

## 6.1 BASICS OF MANAGEMENT

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### RATIONALE

The diploma holders are generally expected to take up middle level managerial positions, their exposure to basic management principles is very essential. Topics like Structure of Organization, Leadership, Motivation, Ethics and Values, Customer Relationship Management (CRM), Legal Aspects of Business, Total Quality Management (TQM), Intellectual Property Rights (IPR) etc. have been included in the subject to provide elementary knowledge about these management areas.

### DETAILED CONTENTS

1. Principles of Management (06 hrs)
  - 1.1. Introduction, definition and importance of management.
  - 1.2. Functions of Management  
Planning, Organizing, Staffing, Coordinating, Directing, Motivating and Controlling.
  - 1.3. Concept and Structure of an organization  
  
Types of industrial organization
    - a) Line organization
    - b) Functional organization
    - c) Line and Functional organization
  - 1.4. Hierarchical Management Structure  
Top, middle and lower level management
  - 1.5. Departmentalization  
Introduction and its advantages.
2. Work Culture (06 hrs)
  - 2.1. Introduction and importance of Healthy Work Culture in organization
  - 2.2. Components of Culture
  - 2.3. Importance of attitude, values and behaviour  
Behavioural Science – Individual and group behaviour
  - 2.4. Professional ethics – Concept and need of Professional Ethics

3. Leadership and Motivation (06 hrs)
- 3.1. Leadership
    - a) Definition and Need of Leadership
    - b) Qualities of a good leader
    - c) Manager vs. leader
  - 3.2. Motivation
    - a) Definition and characteristics of motivation
    - b) Factors affecting motivation
    - c) Maslow's Need Hierarchy Theory of Motivation
  - 3.3. Job Satisfaction
4. Legal Aspects of Business: Introduction and need (06 hrs)
- 4.1. Labour Welfare Schemes
    - a) Wage payment : Definition and types
    - b) Incentives: Definition, need and types
  - 4.2. Factory Act 1948
  - 4.3. Minimum Wages Act 1948
5. Management Scope in different Areas (12 hrs)
- 5.1. Human Resource Development
    - a) Introduction and objective
    - b) Manpower Planning, recruitment and selection
    - c) Performance appraisal methods
  - 5.2. Material and Store Management
    - a) Introduction, functions and objectives of material management
    - b) Purchasing: definition and procedure
    - c) Just in time (JIT)
  - 5.3. Marketing and Sales
    - a) Introduction, importance and its functions
    - b) Difference between marketing and selling
    - c) Advertisement- print media and electronic media
    - d) Market-Survey and Sales promotion.

- 5.4. Financial Management – Introduction
  - a) Concept of NPV, IRR, Cost-benefit analysis
  - b) Elementary knowledge of Income Tax, Sale Tax, Excise duty, Custom duty, Provident Fund
- 5.5 Maintenance Management
  - a) Concept
  - b) Preventive Maintenance
- 6. Miscellaneous topics (12 hrs)
  - 6.1. Customer Relationship Management (CRM)
    - a) Definition and Need
    - b) Types of CRM
    - c) Customer satisfaction
  - 6.2. Total Quality Management (TQM)
    - a) Inspection and Quality Control
    - b) Concept of Quality Assurance
    - c) TQM
  - 6.3. Intellectual Property Rights ( IPR)
    - a) Introduction, definition and its importance
    - b) Infringements related to patents, copyright, trade mark

## **INSTRUCTIONAL STRATEGY**

It is observed that the diploma holders generally take up middle level managerial positions, therefore, their exposure to basic management principles is very essential. Accordingly students may be given conceptual understanding of different functions related to management. Some of the topics may be taught using question answer, assignment or seminar method. The teacher will discuss success stories and case studies with students, which in turn, will develop appropriate managerial qualities in the students. In addition, expert lectures may also be arranged from within the institutions or from management organizations. Appropriate extracted reading material and handouts may be provided.



