

18. STUDY AND EVALUATION SCHEME

FIFTH SEMESTER :

| Sr. No. | SUBJECTS | STUDY SCHEME | | Credits (C) L+P = C | MARKS IN EVALUATION SCHEME | | | | | | Total Marks of Internal & External |
|------------------------------------|----------------------------------------------|--------------|-----------|------------------------|----------------------------|------------|------------|---------------------|------------|------------|------------------------------------|
| | | Periods/Week | | | INTERNAL ASSESSMENT | | | EXTERNAL ASSESSMENT | | | |
| | | L | P | | Th | Pr | Tot | Th | Pr | Tot | |
| 5.1 | Industrial/In-house Training-II | - | 2 | 0+1=1 | - | 40 | 40 | - | 60 | 60 | 100 |
| 5.2 | Refrigeration and Air Conditioning | 3 | 2 | 3+1=4 | 40 | 40 | 80 | 60 | 60 | 120 | 200 |
| 5.3 | **CNC Machines and Automation | 3 | 2 | 3+1=4 | 40 | 40 | 80 | 60 | 60 | 120 | 200 |
| 5.4 | Programme Elective I | 3 | - | 3+0=3 | 40 | - | 40 | 60 | - | 60 | 100 |
| 5.5 | Theory of Machines | 3 | 2 | 3+1=4 | 40 | 40 | 80 | 60 | 60 | 120 | 200 |
| 5.6 | Multi- disciplinary Elective (MOOCs/offline) | 2 | - | 2+0=2 | 40 | - | 40 | 60 | - | 60 | 100 |
| 5.7 | Workshop Practice – IV | - | 4 | 0+2=2 | - | 40 | 40 | - | 60 | 60 | 100 |
| 5.8 | Minor Project | - | 4 | 0+2=2 | - | 40 | 40 | - | 60 | 60 | 100 |
| # Student Centered Activities(SCA) | | - | 5 | - | - | - | - | - | - | - | - |
| Total | | 14 | 21 | 22 | 200 | 240 | 440 | 300 | 360 | 660 | 1100 |

** Common with other Diplomas

Programme Elective I: 5.4.1. Industrial Engineering **5.4.2.** Plant Maintenance & Material Handling **5.4.3.** Stainless Steel Technology

Student Centered Activities will comprise of co-curricular activities like extension lectures on Constitution of India, Electoral Literacy, Motor Vehicles (Driving) Regulations 2017 etc., games, hobby clubs e.g. photography etc., seminars, declamation contests, educational field visits, N.C.C., NSS, Cultural Activities and self-study etc.

5.1 INDUSTRIAL / IN – HOUSE TRAINING-II

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RATIONALE

Industrial training / In – house training will help the students to understand the working environment of relevant industries. The student will learn to work in team to solve the industrial problems. It will also give exposure about the present and future requirements of the relevant industries. This training is very important for development of required competencies and skills for employment and start-ups.

COURSE OUTCOMES

After undergoing the training, the students will be able to:

- CO1: Explain the working environment of industries
- CO2: Take necessary safety precautions and measures.
- CO3: Describe present and future requirement of industries.
- CO4: Work in team for solving industrial problems
- CO5: Develop competencies and skills required by relevant industries.
- CO6: Develop writing, speaking and presentations skills.

PRACTICAL EXERCISES

1. Report writing based on industrial training.
2. Preparation of Power Point Slides based on industrial training and presentation by the candidate.
3. Internal Evaluation based on quality of Report, PPT preparation, PPT presentation and answer to queries.
4. External Evaluation based on quality of Report, PPT preparation, PPT presentation and answer to queries.

GUIDELINES

Students will be evaluated based on Industrial training / In – house training report and their presentation using Power Point about the knowledge and skills gained during the training. The Head of the Department will depute faculty coordinators by assigning a group of students to each. The coordinators will mentor and guide the students in preparing the PPTs for final presentation. The following performance parameters are to be considered for assessment of the students out of 100 marks:

| | Parameter | Weightage |
|-----|------------------------------------------------------------------|------------------|
| i | Industrial / In-house assessment of the candidate by the trainer | 40% |
| ii | Report Writing | 20% |
| iii | Power Point Presentation | 20% |
| iv | Viva-voce | 20% |

5.2 REFRIGERATION AND AIR CONDITIONING

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RATIONALE

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

COURSE OUTCOMES

After undergoing the training, the students will be able to:

- CO1 Explain the working and construction features of refrigeration and air conditioning systems
- CO2 Classify, draw and interpret various refrigeration cycles with their applications.
- CO3 Make basic calculation of psychometric properties and processes.
- CO4 Calculate heating and cooling load requirements of a room.
- CO5 Explain latest developments in the field of refrigeration and air conditioning.
- CO6 Calculate the properties of air by using psychometric chart.
- CO7 Detect faults and trouble shooting in an air-conditioner/refrigerator.
- CO8 Carry out charging of air conditioner.
- CO9 Describe the construction and features of air compressor and working on different air compressors.

DETAILED CONTENTS

UNIT-I

Introduction to Refrigeration

Definition of Refrigeration; Refrigerating effect-unit of refrigeration, Types of Refrigeration-Ice, dry ice, Steam jet, Throttling, Liquid nitrogen refrigeration, Basic Air Refrigeration; Difference Between a

Heat Engine, Refrigerator and Heat Pump, Coefficient of performance;

Difference between COP and efficiency, Reversed Carnot Cycle(P-V, T-S diagrams & efficiency), Simple Numerical problems based on calculation of efficiency and COP , Refrigeration effect, etc.

