe drawing, Tube drawing

2. Conventional Metal Cutting Processes :

- 2.1 Metal Cutting
 - 2.1.1 Elementary theory of metal cutting, chip formation, continuous chip, continuous chips with B.U.E., discontinuous chips
 - 2.1.2 Mechanism of chips formation, geometry of chip formation, forces on chip. Merchant's diagram
 - 2.1.3 Tool life, Economics of tool life
 - 2.1.4 Machinability
 - 2.1.5 Factors affecting Machinability
- 2.2 Broaching Machine :
 - 2.2.1 Classification and description of broaching machines
 - 2.2.2 Elements of broach
 - 2.2.3 Types of boraches
- 2.3 Gear manufacturing processes :
 - 2.3.1 Gears hobbing
 - 2.3.2 Gear shaping
- 2.4 Gear Finishing methods :
 - 2.4.1 Gear shaving, gear burnishing
- 2.5 External threading processes :
 - 2.5.1 Die heads, thread milling
 - 2.5.2 Thread grinding, thread rolling

3. **Newer Machining Processes :**

- 3.1 Mechanical Processes
 - 3.1.1 Ultrasonic Machining (USM) : Introduction, fundamental principles, process, advantages and Limitation, application
 - 3.1.2 Abrasive jet machining (AJM) - Introduction, principles, process, advantages and Limitation, application
- 3.2 Electro Chemical Processes
 - 3.2.1 Electro chemical machining (ECM) - Fundamental principles, process, applications
 - 3.2.2 Electro chemical grinding (ECG) - Fundamental principles, process, applications
- 3.3 Electrical Discharge Machining (EDM) -
 - 3.3.1 Introduction, mechanism of metal removal basic EDM circuit
 - 3.3.2 Principle of operation, material removing rate, dielectric fluid and applications of EDM
- 3.4 Laser beam machining (LBM) - Introduction, machining process and applications
- 3.5 Electro beam machining (EBM) - Introduction, principle processes and applications
- 3.6 Plasma arc machining (PAM) and Welding -Introduction,principle processes and applications.

4. **Metallic Coating Processes :** Metal spraying, galvanising, Electroplating and anodising.

5. **Plastic Process - Working principle, Advantages and limitation of following process :**

- 5.1 Injection moulding
- 5.2 Blow moulding
- 5.3 Compressive moulding

6. **Jigs and Fixtures :**

- 6.1 Importance and use of jigs and fixtures
- 6.2 Principle of location
- 6.3 Locating devices
- 6.4 Clamping devices
- 6.5 Types of jigs-Drilling jigs, bushes (fixed, liker, slip). Types of drilling jig - Template jigs, plate jig, channel jig, leaf jig.
- 6.6 Fixture for milling, Advantages of jigs and fixtures

PRACTICALS

- 1. Exercise on forging operation by power hammers
- 2. Study of USM.
- 3. Exercise on buffing.
- 4. Exercise on lapping.
- 5. Exercise on super finishing.
- 6. Exercises on Electro plating.
- 7. Demonstration of Engine cylinder honing with the help of honing machine through industrial visit.
- 8. Design and manufacture of one drilling jig.
- 9. Design and manufacture of one milling fixture.
- 10. Demonstration of newer machining processes / metal cutting process/ plastic process through industrial visits.

REFERENCE BOOKS :

- | | |
|---------------------------------|-------------------------------|
| 1. Production Engineering | R.K. Jain |
| 2. Manufacturing Science | Amitabha Ghosh & A.K. Mallik |
| 3. Production Technology | Pandey.Singh |
| 4. Manufacturing Technology | Gupta & Adithan |
| 5. Modern Machining Methods | M.Adithan |
| 6. Production Engineering | P.C. Sharma (S. Chand) |
| 7. Introduction to Mfg. Process | John Schely (Mc-Graw Hill) |
| 8. Metal Forming Process | G.R. Nagpal (Khanna Pub.) |
| 9. Manufacturing Process – II | Bhatnagar, Sharma (Nav Bhart) |

RATIONALE

This subject imparts the knowledge of engine fuels combustion phenomenon of various types of combustion chambers. Different modes of heat transfer and the knowledge of heat control through refrigeration and air-conditioning is also included in this subject.

CONTENTS

1. Combustion in S.I. Engine :

- 1.1 General idea of combustion theory
- 1.2 Normal combustion stages
- 1.3 Effect of engine variables on ignition lag and flame propagation.
- 1.4 Abnormal combustion
- 1.5 Theories of detonation
- 1.6 Effect of engine variables on detonation

2. S.I. Engine Combustion Chambers :

- 2.1 Basic requirements of a good combustion chamber
- 2.2 Combustion chamber design principles
- 2.3 Comparison of various types of combustion chambers with line sketches by show in the position of valves and spark plugs.
- 2.4 Description of the combustion chambers namely
 - 2.4.1 Bathtub shape
 - 2.4.2 Wedge shape
 - 2.4.3 turbulent head
 - 2.4.4 Hemispherical shape
 - 2.4.5 Recessed or cavity shapes

3. Combustion In C.I. Engines :

- 3.1 Stages of combustion
- 3.3 Delay period or ignition lag
- 3.4 Variables effecting delay period
- 3.5 Diesel knock
- 3.6 Methods of controlling diesel knock

4. C.I. Engine Combustion Chambers :

- 4.1 C.I. engine combustion chambers
- 4.2 Methods of generating air swirl
- 4.3 Induction swirl and open combustion chambers
- 4.4 Compression swirl and divided or turbulent swirl chambers
- 4.5 Combustion induced swirl and divided chambers

5. I.C. Engine Fuels :

- 5.1 Petroleum and non-petroleum base liquid fuels
- 5.2 Chemical structure of liquid petroleum fuel
- 5.3 Gaseous fuels
- 5.4 Heating value of fuels (concept only)
- 5.5 Rating of S.I. fuels
 - 5.5.1 Knock rating - octane no.
 - 5.5.2 Highest useful compression ratio (H.U.C.R.)
 - 5.5.3 Sensitivity
 - 5.5.4 Performance number
- 5.6 Flash point and fire point

6. Air Pollution by Exhaust Gases :

- 6.1 Gases exhausted by automobile vehicles.
- 6.2 Smoke and soot formation.
- 6.3 Control of pollutant, catalytic converter
- 6.4 Diesel odour and control
- 6.5 Measurement of pollution -Smoke meter and exhaust gas analyzer.