## RECOMMENDED BOOKS

1. Principles of Management by Philip Kotler TEE Publication
2. Principles and Practice of Management by Shyamal Bannerjee: Oxford and IBM Publishing Co, New Delhi.
3. Financial Management by MY Khan and PK Jain, Tata McGraw Hill Publishing Co., 7, West Patel Nagar , New Delhi.
4. Modern Management Techniques by SL Goel: Deep and Deep Publications Pvt Limited , Rajouri Garden, New Delhi.
5. Management by James AF Stoner, R Edward Freeman and Daniel R Gilbert Jr. : Prentice Hall of India Pvt Ltd, New Delhi.
6. Essentials of Management by H Koontz, C O' Daniel , McGraw Hill Book Company, New Delhi.
7. Marketing Management by Philip Kotler, Prentice Hall of India, New Delhi
8. Total Quality Management by DD Sharma, Sultan Chand and Sons, New Delhi.
9. Intellectual Property Rights and the Law by Dr. GB Reddy.
10. Service Quality Standards, Sales & Marketing Department, Maruti Udyog Ltd.
11. Customer Relationship Management: A step-by-step approach, Mohamed & Sagadevan Oscar Publication, Delhi
12. Customer Relation Management, Sugandhi RK, Oscar Publication, Delhi.

## SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (hrs)	Marks Allotted (%)
1.	06	15
2.	06	10
3.	06	15
4.	06	10
5.	12	25
6.	12	25
<b>Total</b>	<b>48</b>	<b>100</b>

## 6.2 CNC MACHINES AND AUTOMATION

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### RATIONALE

Diploma holders are required to supervise and handle specialized machines and equipment 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.

### DETAILED CONTENTS

1. Introduction (08hrs)  
  
Introduction to NC, CNC & DNC, their advantages, disadvantages and applications, Machine Control Unit, input devices, selection of components to be machined on CNC machines, Problems with conventional NC, New developments in NC, Axis identification, PLC Control and its components. Its advantages and disadvantages.
2. Construction and Tooling (06 Hrs)  
  
Design features, specification Chart of CNC machines, use of slideways, balls, rollers and coatings, motor and leadscrew, swarf removal, safety and guarding devices, various cutting tools for CNC machines, overview of tool holder, different pallet systems and automatic tool changer system, management of a tool room.
3. Part Programming (08 Hrs)  
  
Part programming and basic concepts of part programming, NC words, part programming formats, simple programming for rational components, part programming using canned cycles, subroutines and do loops, tool off sets, cutter radius compensation and wear compensation.
4. System Devices (10 Hrs)  
  
Actuators, Transducers and Sensors, Tachometer, LVDT, opto-interrupters, potentiometers for linear and angular position, encoder and decoder, axis drives, open loop system, close loop system.
5. Problems in CNC Machines (04 Hrs)  
  
Common problems in mechanical, electrical, pneumatic, electronic and PC components of NC machines, diagnostic study of common problems and remedies, use of on-time fault finding diagnosis tools in CNC machines.

6. Automation and NC system (06 Hrs)

Role of computer in automation, emerging trends in automation, automatic assembly, manufacture of magnetic tape, manufacture of printed circuit boards, manufacture of integrated Circuits, Overview of FMS, Group technology, CAD/CAM and CIM.

6. Robot Technology (06 hrs)

Introduction to robot technology, basic robot motion, robot applications

### **LIST OF PRACTICALS**

- 1 Study the constructional details of CNC lathe.
2. Study the constructional details of CNC milling machine.
3. Study the constructional details and working of:
  - 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.
  - 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
  - Plain milling
  - Slot milling
  - Contouring
  - Pocket milling
6. Preparation of work instruction for machine operator
7. Preparation of preventive maintenance schedule for CNC machine.
8. Demonstration through industrial visit for awareness of actual working of FMS in production.
9. Use of software for turning operations on CNC turning center.

10. Use of software for milling operations on machine centres.
11. Operation of robot.
12. Use of PLC for various mechanical outputs viz. piston motion in a single cylinder, multiple cylinder etc

## INSTRUCTIONAL STRATEGY

This is highly practice-based course. Efforts should be made to develop programming skills amongst the students. During practice work, it should be ensured that students get opportunity to individually perform practical tasks.

## RECOMMENDED BOOKS

1. CNC Machines – Programming and Applications by M Adithan and BS Pabla;  
New Age International (P) Ltd., Delhi.
2. Computer Aided Manufacturing by Rao, Kundra and Tiwari; Tata Mc Graw Hill,  
New Delhi.
3. CNC Machine by Bharaj; Satya Publications, New Delhi.

## SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1	08	16
2	06	16
3	08	16
4	10	20
5	04	08
6	06	12
7	06	12
<b>Total</b>	<b>48</b>	<b>100</b>



## 6.3 MACHINE DESIGN

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### RATIONALE

A diploma holder in this course is required to assist in the Design and Development of Prototype and other components. For this, it is essential that he is made conversant with the principles related to design of components and machine and application of these principles for designing. The aim of the subject is to develop knowledge and skills about various aspects related to design of machine components.

### DETAILED CONTENTS

1. Introduction (08 hrs)
  - 1.1 Design – Definition, Type of design, necessity of design
    - 1.1.1 Comparison of designed and undesigned work
    - 1.1.2 Design procedure
    - 1.1.3 Characteristics of a good designer
  - 1.2 Design terminology: stress, strain, factor of safety, factors affecting factor of safety, stress concentration, methods to reduce stress concentration, fatigue, endurance limit.
    - 1.2.1 General design consideration
    - 1.2.2 Codes and Standards (BIS standards)
  - 1.3 Engineering materials and their mechanical properties :
    - 1.3.1 Properties of engineering materials: elasticity, plasticity, malleability, ductility, toughness, hardness and resilience. Fatigue, creep, tenacity, strength
    - 1.3.2 Selection of materials, criterion of material selection
2. Design Failure (04 hrs)
  - 2.1 Various design failures-maximum stress theory, maximum strain theory, maximum strain energy theory
  - 2.2 Classification of loads
  - 2.3 Design under tensile, compressive and torsional loads.
3. Design of Shaft (10 hrs)
  - 3.1 Type of shaft, shaft materials, Type of loading on shaft, standard sizes of shaft available
  - 3.2 Shaft subjected to torsion only, determination of shaft diameter (hollow and solid shaft) on the basis of :
    - Strength criterion
    - Rigidity criterion

- 3.3 Determination of shaft dia (hollow and solid shaft) subjected to bending
- 3.4 Determination of shaft dia (hollow and solid shaft) subjected to combined torsion and bending .
  
- 4. Design of Key (06 hrs)
  - 4.1 Types of key, materials of key, functions of key
  - 4.2 Failure of key (by Shearing and Crushing).
  - 4.3 Design of key (Determination of key dimension)
  - 4.4 Effect of keyway on shaft strength. (Figures and problems).
  
- 5. Design of Joints (20 hrs)
 

Types of joints - Temporary and permanent joints, utility of various joints

  - 5.1 Temporary Joint:
    - 5.1.1 Knuckle Joints – Different parts of the joint, material used for the joint, type of knuckle Joint, design of the knuckle joint. (Figures and problems).
    - 5.1.2 Cotter Joint – Different parts of the spigot and socket joints, Design of spigot and socket joint.
  - 5.2 Permanent Joint:
    - 5.2.1 Welded Joint - Welding symbols. Type of welded joint, strength of parallel and transverse fillet welds.
    - 5.2.2 Strength of combined parallel and transverse weld.
    - 5.2.3 Riveted Joints. : Rivet materials, Rivet heads, leak proofing of riveted joint – caulking and fullering.
    - 5.2.4 Different modes of rivet joint failure.
    - 5.2.5 Design of riveted joint – Lap and butt, single and multi riveted joint.
  
- 6. Design of Flange Coupling (08 hrs)
 

Necessity of a coupling, advantages of a coupling, types of couplings, design of muff coupling, design of flange coupling. (both protected type and unprotected type).
  
- 7. Design of Screwed Joints (08 hrs)
  - 7.1 Introduction, Advantages and Disadvantages of screw joints, location of screw joints.
  - 7.2 Important terms used in screw threads, designation of screw threads
  - 7.3 Initial stresses due to screw up forces, stresses due to combined forces
  - 7.4 Design of power screws (Press, screw jack, screw clamp)

**Note :** The paper setter should provide all the relevant data for the machine design numericals in the question paper.