Refrigeration Systems

Vapour compression Refrigeration cycle: Basic Components(compressor, condenser, throttling devices and evaporator), Working of Vapour compression cycle; Representation of the vapour compression cycle on T-S & P-V Diagram; Introduction to Dry Saturated Vapour after Compression, Wet Vapour after Compression, Superheated Vapour after Compression, with Superheated Vapour after Compression; Effects of super heating and under cooling, its advantages and disadvantages.

UNIT-II

REFRIGERATION COMPONENT AND DEVICES:

Compressor - types of compressors; Hermetically sealed and Semi hermetically sealed compressor; Relative advantages

Condensers - Air Cooled, water cooled, natural and forced cooling system; Advantages and disadvantages of air cooled and water cooled condensers;

Evaporators -natural, convection, forced convection types.

Refrigerant flow controls devices: Capillary tube; Automatic Expansion valve; Thermo static expansion valve; High side and low side float valve; Solenoid valve; Evaporator pressure regulator, application of various expansion valves.

Safety Devices-Thermostat, overload protector, L, HP cutout switch, Strainer and accumulator.

UNIT III

REFRIGERANTS: Introduction to refrigerants, Functions of refrigerants; Primary and secondary refrigerants, Properties of ideal refrigerants; Classification of refrigerants by group number and commonly used refrigerants in practice; Selection of refrigerant.

Properties of R - 717, R – 22, R–134 (a), R744 (CO₂), R-454B as an alternate to R410A, Detection of refrigerants leakage and safety measures; charging the system with refrigerant. Lubricants used in refrigeration and their properties.

UNIT IV

AIR CONDITIONING: Introduction to Air conditioning; Factors affecting Air conditioning, Psychrometry, Definition and importance of specific humidity, relative humidity, degree of saturation, DBT, WBT, DPT, sensible heat, latent heat, Total enthalpy of air. Psychrometric process-sensible heating and cooling, Humidifying and dehumidifying; Psychrometric chart and its use, various lines, psychrometric process, Psychrometric process-sensible heating and cooling, Humidifying and dehumidifying; By-pass factor, room sensible heat factor(Concept only).

UNIT V

REFRIGERATION AND AIR-CONDITIONING TOOLS: Tools used in refrigeration and Air conditioner installation; Installation procedure; Faults in refrigeration and air conditioning system; Servicing procedure.

LATEST DEVELOPMENT IN REFRIGERATION AND AIR CONDITIONING:- Inverter technology, auto-defrosting, blast cooling, star rating; Window and Split air conditioning, Year-round Air-Conditioning system; Industrial Air conditioning. Dairy refrigeration, Cold Storage, Introduction to Solar Refrigeration.

PRACTICALS EXERCISES

1. Identify various tools of refrigeration kit.
2. Practice in cutting, bending, flaring, swaging and brazing of tubes.
3. Study of thermostatic switch, LP/HP cut out overload protector filters, strainers and filter driers.
4. Identify various parts of a refrigerator and window air conditioner.
5. Charging of a refrigerator/ air conditioner (demonstration only).
6. To detect faults in a refrigerator/ air conditioner
7. Leak detection of refrigeration equipment
8. Conduct performance test on A/C test rig to determine COP of the refrigerator
9. Visit to an ice plant or cold storage plant or central air conditioning plant

RECOMMENDED BOOKS

1. Refrigeration and Air Conditioning – Sadhu Singh, Khanna Book Publishing Co., New Delhi
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2. Refrigeration and Air Conditioning – S. Domakundawar, Dhanpat Rai publications.
3. Refrigeration and Air Conditioning – A.S. Sarao & G.S. Gabi, 6th edition, Satya Prakashan Publications, New Delhi, 2004.
4. Principles of Refrigeration – Roy J. Dossat, 5th edition, Pearson Publications, 2001.
5. Refrigeration and Air Conditioning – M. Zakria Baig, Premier/ Radiant Publishing House.
6. Refrigeration and Air Conditioning – C.P Arora, Tata McGraw Hill Education, 2000.

RECOMMENDED WEBSITES

1. <https://www.vedantu.com/jee-main/physics-difference-between-air-conditioning-and-refrigeration>
2. <https://www.geeksforgeeks.org/refrigeration-and-air-conditioning/>
3. <https://www.sciencedirect.com/book/9780750685191/refrigeration-and-air-conditioning>

INSTRUCTIONAL STRATEGY

This is hands on practice based subject and topics taught in the class should be practiced in the Lab regularly for development of required skills among the students. This subject contains five units of equal weightage. Teachers should take the students to industry and explain the details of refrigeration and air-conditioning systems and their components. While imparting instructions, focus should be on conceptual understanding. Training slides of “Carrier Fundamentals of Refrigeration Air Conditioning” to be shown to students.

5.3 CNC MACHINES AND AUTOMATION

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RATIONALE

Diploma holders are required to supervise and handle specialized machines and equipments like CNC machines. For this purpose, knowledge and skills about NC machines, part programming in NC machines and tooling for CNC machines are required to be imparted for enabling them to perform above functions. This subject aims at development of knowledge and skills about CNC machines, tools, equipment and use of high tech machines for increased productivity and quality.