7. Refrigeration and Refrigerants :

- 7.1 Introduction, principles and applications
- 7.2 units and rating of machines
- 7.3 Classification and properties of refrigerants
- 7.4 Nomenclature of refrigerants

8. Refrigeration System :

- 8.1 Air refrigeration system - Reversed Carnot cycle, theoretical and actual.
- 8.2 Vapour Compression Cycle:
 - 8.2.1 Theoretical and actual vapour compression cycle
 - 8.2.2 Effect of sub-cooling, super heating on compression cycle
 - 8.2.3 Coefficient of performance (COP)
 - 8.2.4 Effect of varying temperature and pressure of condensing and suction side
 - 8.2.5 Use of P-H chart, simple numerical problem
 - 8.2.6 Methods of improving COP
- 8.3 Simple vapour absorption system and comparison with vapour compression system.

9. Psychrometry :

- 9.1 Properties of air vapour mixture
- 9.2 Saturation of air. dry and wet bulb temperature, specific humidity, degree of saturation and relative humidity
- 9.3 Enthalpy of moist air
- 9.4 Psychrometric charts and its uses
- 9.5 Psychrometric process, sensible heating and cooling, cooling dehumidification and humidification, evaporative cooling
- 9.6 Mixing of air streams
- 9.7 Human comfort, metabolism in human body, comfort chart and effective temperature

10. Automobile Air Conditioning:

- 10.1 Various transport air conditioning applications
- 10.2 Summer and winter design conditions
- 10.3 Operations of automobile air conditioning
- 10.4 Components and controls
 - 10.4.1 Compressors - reciprocating, rotary and centrifugal
 - 10.4.2 Condenser and evaporators
 - 10.4.3 Throttling devices-
 - 10.4.4 Receiver - driers
 - 10.4.5 Magnetic clutch control
 - 10.7.6 Insulation
- 10.5 Air distribution system
- 10.6 Trouble chart for Auto-air conditioning

11. Heat Transfer:

- 11.1 Importance of Heat Transfer

- 11.2 Modes of Heat transfer
 - 11.2.1 Conduction
 - 11.2.2 Convection
 - 11.2.3 Radiation

12. Conduction :

- 12.1 Fourier's law
- 12.4 Overall Heat transfer coefficient
- 12.5 Critical insulation
- 12.6 Heat transfer through fins

13. Convection :

- 13.1 Natural convection
- 13.2 Forced convection
- 13.3 Heat exchangers

14. Radiation :

- 14.1 Absorption, Reflection and transmission
- 14.2 Radiant energy distribution curve
- 14.3 Emissive power
- 14.4 Black body & white body
- 14.5 Grey body
- 14.6 Kirchoff's law

PRACTICALS

1. Study of different type of S. I. combustion chambers.
2. Study of different type of C. I. combustion chambers
3. Emission measurement by smoke meter and exhaust gas analyzer.
4. To acquaint with the use of refrigeration tools, charging board, special refrigeration tube fittings.
5. Copper tube jointing practice, flaring and brazing.
6. Study of following components:-
 - 5.1 Auto air-conditioning Compressor
 - 5.2 Expansion valves
 - 5.3 Starting and over load relay
 - 5.4 Thermostats
 - 5.5 Strainer and receiver drier
 - 5.6 Magnetic clutch
7. Charging practice including making vacuum, pressure testing, charging and final testing for performance
8. Determination of psychometric properties of air at different places with the help of sling- psychrometer and hygrometer.
9. Using refrigeration trainer test rig / Air-conditioning test rig to find out its refrigerating capacity, power input and C.O.P.
10. Study of different type of heat exchangers.

REFERENCE BOOKS:

- | | |
|-------------------------------------|------------------------|
| 1. Internal Combustion Engines | ML.Mathur & R.P.Sharma |
| 2. Automobile Engines | Dr. Kirpal Singh |
| 3. Automobile Engg. | R.B. Gupta |
| 4. Automobile Engg. | H. Croure |
| 5. I.C. Engines | Lester C. Lichty |
| 6. Refrigeration & Air Conditioning | Domkundwar |
| 7. Refrigeration & Air Conditioning | Manohar Prasad |
| 8. Refrigeration & Air Conditioning | C.P.Arora |
| 9. Principles of Refrigeration | Dossatt |

10. Refrigeration & Air Conditioning
11. Refrigeration & Air Conditioning
12. Refrigeration & Air Conditioning
13. Elements of Heat Engineering (Vol I & II)
14. Thermal Engineering
15. Heat Transfer

R.K. Rajput
R.S. Khurmi
Rao –Sarao
Patel & Karamchandani
Rai & Sonrao (Satya Prakashan)
Arora & Domkundwar

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CNC MACHINES & AUTOMATION

CODE MA 304
ME 304/ MP 304

L T P
2 -- 2

RATIONALE

Diploma holders in mechanical engineering are required to supervise and handle CNC machines. For this purpose, knowledge and skills about CNC machines and part programming for CNC machines are required for enabling them to perform this function.