COURSE OUTCOMES

After undergoing the training, the students will be able to:

- CO1 Explain the construction and tooling of CNC machine.
- CO2 Prepare simple part programme.
- CO3 Demonstrate and Operate a CNC lathe and milling machine.
- CO4 Assess the part program, edit and execute in CNC turning and machining centre
- CO5 Diagnose common problems in CNC machines.
- CO6 Explain the trends in the field of automation.
- CO7 Use Advanced programming structures.
- CO8 Develop the part program and tool path generation using simulation software for Lathe and Milling machines

DETAILED CONTENTS

UNIT-I

Introduction

Introduction to NC, Basic Components of NC, binary coding, MCU, input devices, advantages / disadvantages of NC machines over conventional machines, CNC & DNC, their types, their relative advantages, disadvantages, Adaptive control systems, selection of parts to be machined on CNC machines, Problems with conventional NC, PLC Control and its purpose, types and applications.

Classification Of NC Systems

According to Feedback, motion, positioning.

UNIT-II

Part Programming

Part programming and basic procedure of part programming, Rules for Axis identification, NC words, Blocks, part programming formats, simple programming for rational components (Point to point, Straight line, curved surface), tool off sets, cutter radius compensation and wear compensation. Comparative study of Fanuc Controller and Sinumerik codes.

Advanced Structures in Part Programming

Advantages of using advanced structures, part programming using canned cycles, subroutines and do loops, mirror image.

UNIT III

Construction and Tooling

Need of Special mechanical design features for CNC, specification Chart of CNC machines, types of slideways, balls, rollers, motor- servo/stepper , recirculating ball screw and nut assembly, swarf removal, safety and guarding devices,

Various cutting tools for CNC machines, overview of tool holder, different pallet systems and automatic tool changer-ATC system, tool change cycle, types of tool magazines, specialized work done in CNC tool room.

UNIT IV

System devices

Control System, Transducers and Sensors, characteristics of sensors, Tachometer, LVDT, opto-interrupters, potentiometers for linear and angular position, encoder, Actuators, axis drives.

Problems in CNC Machines

Common problems in mechanical, electrical, pneumatic, electronic and PC components of NC machines, diagnostic study of common problems and remedies, use of on-line fault finding diagnosis tools in CNC machines, methods of using discussion forums.

UNIT V

Automation System

Automation, suitability of production system to automation , types, automatic assembly, manufacture of printed circuit boards(PCB), manufacture of integrated Circuits, Overview of FMS, AGV-types, ASRS, Group technology, CAD/CAM and CIM, Automated Identification system ,

Automated inspection: Off-line, On-line, Contact, Non-contact; Coordinate Measuring machines; Machine vision, concept of AI and its applications in manufacturing, Robotics, nomenclature of joints, motion.

PRACTICAL EXERCISES

1. Comparative Study of the constructional details of CNC lathe and CNC milling Machine.
2. Comparative Study of international standard codes:
-G-Codes and M-Codes; for major operations.
3. Study the constructional details of following components of CNC machine installed in lab for:
 - Automatic tool changer and tool setter
 - Multiple pallets
 - Swarf removal
 - Safety devices
4. Develop a part programme for following lathe operations and make the job on CNC lathe and CNC turning center.(for finish pass only) – (At least two) Calculating coordinate points for a cylindrical job by considering sign convention for lathe (Material: Aluminium/Acrylic/Plastic rod)
 - Plain turning and facing operations
 - Taper turning operations
 - Operation along contour using circular interpolation.
5. Develop a part programme for the following milling operations and make the job on CNC milling (for finish pass only)- At least two (Material: Aluminium/Acrylic/Plastic rod)
 - Plain milling
 - Slot milling
 - Contouring
 - Pocket milling
6. Calculate coordinate points for a zig zag job by considering sign convention for milling
7. Using canned cycle - Create a part program for drilling, tapping, counter sinking and produce component in the Machine

8. Demonstration through industrial visit for awareness of actual working of FMS in production.
9. Use of software for any one of turning or milling operations on CNC turning center. Program writing – Turning simulator for generation of tool path.
10. Demo of 3-D Printing.

RECOMMENDED BOOKS

1. CNC Machine and Automation by JS Narang, Dhanpat Rai & Co, New Delhi.
2. CNC Machines – Programming and Applications by M Adithan and BS Pabla; New Age International (P) Ltd., Delhi.
3. Computer Aided Manufacturing by Rao, Kundra and Tiwari; Tata McGraw Hill, New Delhi.
4. CNC Machine by Bharaj; Satya Puble-books Publications, New Delhi.
5. e-books/e-tools/relevant software to be used as recommended by AICTE/HSBTE/NITTTR.

RECOMMENDED WEBSITES

1. <http://swayam.gov.in>

INSTRUCTIONAL STRATEGY

This is hands on practice based subject and topics taught in the class should be practiced in the Lab regularly for development of required skills among the students. This subject contains five units of equal weightage. 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.

5.4 PROGRAMME ELECTIVE-I

5.4.1 INDUSTRIAL ENGINEERING

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RATIONALE

In the competitive production houses, it is required that a diploma holder at supervision level have knowledge of time and motion study procedures to improve the methods/system. For this, knowledge and related skills in method study and work measurement are essential. In addition, knowledge of production planning and control is required for the optimized control on production process.

COURSE OUTCOMES

After undergoing the training, the students will be able to:

- CO1 Use industrial engineering concepts to improve productivity
- CO2 Use resources optimally and economically.
- CO3 Apply work study techniques to eliminate unproductive activities
- CO4 Explain various incentive plans
- CO5 Solve planning, scheduling and sequencing problems for shop floor
- CO6 Interpret different kinds of production systems
- CO7 Prepare break-even analysis and Gantt chart.
- CO8 Locate suitable plant location and draw plant layout for different production system.
- CO9 Maintain inventory optimally and classify different types of inventory

DETAILED CONTENTS

UNIT-I

Productivity

Introduction to productivity, Standard of living, factors affecting productivity, practical measurement of productivity, difference between production and productivity, causes of low productivity and methods

to improve productivity, contribution of standardization in improving productivity. Importance of good working conditions.

Work Study

Definition and scope of work study; factors for selection of work study job, uses and limitations of work study, Inter-relation between method study and work measurement; Human aspects of work study; Role of work study in improving productivity. Method Study - Objectives and procedure for Method study analysis

UNIT-II

Motion Analysis

Principles of Motion analysis; Therbligs and SIMO charts; Normal work area (Principle of motion economy), Arrangement of work place with motion economy. Ergonomics, ergonomic aspect in design of machine tools and equipment.

Work measurement

Objectives; work measurement techniques, Time study, Basic procedure in making a time study; Employees rating factor;

Application of time allowances: Rest, Personal, Process, Special and Policy allowances; Calculation of standard time; Simple Numerical Problems; Techniques of Work Measurement; standard data and its usage.; Pre determined Motion Time System (PMTS)., work sampling,

UNIT III

Wages and Incentive Schemes

Introduction to wages, Wage payment for direct and indirect labour, wage payment plans. Incentives, types of incentives, various incentive plans, incentives for indirect labour.

Plant Layout

Location, layout of machines in Plant Layout, Principles of Plant layout, types of plant layout and positioning of machines

UNIT IV

Production Planning and Control

Production and its types- job order, batch type and continuous type of productions.

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, dispatching – purpose, and procedure, follow up – purpose and procedure. GANTT charts-types. CPM/PERT technique.

Stores Management

Different Layout and structures of stores, Inventory control, Types of inventory, Various terms of inventory like: reorder quantity, etc. ABC Analysis, calculation of EOQ, Bin cards and various forms required in stores for documentation. Purchase procedures.

UNIT V

Miscellaneous

Value Engg: Value engineering concepts, advantages, applications, problem recognition, and role in productivity, criteria for comparison, and element of choice. VE activity, use, esteem and exchange values, basic vs. secondary vs. unnecessary functions. Approach of function, Evaluation of function, determining function, classifying function, evaluation of costs, Monte Carlo method for make or buy.

Break –Even Analysis.

PRACTICAL EXERCISES

1. Stop watch time study on any machine like lathe, drilling machine or milling machine
2. Method improvement - Assembly of bolt, nut and 3 washers
3. Determination of standard time for assembly of electrical switch
4. Preparation of flow process chart
5. Preparation of SIMO chart
6. Preparation of flow diagram

RECOMMENDED BOOKS

1. Production and costing by GBS Narang; Khanna Publishers, New Delhi.
2. Production Management by MS Sehrawat and JS Narang, Dhanpat Rai and Sons, New Delhi.
3. Industrial Engineering and Management by O.P. Khanna, Dhanpat Rai and Sons, Delhi.
4. Work Study and Ergonomics by S Dalela and Sourabh
5. Industrial Engineering and Management by M. Mahajan; Dhanpat Rai and Sons, New Delhi.
6. Introduction to Work Study, ILO Publication

7. Anil Kumar Mukhopadhyaya, “Value Engineering: Concepts Techniques and applications”, SAGE Publications 2010.
8. Miles, L.D., “Techniques of Value Analysis and Engineering”, McGraw Hill second Edition, 1989

RECOMMENDED WEBSITES

1. <https://www.shiksha.com/engineering/industrial-engineering-chp>
2. <http://swayam.gov.in>

INSTRUCTIONAL STRATEGY

This subject contains five units of equal weightage. Teacher should use models and encourage students to develop some other suitable model. The teacher should observe and redress the difficulties faced by students in performing the work while working on ergonomically good and poorly designed workstation. The teacher should show them real forms to be filled from stores and record keeping.

5.4.2 PLANT MAINTENANCE AND MATERIAL HANDLING

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RATIONALE

A diploma holder is involved in supervision and maintenance related jobs. He must know the various processes carried out during maintenance, material handling and documentation of the same. The students should understand the concepts of testing, erection and commissioning of machines, periodical repair and maintenance.

COURSE OUTCOMES

After undergoing the subject, the students will be able to:

- CO1: Explain the concept of testing, repair and maintenance.
- CO2: Explain the procedure for erection and commissioning of machines
- CO3: Explain the procedure for testing of machines
- CO4: Explain various lubrication systems
- CO5: Describe the procedure of repair and maintenance
- CO6: Explain the means to maintain various Material Handling systems

DETAILED CONTENTS

UNIT-1

Introduction

Necessity and advantages of testing, repair and maintenance, Significance of work content of testing, repair and maintenance. Common instruments required for testing, significance of B-T curve in life span of machine tool, Acceptance test for machine tools, Economic aspects, manpower planning and materials management

Plant Layout, Erection and Commissioning of Machines (Installation)

Location, layout of machines in Plant Layout, Principles of Plant layout, types of plant layout and method of positioning of machines, grouping of machines.

Foundation – types of foundation, various considerations for machine foundations, foundation plan, types of foundation bolts, erection and leveling, grouting Vibration, damping, vibration isolation – methods of isolation, anti-vibration mounts.

UNIT-II

Testing Of Machines

Testing equipment – dial gauge, mandrel, spirit level, straight edge, auto collimator, Recalibration of measuring instruments like vernier calliper

Testing methods – geometrical/alignment test, performance test, testing under load, run test, vibrations, noise

Testing of appliances (for safety and operational efficiency)-ACs, Lifts.