CONTENTS

1. Introduction :

- 1.1 NC machines
- 1.2 CNC machines
- 1.3 DNC machines
- 1.4 Advantages of NC machines over conventional machines
- 1.5 Difference between NC machines and SPM
- 1.6 Advantage and disadvantages of CNC machines over NC machines
- 1.7 Application of CNC machines

2. Component of NC Machines :

- 2.1 Basic components of NC system
- 2.2 Input mediums- punched cards, magnetic tapes, floppy disks and papers tape
- 2.3 NC coding
- 2.4 Machine control unit (MCU)
- 2.5 Sub units of MCU
- 2.6 Machines tool
- 2.7 Numerical control procedure

3. Classification of Numerical Control Machines :

- 3.1 Classification based on feed back control system
- 3.2 Feed back devices – Velocity feed back devices and position feed back devices.
- 3.3 Classification based on motion control system
- 3.4 Interpolators
- 3.5 Classification based on circuit technology
- 3.6 NC coordinate system
- 3.7 Axis identification

4. Constructional Details of CNC Machines :

- 4.1 Introduction
- 4.2 Machine structure
- 4.3 Slide ways
- 4.4 Spindle
- 4.5 Drive System
- 4.6 Motion transmission
- 4.7 Location of transducers
- 4.8 Swarf removal
- 4.9 Safety and guarding

5. Tooling for CNC Machines :

- 5.1 Introduction

- 5.2 Cutting tools for CNC machines
 - 5.2.1 Pre set tools
 - 5.2.2 Indexable inserts
 - 5.2.3 Qualified tools
- 5.3 Cutting tools material for CNC machines
- 5.4 Automatic tool changer (ATC)
- 5.5 Work holding devices

6. Fundamentals of Part Programming :

- 6.1 NC Words
- 6.2 Programming formats
- 6.3 Part programming for machining- point-to-point , straight line and along curved surface
- 6.4 Part programming for lathe, milling and drilling operations

7. Advanced Part Programming :

- 7.1 Standardised fixed cycles
- 7.2 Non- Standardised fixed cycles
 - 7.2.1 Do-loops
 - 7.2.2 Subroutines

8. Computer Aided Part Programming :

- 8.1 Geometry statements
- 8.2 Motion statements
- 8.3 Post processor statements
- 8.4 Auxiliary statements

9. Robotics :

- 9.1 Introduction
- 9.2 Advantages of a robot
- 9.3 Robot terminology
- 9.4 Major Features of a robot
 - 9.4.1 Manipulator
 - 9.4.2 Controller
 - 9.4.3 Sensors
 - 9.4.4 Power supply unit
- 9.5 Types of Robots
 - 9.5.1 According to the structure of Manipulator
 - 9.5.2 According to type of system
 - 9.5.3 According to type of control loops
- 9.6 Application of robots.

10 Automation in Manufacturing :

- 10.1 Introduction to machining centre
- 10.2 Introduction to computer Integrated manufacturing (CIM)
- 10.3 Introduction to flexible manufacturing system (FMS)
- 10.4 Introduction to group technology (GT)
- 10.5 Introduction to computer process planning (CAPP)

PRACTICALS

1. To prepare jobs on CNC machine by using various operations like turning, facing, taper turning, step turning, profile cutting, threading, chamfering etc on available machine.
2. To develop various types of CNC machine programmes.
3. Industrial Visit

REFERENCE BOOKS :

1. CNC Machine- Programming & Application
2. CNC Machine
3. CAD/CAM
4. Computer Aided Manufacturing
5. CAM
6. CAM

Adithan & Pabla New Age International
Dhanpat Rai & Sons
Groover (TMH)
Rao, Kundra, Tiari (TMH)
Vikram Sharma (S. K. Kataria & Sons)
S. Vishal (S. K. Kataria & Sons)

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POWER GENERATION

CODE MA 305
ME 305

L T P
2 2/2 --

RATIONALE

With the increased consumption of electrical power in industries, agriculture and human comfort, more and more thermal, hydro and nuclear power plants are being installed through out the country. Gas turbine power plants are also being set up. This all has necessitated to train more and more people for the operation of different types of power plants, Solar energy, wind energy and renewable energy sources.

CONTENTS

1. Introduction :

- 1.1 Different types of conventional sources of energy
- 1.2 Base load and peak load plants
- 1.3 Scope of conventional energy sources in India
- 1.4 Status of conventional power plants in India

2. Thermal Power Plants :

- 2.1 General layout and working
- 2.2 Factors of site selection
- 2.3 Methods of coal handling
- 2.4 Unloading devices
- 2.5 Ash handling system
- 2.6 Concept of super thermal power plants
- 2.7 Combustion equipment
 - 2.7.1 Basic requirements
 - 2.7.2 Methods of coal burning : Hand firing, Stoker fired systems, Pulverised fuel fired system
 - 2.7.3 Coal Burners : Stream line, Turbulent types
 - 2.7.4 Combustion control, fluidised bed combustion

3. Hydro-Electric Power Plant :

- 3.1 Advantages and application of hydroelectric power plants
- 3.2 Elements of hydroelectric power plant
- 3.3 Plant layout of low head and high head intake
- 3.4 Combination of Hydel – Thermal power plants
- 3.5 Hydro electric power plants in India.

4. Nuclear Power Plant :

- 4.1 Introduction to nuclear reactions and nuclear fuels
- 4.2 Site selection of nuclear power plants
- 4.3 Nuclear reactors : various elements of nuclear reactors.
- 4.4 Comparison of nuclear power plant with thermal and hydel power plants
- 4.5 Common types of nuclear reactors
 - 4.5.1 Pressurised water reactor
 - 4.5.2 Boiling water reactor
 - 4.5.3 Gas cooled reactors
 - 4.5.4 Liquid metal cooled reactor
 - 4.6.5 Fast breeder reactor
- 4.6 Nuclear power plants in India
- 4.7 Hazards in nuclear power plants and safety measures
- 4.8 Nuclear waste disposal

5. Diesel Power Plants :

- 5.1 Elements of a diesel power plant
- 5.2 Building and general layout
- 5.3 Use of diesel engine with steam power plants
- 5.4 Applications of diesel power plants
- 5.5 Limitation of diesel power plants

6. Gas Turbine Plants :

- 6.1 Classification and application
- 6.2 Elementary description of gas turbines
- 6.3 Details of elements of a gas turbine plant and plant layout
- 6.4 Advantages over thermal and diesel power plants

7. Power Plant Economics :

- 7.1 Elements of cost of power
- 7.2 Factors affecting economics of generation and distribution of power
- 7.3 Factors affecting choice and type of power plants on economics of power generation
- 7.4 Simple numerical problems on cost of power generation.

8. Renewal Energy Sources :

- 8.1 Present position of conventional energy sources in India
- 8.2 Need for non-conventional energy sources
- 8.3 Various alternate energy sources – solar, biogas, wind, geothermal, tidal, Magneto hydro dynamic, thermo electric power etc.

9. Solar Energy :

- 9.1 Introduction to solar power
- 9.2 Solar energy collectors
- 9.3 Application of solar energy
 - 9.3.1 Solar water heating
 - 9.3.2 Solar heating of Buildings
 - 9.3.3 Solar thermal electric conversion
 - 9.3.4 Solar photo voltaic
 - 9.3.5 Solar distillation
 - 9.3.6 Solar green house
 - 9.3.7 Space cooling
- 9.4 Solar energy storage
 - 9.4.1 Thermal storage
 - 9.4.2 Chemical storage
 - 9.4.3 Mechanical energy storage
 - 9.4.4 Solar pond

10. Wind Energy :

- 10.1 Scope of wind energy
- 10.2 Merits and demerits of wind energy
- 10.3 Measurement of wind velocity by Anemometer : Indicating and recording type
- 10.4 Wind Machines
 - 10.4.1 Horizontal axis wind machine
 - 10.4.2 vertical axis wind machine

- 10.5 Wind power and energy pattern factor
- 10.6 Efficiency of wind machine
- 10.7 Site selection of wind machine

REFERENCE BOOKS :

- | | |
|--|------------------------------|
| 1. Power Plant Engineering | Dr. Mahesh Verma |
| 2. Power Plant Engineering | Keshwani |
| 3. शक्ति सयंत्र | R.L.Agrawal |
| 4. Power Plant Engineering | Domkumdwat |
| 5. Power Plant Engineering (Hindi) | Prakash & Kumar |
| 6. Power Plants Engineering | P.K. Nag (TMH) |
| 7. Power Plants | G.R. Nagpal |
| 8. Power Plants Technology | M.M. El-Wakil (Mc-Graw Hill) |
| 9. Non Conventional Energy Sources | G.D. Rai (Khanna Pub.) |
| 10. Energy Technology – Non Conventional | S.Rao (Khanna Pub.) |
| 11. Non Conventional Sources of Energy (Hindi) | Agrawal & Gupta (Nav Bharat) |
| 12. अपारम्परिक ऊर्जा स्रोत | ए. एन. माथुर / एन.एस. राठौड़ |

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ADVANCE WORKSHOP TECHNIQUES

CODE MA 306
ME 306

L T P
2 -- 3

RATIONALE

This subject gives knowledge to the students with regard to many kinds of machine tools used in industry. Major thrust is to expose the students to acquire practical skill in handling milling machines, grinding machines, capstan and turret lathes and many other kinds of machines. This enables students to perform well on the shop floor in the industry.

CONTENTS

1. Metal Cutting Saws :

- 1.1 Specifications, description, working and uses of sawing machine
- 1.2 Description, specification of cutters/ blade for sawing machines, blade setting.

2. Boring :

- 2.1 Principle of boring
- 2.2 Classification of boring machines and their description
- 2.3 Specification of boring machine
- 2.4 Boring tools
- 2.5 Boring bars and boring heads
- 2.6 Description of Jig boring machine

3. Milling Machine :

- 3.1 Specifications and working principle of milling machine
- 3.2 Classification of milling machines and their brief description and their applications.
- 3.3 Details of column and knee type milling machine
- 3.4 Milling machine accessories and attachment -Arbors, adaptors, collets, vices, circular table, indexing head and tail stock, vertical milling attachment, spiral milling attachment, slotting attachment and rack milling attachment.
- 3.5 Work holding devices.
- 3.6 Milling methods-up milling and down milling
- 3.7 Various types of milling cutters and mandrels for milling machines
- 3.8 Milling operations-face milling, angular milling, form milling, straddle milling and gang milling
- 3.9 Cutting speed and feed. Simple numerical problems
- 3.10 Indexing on dividing heads, plain and universal dividing heads
- 3.11 Indexing methods : direct, plain or simple, compound, differential and angular indexing. Numerical problems on indexing
- 3.12 Helical and spiral milling
- 3.13 Introduction to machining centre

4. Grinding and Grinding Machines :

- 4.1 Purpose of grinding
- 4.2 Various elements of grinding wheel – Abrasive, Grade, Structure, Bond
- 4.3 Common wheel shapes and types of wheels - built up wheels, mounted wheels and diamond wheels. Specifications of grinding wheels as per BIS
- 4.4 Truing and dressing, balancing and mounting of wheel
- 4.5 Grinding methods: surface grinding, cylindrical grinding and centreless grinding.
- 4.6 Grinding Machines- cylindrical grinders, surface grinders, internal grinders, centreless grinders and tools and cutter grinders.
- 4.7 Selection of grinding wheel

5. Capstan and Turret Lathes :

- 5.1 Concept of ram or capstan type and turret or saddle type machine
- 5.2 Principal parts of capstan and turret lathes
- 5.3 Capstan and Turret lathe mechanism : Turret indexing mechanism, Bar feeding mechanism
- 5.4 Work holding devices : Jaw and collet chucks
- 5.5 Tool holding devices : slide tool holder, knee tool holder, knurling tool holder, recessing tool holder, form tool holder, Tap and Die holder, V-steady box tool holder, roller steady box tool holder
- 5.6 Introduction to turret tooling layout
- 5.7 Difference among capstan, turret and conventional lathe.