Maintenance

Definition, advantages, limitations, functions and types of maintenance organisation. Types of maintenance viz. emergency, preventive, breakdown/corrective, predictive

Introduction to computerized maintenance record like facility register, maintenance request.

Introduction to machine history card – purpose and advantages.

Preparation of scheduled yearly plan for preventive maintenance, difference of work, content of servicing, repairs and overhauling. MTBF and MTTR. Maintainability, Reliability

UNIT-III

Spare Part Provisioning

Spare parts- types of spare parts, need of frequently needed spare parts inventory, Make provision of spares for parts not available in market, Cannibalism.

Repairing

Repair cycle, analysis, Repair complexity, Common parts which are prone to failure, reasons of failure

Repair schedule Parts that commonly need repair such as belts, couplings, nuts, and bolts repairing the engines, compressors and boilers. Maintenance manual, Maintenance records, Housekeeping.

Introduction to Total Productive Maintenance (TPM). Concept of periodic maintenance schedule of items like air conditioner, industrial vehicle & other machines.

UNIT-IV

Lubrication Systems

Lubrication methods and periodical lubrication chart for various machines (daily, weekly, monthly)

Handling and storage of lubricants, Lubricants conditioning and disposal

Lubricant and their grades needed for specific components such as gears, bearings, and chains

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

Functional additives –

surface, performance enhancing, lubricant protective, Lubricants applications – tribological components and industrial machinery, Lubricants testing and test methods, Organization and management of lubrication, lubricant storage and handling.

UNIT-V

Material Handling Systems

Basic principles of material handling, Basic types of material handling equipments and its characteristic, Types of load to be handled, Uses and limitations, Methods of stacking, Unit load: pallet sizing and loading. Forklift trucks, Conveyor models, Working & Maintenance of Traction type conveyors such as Belt conveyors, Chain conveyors, Bucket elevators, Escalators, AGV Systems, Automated Storage & Retrieval System (ASRS), Carousels, Load handling attachments: a) Various types of hooks-Forged, Triangular eye hooks, Appliances for suspending hooks b) Crane grab for unit & piece loads c) Electric lifting magnet, vacuum lifter. d) Grabbing attachment for loose materials e) Crane attachment for handling liquids/molten metals. Load conditions & Economics of material handling system.

RECOMMENDED BOOKS

1. Installation, Testing and Maintenance by JS Narang, Dhanpat Rai & Sons, New Delhi.
2. Industrial Maintenance by HP Garg; S. Chand and Company, Delhi.
3. Plant Maintenance Engineering by RK Jain; Khanna Publishers, Delhi.
4. Installation, Servicing and Maintenance by SN Bhattacharya; S Chand and Company, Delhi.
5. Maintenance Engineering and Management by RC Mishra and K Pathak; Prentice Hall of India Pvt. Ltd., New Delhi.
6. E-books/e-tools/relevant software to be used as recommended by AICTE/HSBTE/NITTTR.

RECOMMENDED WEBSITES

1. <http://swayam.gov.in>
2. <https://www.plantengineering.com/articles/material-handling-maintenance-needs-cloud-based-efficiency/>

INSTRUCTIONAL STRATEGY

This subject contains five units of equal weightage. The Teacher should lay emphasis on following:

- Lay greater emphasis on practical aspects of maintenance.
- Make use of PPTs and video films
- Expose the students to real life situation.
- Promote continued learning through properly planned assignments.
- Demonstrate sample of all types of gear and bearings.

5.4.3 STAINLESS STEEL TECHNOLOGY

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RATIONALE

Many students of Mechanical Engineering find employment in the industries related to stainless steel. They should be having basic understanding of shop floor practices in the production of stainless steel. They should be made aware about transformations and heat treatment operations in the fabrication and manufacture of stainless steel.

COURSE OUTCOMES

After undergoing the subject, the students will be able to:

CO1: Work on shop floor for the Production of stainless steels.

CO2: Undertake processing, fabrication, property evaluation, structure - property correlation of steel.

CO3: Undertake Phase Transformations and Heat treatments

CO4: Select grades for large scale applications

DETAILED CONTENTS

UNIT-1

Introduction

Definition, Alloying elements in Stainless Steels and their functions. Effect of alloying elements on properties of Stainless Steels. Classification of Stainless Steels. Cost implications of alloy additions and substitutes. Comparison of Stainless steel production in India and in the world.

Making And Processing

Raw materials, Electric Arc Furnace, Induction furnace, plasma furnace, Argon oxygen decarburisation, Ladle Refining, Vacuum Oxygen Decarburisation, Vacuum degassing, Ingot casting vis-a-vis Continuous casting, casting defects, inclusion control. Hot Rolling, Hot Forging, Annealing & Pickling, Cold Rolling, Final Annealing and Pickling, Skin Pass Mill, Strip Grinding Line. Finishing of Stainless Steels. Colour Coating of Stainless Steels, Powder Coating process, thermal spray Eutalloy

process for wear resistant.

UNIT-II

Phase Transformations and Heat Treatments

Relevance of Nickel equivalent and Chromium equivalent, Inadequacy Fe-Fe₃C diagram for stainless steels, Role of alloying elements in ferrite and austenite stabilization, Role of deformation on phase transformation. Heat treatment of stainless steels-ferrite, martensite, austenitic, duplex, precipitation hardenable grade stainless steels. Precipitation reaction in stainless steels.

Mechanical Behaviour and Properties

Deformation behavior of stainless steel. Role of precipitates on mechanical properties. Mechanical properties of different grades of stainless steels- tensile, hardness, impact, fatigue.