6. Automatic Machines :

- 6.1 Brief description of single spindle and multi-spindle automatic machines viz. Swiss type automatic screw machine and Turret type screw machines
- 6.2 Transfer Machines- Inline , Rotary Indexing Table , Drum Machines

7. Metal Finishing Processes :

- 7.1 Purpose of finishing surfaces
- 7.2 Description of lapping, super finishing, polishing and buffing processes
- 7.3 Description of honing machine and honing tools

8. Maintenance of Machine Tools :

- 8.1 Importance of maintenance
- 8.2 Different type of maintenance
- 8.3 Sequence of maintenance operation : Disassembly, washing, fault finding, assembly

9. Installation and Testing of Machine Tools :

- 9.1 Different types of machine foundation
- 9.2 Foundation plan
- 9.3 Machine tool testing

PRACTICALS

- 1. Face milling.
- 2. Gear cutting on a milling machine. (Spur and Bevel)
- 3. Key way cutting on shaft
- 4. Exercise on gang milling
- 5. Job on Capstan lathe and Turret lathe.
- 6. Job on grinding machine.
 - 6.1 Surface grinding
 - 6.2 Cylindrical grinding (internal and external)
 - 6.3 Centre less grinding (internal and external)
- 7. Milling cutter grinding on tool and cutter grinder
- 8. Job using copying attachment on lathe
- 9. Exercises on honing and lapping machine
- 10. Super finishing practice on lathe
- 11. Maintenance of milling, Grinding and Lathe machines

REFERENCE BOOKS :

- | | |
|---------------------------------|-----------------------|
| 1. Workshop Technology II | Hazra Chaudhary |
| 2. Workshop Technology II | Raghuvanshi |
| 3. Production Technology | R.K.Jain & S.C. Gupta |
| 4. Workshop Technology (Hindi) | Tahil Maghnani |
| 5. Production Technology | H.M.T |
| 6. Workshop Technology II & III | Chapman |
| 7. Production Technology | Pandey & Singh |

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RATIONALE

This subject will help the student in knowing various electrical, electronic and control equipment used in automobile, their functions, and maintenance and to diagnose the faults due to electrical/electronic equipment failure.

CONTENTS

1. Introduction :

- 1.1 Various electrical system and functions
- 1.2 Insulated and earth return system, negative and positive earthing.
- 1.3 6v, 12v, 24v electrical system

2. Battery :

- 2.1 Function and types of battery
- 2.2 Lead acid battery- principle, chemical reaction and Construction detail
- 2.3 Battery rating.
- 2.4 Battery Charging:
 - 2.4.1 Charging system - constant current and constant voltage
 - 2.4.2 Normal, booster and trickle charging
- 2.5 Battery test
 - 2.5.1 Specific gravity test
 - 2.5.2 Open and short circuit voltage test
 - 2.5.4 High discharge test
 - 2.5.5 Cadmium tip test
- 2.6 Battery failure and rectification
 - 2.6.1 Overcharging
 - 2.6.2 Cycling
 - 2.6.3 Sulfation
 - 2.6.4 Internal short circuit
 - 2.6.5 Buckling and cracking
- 2.7 Battery maintenance and storage (dry and wet type)
- 2.8 Alkaline type battery
 - 2.8.1 Nickel - Iron battery
 - 2.8.2 Nickel - Cadmium battery

3. Alternators :

- 3.1 Construction and working principle
- 3.2 Advantage over dynamo
- 3.3 Rectification
- 3.4 Output control
 - 3.4.1 One unit voltage regulator
 - 3.4.2 Two unit voltage regulator
 - 3.4.3 Regulator with transistor and vibrating contact point
 - 3.4.4 Fully transistorised regulator

4. Starting Motor :

- 4.1 Motor type, and specifications
- 4.2 Construction of motor and working principle
- 4.4 Starter motor drive mechanism
 - 4.4.1 Need of drive mechanism

- 4.4.2 Bendix drive
- 4.4.3 Over running clutch drive
- 4.4.4 Gear reduction type of drive
- 4.5 Starter motor control
 - 4.5.1 Manual switch
 - 4.5.3 Solenoid switch
 - 4.5.4 Series - parallel system

5. Ignition System

- 5.1 Principle
- 5.2 Spark formation, production of high voltage
- 5.3 Factor affecting spark - energy
 - 5.3.1 Voltage
 - 5.3.2 Mixture ratio
 - 5.3.3 Charge pressure and temperature
 - 5.3.4 Throttle opening
 - 5.3.5 Plug gap
 - 5.3.6 Electrode temperature
- 5.4 Coil ignition system :
 - 5.4.1 Working principle
 - 5.4.2 Constructional detail of induction coil and distributor
- 5.5 Ignition timing
- 5.6 Ignition advancing mechanism
 - 5.6.1 Centrifugal type
 - 5.6.2 Vacuum type
- 5.7 Magneto ignition system
- 5.8 Comparison of coil and magneto ignition system

6. Spark Plug :

- 6.1 Constructional details and classification
- 6.2 Effect of leaded fuels
- 6.3 Radio interference
- 6.4 Plug polarity

7. Lighting System :

- 7.1 Lighting circuits
- 7.2 Head lamps
 - 7.2.1 Pre focused bulb type
 - 7.2.2 Sealed beam type
 - 7.2.3 Double filament type
- 7.3 Focusing and alignment of head lamp
- 7.4 Fog lamp, back-up light, brake warning light, side light, direction indicator, hazard warning light (functions only)

8. Switches and Wiring :

- 8.1 Switches (function only)-Tumbler door switch, Head light, Parking light, Combination switch, Horn switch
- 8.2 Wiring
 - 8.2.1 Wiring circuitry for two wheeler and four wheeler vehicle.
 - 8.2.2 Starting cable and specification
 - 8.2.3 H.T.L.T. cable and specification
 - 8.2.4 Fuse and fuse rating
 - 8.2.5 Cable colour code

9. Horn :

- 9.1 Electrical horn- Diaphragm type, Wind tone type
- 9.2 Air pressure horn

10. Recent Electrical Equipment in Automobiles :

- 10.1 Electronic magneto ignition system
- 10.2 Electronic fuel injection
 - 10.2.1 E.C.M.
 - 10.2.2 Sensors and their supporting circuits
- 10.3 Indicating devices and circuit
 - 10.3.1 Fuel gauge
 - 10.3.2 Engine temperature indicator
 - 10.3.3 Oil pressure indicator
- 10.4 Electrical fuel pump control system
- 10.5 Central Door locks
- 10.6 Heater and defroster
- 10.7 Electrical control circuits of air conditioner for a car.