UNIT-III

Fabrication of Steels I

Cold roll forming(CRF) processes, Forging, Extrusion, Deep Drawing, Coin blanking, machining, Cutting of Stainless Steels, Welding of Stainless Steels- Welding, Brazing, Soldering and Overlaying, Common welding techniques, welding consumables and precautions required. Fusion Welding processes- Shielded Metal Arc Welding (SMAW), Gas Tungsten AW, Gas Metal AW (Inert/active gas), Flux-cored AW, Plasma AW, Submerged AW, Electro-slag Welding, EBW, LBW. Solid State Welding – All variations of Resistance welding e.g. Spot, Seam, Projection, Flash, Upset, High frequency, Percussion. Friction stir welding.

UNIT-IV

Fabrication of Steels II

Specific difficulties associated with welding of–Martensitic-, Ferritic, Austenitic-, Duplex, Precipitation Hardened-,Martensitic, Semiaustenitic-,Austenitic-precipitation hardened stainless steels. Welding of dissimilar metal combinations with stainless steels. Sensitization/Weld decay: Causes, mechanisms, remedies, High temperature sensitization, 475oC embrittlement, α' phase transformation, Distortion- Causes, mechanisms, remedies, Effect of alloying elements on weldability of Stainless Steels, Schrieffer De Long diagram interpretations. Tools and Equipment. Issues faced during fabrication of stainless steels and their solutions.

Testing, Handling and Storage of Stainless Steel

PMI technique, XRF, Ultrasonic testing, Magnetic Particle testing, Dye penetrate, Portable hardness, Surface roughness measurement, Surface Reflectivity measurement, Recommended procedures for storage

UNIT-V

Corrosion

Types of corrosion, Galvanic corrosion-Mechanism and prevention, Pitting Corrosion- Mechanism and prevention, Interpretation of PREN, Crack propagation mechanisms-Inter-granular, Trans-granular, Crevice Corrosion, Stress Corrosion Cracking(SCC),Microbiologically Induced Corrosion (MIC), Erosion Corrosion. High temperature corrosion, Different corrosion testing procedures. Role of precipitates on corrosion, Corrosion resistance of stainless steels

Applications

Automotive, Railways & Transport, Architecture Building & Construction, Reinforcement bars, Roofing sheets, utensils, Furniture's, Material Handling applications, Process Industries, Biomedical applications. Life Cycle Cost Analysis.

RECOMMENDED BOOKS

1. Corrosion Engineering, MG Fontana, 3rd Edition, McGraw-Hill Book Company, New York,1987
2. Phase Transformation in Metals and Alloys, David A Porter, K.E. Esterling, CRC press, Taylor and francisgroup,3rdEdition, 2009,.
3. Alloys: Preparation, Properties, Applications, Fathi Hubashi, WileyVCH;1 edition,2008
4. Fundamental of Steelmaking by E.T. Turkdogan, The InstituteofMaterials,London,1996,
5. Fundamental of Steelmaking Metallurgy by Brahma *Deo*; Rob *Boom*, Prentice Hall International, 1993.
6. Steel Making by V.Kudrin, Moscow : Mir Publishers ; Boca Raton : CRC Press,1985
7. Steel and its Heat Treatment by K.E.Thieling, Butterworth-Heinemann,1967
8. The Physical Metallurgy of Steels by William C. Leslie, Hemisphere Pub.Corp.,1981
9. Stainless Steel and Their Properties by Bela Lafler
10. Physical metallurgy of Stainless Steel Development, FB Pickering, International Materials Reviews, Volume21, 1976, ASM international
11. 100 years of Stainless Steel by BSSA(UK),2013
12. Handbook of Stainless Steel: Donald Peckner, Irving Melvin Bernstein, Macgraw-hill books,1977

13. Alloy Digest Source Book: Stainless Steel, Joseph R. Davis, ASM international, 1994
14. ASM specialty handbook stainless steel, Joseph R. Davis, ASM international6.OutokompuStainlessSteelHandbooks, 2009
15. Technical Hand book of Stainless steel: The Atlas Steels, 2013.

RECOMMENDED WEBSITES

1. <https://stainlesssteeltech.com/>
2. <https://www.steel-technology.com/articles/stainless-steel-overview-types-buying-guide-and-global-suppliers>
3. <http://www.stainlesstech.com/>

INSTRUCTIONAL STRATEGY

This subject contains five units of equal weightage. The teachers should use teaching aids for classroom teaching and give assignments for solving numerical problems. Arrange industry visits to augment classroom teaching-learning process. Arrange expert lectures from the industry experts.

5.5 THEORY OF MACHINES

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RATIONALE

In industries, the diploma engineers/technicians are supposed to manage functioning of equipment with proper planning, operation and maintenance of equipment and assist in the Design and Development of Prototype and other components. It is essential that he is made conversant with the principles related to use and design of machine components. He needs knowledge and skills of various motion and force transforming mechanisms and devices, such as four bar mechanism, belt pulley, clutches, flywheel, etc. This course is included in the curriculum to provide such necessary knowledge and skills in the area of mechanical equipment and devices to help in understanding of kinematics & dynamics of different equipment being used in industry.

COURSE OUTCOMES

After undergoing the subject, the students will be able to:

- CO1: Describe different machine elements, mechanisms and inversion of mechanism
- CO2: Describe different types of cams and their motions and also draw cam profiles for various Motions.
- CO3: Select Suitable Drives and Mechanisms for a particular application
- CO4: Solve problems on power transmission.
- CO5: Explain the design of Brakes, Dynamometers, Bearings and Clutches.
- CO6: Solve problems on balancing and Vibration

DETAILED CONTENTS

UNIT-1

SIMPLE MECHANISMS

1.1 Introduction to Machines and Theory of Machines

1.2 Kinematics of Machines: - Definition of Kinematics, Dynamics, Statics, Kinetics, Kinematic link, Kinematic Pair and its types, constrained motion and its types, Kinematic chain and its types, Mechanism, inversion, machine and structure.