11. Mechatronics :

- 11.1 Open loop and close loop control system.
- 11.2 Valves, drives and actuators.
- 11.3 Basic pneumatics circuits
- 11.4 Sensors, Transducers and signal conditioners

PRACTICALS

- 1. To study the constructional details of lead acid battery, also study various causes of failures.
- 2. To conduct various tests to determine the condition of battery
- 3. To study the various components of charging system
- 4. To study the regulator and conduct various adjustments and settings
- 5. Study of starting system
- 6. Study of Ignition system and setting procedure
- 7. Study of Light and sound system
- 8. ignition system :
 - 8.1 Spark plug cleaning, setting and testing
 - 8.2 CB point cleaning and ignition timing adjustment
- 9. Practice to read, the wiring diagram of different vehicles and to trace fault in electrical circuit and different electrical components.
- 10. Study of different type of transducers.

REFERENCE BOOKS :

- | | | |
|----|---------------------------------|------------------|
| 1. | Automotive Electrical Equipment | William H Crouse |
| 2. | Basic Automobile Engineering | C.P.Nakra |
| 3. | Automobile Engineering | Kirpal Singh |
| 4. | Automobile Engineering | R.B. Gupta |
| 5. | Automotive Electrical Equipment | P.L. Kohali |

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RATIONALE

Modern automobiles are very much different from the conventional ones. Almost every system of automobile has been improved keeping in view the comfort, economy and safety aspects. This subject keeps the students in touch with these developments.

CONTENTS

1. Chassis Layout :

- 1.1 Different chassis layouts for light vehicles.
 - 1.1.1 Front engine front wheel drive.
 - 1.1.2 Front engine four wheel drive.
 - 1.1.3 Front engine rear wheel drive
 - 1.1.4 Rear engine rear wheel drive.
- 1.2. Layouts for commercial vehicles
 - 1.2.1 Rigid Trucks-4x2, 6x2, 6x4, 8x4.
 - 1.2.2 Articulated vehicles - Rigid 4x2 Tractor and single axle trailer. Rigid 6x4 Tractor and Tandem axle Trailer, 6x2 Dual steer axle Tractor and Tri axle Trailer.

2. Suspension System:

- 2.1. Forces acting on suspension system.
- 2.2. Springs
 - 2.2.1 Types, materials, constructional details.
 - 2.2.2 Nipping and grading of leaf springs.
 - 2.2.3 Variables rate springs (Single unit and two unit types).
- 2.3 Independent Suspension System (Front and Rear)
 - 2.3.1 Construction and operation of different types - Vertical slide. Divided axle. Swinging Arm. Parallel links, McPherson Strut
 - 2.3.2. Stabilizer Rod.
- 2.4 Air Suspension System - Layouts and Working, Advantages.
- 2.5 Gas filled shock absorber - Operation.

3. Braking System :

- 3.1. Power Brakes - Layout, constructional details and working of following
 - 3.1.1 Air Brakes
 - 3.1.2 Air Hydraulic Brakes
 - 3.1.3 Vacuum Brakes.
- 3.2 Disc Brakes
 - 3.2.1 Constructional details and working of floating piston and floating caliper type.
 - 3.2.2 Advantages and disadvantages of disc Brakes.
 - 3.2.3 Proportioning valve - function.
- 3.3. Introduction to Anti Lock Braking System, Electronic Brakeforce Distribution, Electronic Stability Control
- 3.4 Introduction to Engine exhaust brakes used in automobiles.

4. Wheels and Tyres :

- 4.1 Construction of Cross ply. Radial ply and Belted biased ply tyres.
- 4.2 Comparison of cross ply and radial ply characteristics.
- 4.3 Tubeless Tyres – Advantages and Disadvantages
- 4.3 Consideration in Trade design.
- 4.4 Static and Dynamic balancing of wheels.
- 4.5 Wheels and tyre troubles, their causes and remedies, care and maintenance of tyre, tubes and valves. Tyre Rotation, Factor affecting tyre life.
- 4.6 Retreading of tyres.

5. Clutch :

- 5.1 Factors affecting the power transmitted by clutch.
- 5.2 Construction and operation of a Diaphragm spring type clutch, Comparison of coil spring and diaphragm spring type clutches.
- 5.3 Clutch Operation -
 - 5.3.1 Mechanical - Rod and Cable.
 - 5.3.2 Hydraulic operation - Clutch master cylinder and slave cylinder.
 - 5.3.3 Electromagnetic operation.
 - 5.3.4 Vacuum operation.
- 5.4 Fluid Flywheel - Construction, characteristics, Advantages and disadvantages.

6. Transmission :

- 6.1 Transmission requirements, tractive effort.
- 6.2 Vehicle Resistances - Rolling, Air and Gradient resistance and their effect on vehicle motion.
- 6.3 Power and Torque, Power weight ratio, Draw bar pull.
- 6.4 Transfer case- Construction and Operation.
- 6.5 Transaxle Unit - Types construction and operation.
- 6.6 Principle and operation of Overdrive
- 6.6 Torque converter, Automatic transmission, Free wheeling device.

6. Final Drive :

- 6.1 Hotchkiss and Torque tube drive. Torque reaction.
- 6.2 Divided propeller shaft with intermediate support bearings.
- 6.3 Differential - Types construction and working.
 - 6.3.1 Limited slip differential.
 - 6.3.2 Double reduction differential.
 - 6.3.3 Worm, Bevel and Hypoid type final drives.