1.2 Inversions of Kinematic Chain: Inversion of four bar chain, coupled wheels of Locomotive &

Pantograph. Inversion of Single Slider Crank chain- Rotary I.C. Engines mechanism, Crank and Slotted lever quick return mechanism. Inversion of Double Slider Crank Chain- Scotch Yoke Mechanism & Oldham's coupling.

UNIT-II

CAMS & FOLLOWERS

- 2.1 Definition and function of cam. Different types of cams and followers and their specific applications.
- 2.2 Terminology of cam profile.
- 2.3 Displacement diagram for uniform velocity, S.H.M. and uniform acceleration and deceleration.
- 2.4 Drawing of profile of radial cam with knife-edge and roller follower with and without offset with reciprocating motion.

UNIT-III

FLYWHEEL

- 3.1 Flywheel - Concept, function and applications of flywheel. Types of flywheel: (i) Disc type (ii) Rim type (Specific application of these two).
- 3.2 Turning moment diagram for single cylinder 4-Stroke I.C. Engine and Steam Engine (Single Acting & Double Acting).
- 3.3 Coefficient of fluctuation of energy, Coefficient of fluctuation of speed and its significance. (Numerical).

GOVERNORS

Concept, function and applications of Governors.

Comparison between Flywheel and Governor

Terminology used in Governors.

Types of centrifugal Governor: Construction and working of Simple Watt governor, Porter Governor and Hartnell Governor.

UNIT-IV

MECHANICAL POWER TRANSMISSION

- 4.1 Introduction to Mechanical Power, Need of Power Transmission, Methods of Power Transmission.
- 4.2 Introduction to belt drives. Flat belt drive and V -belt drive, Relative advantages and disadvantages,
- 4.3 Types and application of belt drives- Open belt drive, Closed or crossed belt drive, Fast and loose pulley, Stepped cone pulley, Jockey pulley drive, Quarter turn belt drive, Compound belt drive. Length of belt.

- 4.4 Concept of velocity ratio, slip and creep; crowning of pulleys,
- 4.5 Ratio of driving tensions, power transmitted, centrifugal tension, and condition for maximum horse power (simple numerical)
- 4.6 Introduction to Chain Drive, Different types of chains and their applications. Advantages disadvantages of chain drive relative to belt drive.
- 4.7 Gear Drive -Different types of gears and their applications.
- 4.8 Gear train, Types and application of different gear trains: Simple, compound, reverted and epicyclic gear trains(simple numerical)
- 4.9 Relative advantages and disadvantages of Gear drive over other belt drives.

UNIT-V

VIBRATIONS & BALANCING

- 5.1 Concept and terminology used in vibrations, Causes of vibrations in machines; their harmful effects and remedies. Types of vibrations-Free, forced and damped. Damping of vibrations. Resonance.
- 5.2 Concept of balancing, static and dynamic balancing, Need of balancing of machine parts.
- 5.3 Balancing of rotating masses in the same plane and different planes.

PRACTICAL EXERCISES

- 1. To study inversion of Four Bar Mechanism, Single Slider Crank Chain and Double Slider Crank Chain Mechanism with the help of working models.
- 2. To construct radial cam profile for uniform velocity with knife edge and roller follower on drawing sheet.
- 3. To construct radial cam profile for SHM with knife edge and roller follower on drawing sheet.
- 4. To construct radial cam profile for uniform acceleration and retardation with knife edge and roller follower on drawing sheet.
- 5. To find the moment of inertia of a flywheel.
- 6. To Study the different types of centrifugal governors & plot graph between R.P.M & Displacement of sleeve.
- 7. To study various types of belts drives and to calculate velocity ratio.
- 8. To study different types of gear trains with the help of working models and to calculate Velocity ratio.
- 9. To perform the experiment of Balancing of rotating parts and find the unbalanced couple and forces.

RECOMMENDED BOOKS

1. Theory of machines – S.S .Rattan, Tata McGraw-Hill publications.
2. Theory of machines – R.K.Bansa , Laxmi publications.
3. Theory of machines – R.S. Khurmi & J.K.Gupta, S.Chand publications.
4. Dynamics of Machines – J B K Das, Sapna Publications.
5. Theory of machines – Jagdish Lal, Bombay Metro – Politan book Ltd.
6. Theory of machines – P.L. Ballaney, Khanna Publications.

RECOMMENDED WEBSITES

1. https://www.researchgate.net/publication/278026450_Introduction_to_Theory_of_Machines
2. https://www.maritimeknowledge.in/course-details.php?course_id=80&course_name=Mechanics%20of%20Machines-1#
3. <https://www.slideshare.net/akhudaiwala/introduction-to-theory-of-machines>

INSTRUCTIONAL STRATEGY

This subject contains five units of equal weightage. 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.

5.6 MULTIDISCIPLINARY ELECTIVE

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RATIONALE

Multidisciplinary electives are very important and play major role in implementation of National Education Policy. Multidisciplinary is a subject which is useful for two or more disciplines in which students are asked to understand the concept of multidisciplinary or interdisciplinary. It will help the students to gain an arsenal of skills that are easily transferable across work environments.

COURSE OUTCOMES

At the end of the open elective, the students will be able to:

CO1: Apply critical thinking problem solving.