8. Steering Systems :

- 8.1 Steering Mechanisms:
 - 8.1.1 Davis and Ackerman steering system.
 - 8.1.2 Fundamental equation for correct steering.
 - 8.1.3 Cornering force end slip angle, under steer and over steer.
- 8.2 Steering Linkages - Types - Centre Arm, Parallelogram and Long arm short arm types.
- 8.3 Front End Geometry: - Camber, Caster, Kingpin or Steering axis inclination. Included angle, Toe in and Toe out on turns. Definition and their effects.
- 8.4 Power steering :
 - 8.4.1 Types – Integral, linkages types, Electronic power steering.
 - 8.4.2 Construction and working of power steering.

9. Upholstery :

- 9.1 Seats - location, mounting and adjustment
- 9.2 Seat belts - location fitting points and operation
- 9.3 Ceiling, side panels, door channels, beading and furnishing materials

10. Engine components : Types, functions, constructional details, materials and defects in following engine components-

- 10.1 Cylinder, cylinder liner, block and head
- 10.2 Piston, piston rings, gudgeon pin
- 10.3 connecting rod, lubrication of big end and small end
- 10.4 Crank shaft, Flywheel, Ring gear, Vibration damper
- 10.5 Cam shaft, cam driving mechanisms
- 10.6 Valves, valve operating mechanisms, Tappet clearance and its adjustment
- 10.6 Gaskets and oil seals
- 10.8 Bearings
 - 10.8.1 Requirements of bearing
 - 10.8.2 Main bearing, Big end bearing

PRACTICALS

1. Study of Air power brakes used in heavy vehicle.
2. Study of transaxle unit of a car.
3. Tyre study and service:
 - 3.1 To study the construction of radial and cross ply tyres.
 - 3.2 Tyre rotation, and tyre retrading.
 - 3.3 Repair of tubes and tyre.
 - 3.4 Study of cold retreading procedure
4. Balancing of the wheel of a vehicle.
5. Study, checking and adjusting the steering system.
 - 5.1 Steering linkage check.
 - 5.2 Front wheel bearing
 - 5.3 Ball joints
 - 5.4 Steering gear box.
6. Study and checking the front wheel geometry by wheel alignment unit.
6. Study of cylinder liner, head, block and oil pan .
8. Mmeasurement of cylinder liner ovality and taper.
9. Study of piston, piston rings, piston pins, connecting rod and crank shaft.
10. Study of different valve operating and cam driving mechanisms.

REFERENCES BOOKS :

- | | | |
|----|--|----------------|
| 1. | Vehicle and Engine Technology (Vol. 1 & 2) | Heinz Heisler. |
| 2. | Basic Automobile Engineering | C.P. Nakra. |
| 3. | Automobile Engineering | R.B. Gupta |
| 4. | Automobile Engineering | Kripal Singh. |
| 5. | Auto Chassis and Body | P.L. Kohli |
| 6. | Auto Chassis and Body | Crouse, Anglin |
| 6. | Automobile Engineering | G.B.S.Narang |

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RATIONALE

Knowledge of method of finding shapes and sizes of various machine elements is very essential from their strength and stiffness/rigidity viewpoints. Also the knowledge of calculation of manufacturing cost of machine elements is essential. This subject would impart the basic knowledge about the designing of various machine elements and its cost

CONTENTS

1. Introduction :

- 1.1 General consideration in machine design
- 1.2 General procedure in machine design
- 1.3 Selection of material
- 1.4 Working stress and factor of safety, selection of factor of safety
- 1.5 Stress concentration, stress concentration factor and methods of reducing stress concentration
- 1.6 Fatigue and endurance limit
- 1.6 Effect of load, surface finish and size on endurance limit
- 1.8 Preferred number

2. Design of Welding Joints :

- 2.1 Types of welded joint and Design of lap joint and butt joint
- 2.2 Strength of transverse and parallel fillet welded joints in axial loading
- 2.3 Basic welding symbols

3. Design of Screw and Bolts :

- 3.1 Initial stresses due to screwing up
- 3.2 Stress due to external forces
- 3.3 Stress due to combined forces
- 3.4 Bolt of uniform strength
- 3.5 Screw thread, designations and its dimensions.

4. Design of joints & components :

- 4.1 Design of simple cotter joints
- 4.2 Design of knuckle joints
- 4.3 Design of turnbuckle
- 4.4 Design of hand lever
- 4.5 Design of foot lever

5. Design of Keys and Couplings:

- 5.1 Design of sunk key
- 5.2 Design of rigid flange coupling

6. Design of Shaft :

- 6.1 Shaft subjected to twisting moment
- 6.2 Shaft subjected to bending moment
- 6.3 Shaft subjected to combined twisting and bending moment

6. Bearings (no numerical problems) :

- 6.1 Introduction and Classification
- 6.2 Material used for bearings and their properties
- 6.3 Types and uses of rolling contact bearings
- 6.4 Standard dimension and designations of ball bearings
- 6.5 Selection of rolling elements bearings

8. Estimating :

- 8.1 Definition
- 8.2 Importance of estimating
- 8.3 Aims and functions
- 8.4 Estimating procedure

9. Costing :

- 9.1 Definition
- 9.2 Aims of costing
- 9.3 Procedure of costing

10. Elements of Costs :

- 10.1 Material cost
- 10.2 Labour cost
- 10.3 Expenses
 - 10.3.1 Direct expenses
 - 10.3.2 Indirect expenses
- 10.4 Component of cost
- 10.5 Overhead cost
- 10.6 Allocation of on cost

11. Break Even Analysis :

Break even analysis (cost, volume, profit analysis), determination of Break even point, break even point theory

REFERENCE BOOKS :

- | | | |
|----|--------------------|-------------------------------|
| 1. | Machine Design | Pandya & shah |
| 2. | Machine Design | R.S.Khurmi |
| 3. | Machine Design | Sharma & Aggrawal |
| 4. | Machine Design | V. B. Bhandari |
| 5. | Engineering Design | J. E. Shieglay (McGraw-Hill) |

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RATIONALE

To achieve the targets and goal of any industry, it is essential to co-ordinate the manufacturing systems. For efficient working of organization evaluation of manufacturing jobs is also necessary. For this purpose topics like plant location and layout, work study, production planning and control, quality control, inventory control, fleet organization, road accident break down of vehicle and motor vehicle act are included in the syllabus. It is suggested that students should be taken to different factories to learn about the actual application of subject.

CONTENTS**1. Plant Location and Layout :**

- 1.1 Factors affecting plant location
- 1.2 Factor effecting plant layout
- 1.3 Types of plant layout

2. Production Planning and Control :

- 2.1 Definition and importance
- 2.2 Types of production - Jobs, batch, mass
- 2.3 Forecasting
- 2.4 Routing
- 2.5 Scheduling
- 2.6 Dispatching
- 2.6 Follow up
- 2.8 CPM & PERT techniques
 - 2.8.1 Analysis and control of project cost in CPM & PERT
 - 2.8.2 Simple numerical problems

3. Inspection and Quality Control :

- 3.1 Inspection and its objectives
- 3.2 Types of inspection
 - 3.2.1 Remedial, preventive and operative stage of inspection
 - 3.2.2 Inspection of incoming material
 - 3.2.3 Inspection of work in process
 - 3.2.4 Inspection of finished goods
- 3.3 Objectives and advantages of quality control
- 3.4 Functions of quality control department

4. Work Study :

- 4.1 Definition
- 4.2 Production and productivity
- 4.3 Method study
 - 4.3.1 Definition
 - 4.3.2 Objectives
 - 4.3.3 Methods study procedure
 - 4.3.4 Principles of motion economy
- 4.4 Work measurement
 - 4.4.1 Definition
 - 4.4.2 Principle
 - 4.4.3 Calculating of standard time

5. Inventory Control :

- 5.1 Definition and Objectives
- 5.2 Methods of inventory control
 - 5.2.1 Economic ordering quantity
 - 5.2.2 Carrying cost
 - 5.2.3 Procurement cost
 - 5.2.4 Lead-time

- 5.2.5 Re-order point
- 5.2.6 ABC Analysis

6. Depreciation :

- 6.1 Definition
- 6.2 Causes of depreciation
- 6.3 Different method of calculating depreciation

6. Structure of a Fleet Organisation :

- 6.1 Route planning
 - 6.1.1 Necessity for route planning
 - 6.1.2 Road and traffic surveys
 - 6.1.3 Urban route planning
 - 6.1.4 Running time
 - 6.1.5 Fare stage
 - 6.1.6 Bus stops
- 6.2 Vehicle and crew scheduling
 - 6.2.1 Road worthiness requirement of a vehicle
 - 6.2.2 Vehicles and scheduling
 - 6.2.3 Maintenance schedules
 - 6.2.4 Need of vehicle history sheet, log sheets, spare part catalogue, service manuals
 - 6.2.5 Crew scheduling
- 6.3 Road Accident
 - 6.3.1 Definition
 - 6.3.2 Classification of accidents
 - 6.3.3 Causes of accidents
 - 6.3.4 Investigation procedure
 - 6.3.5 Prevention

8. Motor Vehicle Laws :

- 8.1 Motor vehicle act and rules
 - 8.1.1 Driving license
 - 8.1.2 Age limit
 - 8.1.3 Addition and renewal of driving license
- 8.2 Control of transport vehicle
 - 8.2.1 Registration
 - 8.2.2 Permit
 - 8.2.3 Insurance
 - 8.2.4 Offences
 - 8.2.5 Penalties
- 8.3 Traffic rules and regulation
 - 8.3.1 Speed limit
 - 8.3.2 Parking places
 - 8.3.3 Signals and signal devices
 - 8.3.4 Traffic symbols
 - 8.3.5 Driving safety devices

9. Principles of Management : (Elementary Idea)

- 9.1 Management, administration and organisation, difference between them.
- 9.2 Scientific management : Meaning, characteristics, objectives and advantages, Taylor's scientific management, Fayol's principles of management, functions of management
- 9.3 Types of ownership, sole trading, partnership, joint stock, co-operative and public enterprise
- 9.4 Types of organisation, different types and their charts.
- 9.5 Importance of human relation professional ethics
- 9.6 Need for leadership, leadership qualities

9.6 Introduction, objectives and functions of Human Resource Development, Finance, Marketing and Material management (Purchase, Store, sales)

10. Wages and Incentives :

- 10.1 Definition and requirements of a good wage system methods of wage payment
- 10.2 Wage incentives - type of incentive, difference in wage incentive and bonus. incentive to supervisor.

11. Entrepreneurship :

- 11.1 Entrepreneurship and Entrepreneur
- 11.3 Essential Characteristics of a good Entrepreneur
- 11.4 Industrial Policy.
- 11.5 Classification of industries- Tiny, small scale, Medium scale, Large scale, Handicraft, Ancillary
- 11.6 Type of industries- Production, Job based & Service

12. ISO : 9000 Series of Quality System :

- 12.1 Definition of few important terms related to ISO quality system
- 12.2 Various models for quality assurance in ISO : 9000 series
- 12.3 Various elements of ISO : 9001 model (20 points)
- 12.4 Benefits by becoming an ISO : 9000 company
- 12.5 Introduction to total quality management (TQM)

REFERENCE BOOKS :

- | | |
|--|---------------------------|
| 1. Industrial Management | V.K. Sharma & O.P. Harkut |
| 2. Industrial Engg. & Management | O.P. Khanana |
| 3. Industrial Engg. & Management | T.R. Banga |
| 4. Hand Book of Small Scale Industry | P.M. Bhandari |
| 5. Hand Book on Entrepreneurship Development | O.P. Harkut |
| 6. Entrepreneurial Development | S.S. Khanka |
| 6. Statistical Quality Control | Mahohar Mahajan |
| 8. ISO : 9000 Quality System | S. Dalela |

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