CO2: Demonstrate self and time management.

CO3: Display analytical and research abilities.

CO4: Integrate multiple knowledge domains.

CO5: Enhance the scope and depth of learning.

LIST OF MULTIDISCIPLINARY ELECTIVES

(The list is indicative and not exhaustive)

1. Introduction to Internet of Things
2. Introduction to Robotics
3. Introduction to Embedded System Design
4. Fundamentals of Artificial Intelligence
5. Digital Image Processing
6. Introduction to Machine Learning
7. Fundamentals of Artificial Intelligence
8. The Joy of Computing Using Python
9. Cloud Computing
10. Introduction to Industry 4.0

11. Industrial Internet of Things

12. Object Oriented System Development using UML, Java and Patterns

GUIDELINES

Multidisciplinary Elective shall be offered preferably in online mode. Online mode multidisciplinary elective shall preferably be through Massive Open Online Courses (MOOCs) from Swayam, NPTEL, Upgrad, Udemy, Khan Academy or any other online portal to promote self-learning. A flexible basket of large number of multidisciplinary electives is suggested which can be modified depending upon the availability of courses at suggested portals and requirements. For online multidisciplinary electives, department coordinators shall be assigned to monitor and guide the group of students for selection of minimum 20 hours duration online course of their choice. For offline multidisciplinary electives, a suitable relevant subject shall be offered by the respective department to the students with minimum 40% of the total class strength as per present and future requirements.

Assessment of MOOCs multidisciplinary elective shall be based on continuous evaluation by the respective coordinator. The coordinator shall consider the submitted assignments by the students from time to time during the conduct of MOOCs. The MOOCs assessment shall be conducted by the coordinator along with one external expert by considering submitted assignments out of 100 marks.

In case, no suitable multidisciplinary elective is available online, only then the course may be conducted in offline mode. The assessment of offline multidisciplinary elective shall be internal and external. The offline multidisciplinary elective internal assessment of 40 marks shall be based on internal sessional tests, assignments etc. and external assessment of 60 marks shall be based on external examination at institute level.

SUGGESTED WEBSITES

1. <https://swayam.gov.in/>
2. <https://www.udemy.com/>
3. <https://www.upgrad.com/>
4. <https://www.khanacademy.org/>

5.7 WORKSHOP PRACTICE-IV

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RATIONALE

Diploma holders are responsible for supervising production processes to achieve production targets and for optimal utilization of resources. For this purpose, skills in operating various machines are required to be developed among the students.

COURSE OUTCOMES

After undergoing the training, the students will be able to:

CO1: Prepare jobs using gear hobbing EDM and grinding machine.

CO2: Carry out metal finishing operations.

CO3: Carry out powder coating, honing and scraping operations.

PRACTICAL EXERCISES

UNIT I

MODERN MACHINE SHOP-I

- Prepare a cavity/hole on EDM machine.
- Exercise of cutting a helical gear on gear hobbing machine

UNIT II

MODERN MACHINE SHOP-II

- Prepare a job on centre less grinding machine.
- Demonstration of 3-D printing Machine through industrial visit.

UNIT III

ADVANCE FINISHING SHOP-I

- Prepare a job on powder coating machine.

- Prepare a job to finish an external surface using honing process.

UNIT-IV

ADVANCE FINISHING SHOP-II

- To perform a scraping operation on flat surface.
- Demonstration of advance finishing processes through industrial visit.

RECOMMENDED WEBSITES

1. B.S. Raghuwanshi, “Workshop Technology”, Dhanpat Rai and Sons, Delhi.
2. S.K. Choudhry and Hajra, “Elements of Workshop Technology”, Asia Publishing House.
3. PC Sharma, “A Textbook of Production Engineering”, S. Chand and Company Ltd. Delhi.

INSTRUCTIONAL STRATEGY

This is hands-on practice based workshop for development of required skills in the students. Instructor should conduct classes of each Workshop explaining use of tools, jobs to be made and safety precautions related to each workshop prior to students being exposed to actual. Industrial visits may be arranged for demonstration of above shops, wherever in –house infrastructure is not available.

5.8 MINOR PROJECT

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RATIONALE

Minor project work will help in developing the relevant skills among the students as per National Skill Qualification Framework. It aims at exposing the students to the present and future needs of various relevant industries. It is expected from the students to get acquainted with desired attributes for industrial environment. For this purpose, students are required to be involved in Minor Project Work by apply the knowledge and skills gained through course work.

COURSE OUTCOMES

After undergoing this course, the students will be able to:

- CO1: Define the problem statement of the minor project according to the need of industry.
- CO2: Work as a team member for successful completion of minor project.
- CO3: Write the minor project report effectively.
- CO4: Present the minor project report using PPT.
- CO5: Presentation Skills development.

GUIDELINES

Depending upon the interest of the students, they can develop minor projects as per present and future demand of the industry. The supervisors may guide the students to identify their minor project work and prepare their plan of action well in advance. As a minor project activity each student is supposed to study the operations and prepare a detailed project report of the operations/processes/activities. The supervisor may create a group of 5-6 students as per their interest to work as a team for successful completion of the minor project. Necessary infrastructure and facilities of workshop and other labs will be provided for executing the minor projects.

The supervisor shall evaluate the students along with one external expert by considering the following parameters:

| | Parameter | Weightage |
|-----|-----------------------------|------------------|
| I | Selection of minor project | 20% |
| ii | Innovation / creativity | 20% |
| iii | Performance, responsibility | 20% |
| iv | Report Writing | 20% |
| v | Viva -voce / presentation | 20% |