## INSTRUCTIONAL STRATEGY

1. While imparting instructions, focus should be on concepts.
2. Presentation should be arranged for various topics.

## RECOMMENDED BOOKS

1. Machine Design by R.S. Khurmi and JK Gupta, Eurasia Publishing House (Pvt.) Limited, New Delhi.
2. Machine Design by V.B.Bhandari, Tata McGraw Hill, New Delhi.
3. Engineering Design by George Dieter; Tata McGraw Hill Publishers, New Delhi.
4. Mechanical Engineering Design by Joseph Edward Shigley; McGraw Hill, Delhi.
5. Machine Design by Sharma and Agrawal; Katson Publishing House, Ludhiana.
6. Design Data Handbook by D.P. Mandali, SK Kataria and Sons, Delhi.
7. Machine Design by A.P.Verma; SK Kataria and Sons, Delhi
8. Machine Design by AR Gupta and BK Gupta ; Satya Parkashan, New Delhi.

## SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1	08	12
2	04	06
3	10	16
4	06	10
5	20	32
6	08	12
7	08	12
<b>Total</b>	<b>64</b>	<b>100</b>

## 6.4 REFRIGERATION AND AIR CONDITIONING

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### RATIONALE

The diploma holder of 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 good.

### DETAILED CONTENTS

#### REFRIGERATION

1. Fundamentals of Refrigeration (02 hrs)

Introduction to refrigeration, and air conditioning, meaning of refrigerating effect, units of refrigeration, COP, difference between COP and efficiency, methods of refrigeration, Natural system and artificial system. Rating of refrigeration

2. Vapour Compression System (12 hrs)

Introduction, principle, function, parts and necessity of vapour compression system, T-  $\phi$  and p- H charts, dry, wet and superheated compression. Effect of sub cooling, super heating, mass flow rate, entropy, enthalpy, work done, Refrigerating effect and COP. actual vapour compression system

3. Refrigerants (04 hrs)

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

4. Air Refrigeration System (08 hrs)

Introduction, advantages and disadvantages of air-refrigeration system over vapour compression system, bell – Collemann cycle, calculation of mass flow rate, work done and COP

5. Vapour Absorption System (06 hrs)

Introduction, principle and working of simple absorption system and domestic electrolux refrigeration systems. Solar power refrigeration system, advantages and disadvantages of solar power refrigeration system over vapour compression system.

6. Refrigeration Equipment (12 hrs)

- 6.1 Compressors- Function, various types of compressors
- 6.2 Condensers - Function, various types of condensers
- 6.3 Evaporators- Function, types of evaporators
- 6.4 Expansion Valves - Function, various types such as capillary tube, thermostatic expansion valve, low side and high side float valves, application of various expansion valves
- 6.5. Safety Devices-Thermostat, overload protector LP, HP cut out switch.

**AIR CONDITIONING**

7. Psychrometry (08 hrs)

Definition, importance, specific humidity, relative humidity, degree of saturation, DBT, WBT, DPT, sensible heat, latent heat, Total enthalpy of air.

8. Applied Psychrometry and Heat Load Estimation. (12 hrs)

Psychrometric chart, various lines, psychrometric process, by pass factor, room sensible heat factor, effective room sensible heat factor, grand sensible heat factor, ADP, room DPT.

Heating and humidification, cooling and dehumidification, window air-conditioning, split type air-conditioning, central air-conditioning.

**LIST OF PRACTICALS**

- 1. Identify various tools of refrigeration kit and practice in cutting, bending, flaring, swaging and brazing of tubes.
- 2. Study of thermostatic switch, LP/HP cut out overload protector filters, strainers and filter driers.
- 3. Identify various parts of a refrigerator and window air conditioner.
- 4. To find COP of Refrigeration system
- 5. To detect trouble/faults in a refrigerator/window type air conditioner
- 6. Charging of a refrigerator/ window type air conditioner.
- 7. Disassembly and assembly of single cylinder open type compressor

8. Visit to an ice plant or cold storage plant. or central air conditioning plant

### **INSTRUCTIONAL STRATEGY**

1. Teaches should take the students to industry and explain the details of refrigeration and air-conditioning systems and their components.
2. While imparting instructions, focus should be on conceptual understanding.
3. Training slides of “Carrier Fundamentals of Refrigeration Air Conditioning” to be shown to students.

### **RECOMMENDED BOOKS**

1. Refrigeration and Air Conditioning by Domkundwar; Dhanpat Rai and Sons, Delhi.
2. Refrigeration and Air Conditioning by CP Arora; Tata McGraw Hill, New Delhi.
3. Refrigeration and Air Conditioning by R.S Khurmi and J.K. Gupta; S Chand and Company Limited, New Delhi.

### **SUGGESTED DISTRIBUTION OF MARKS**

<b>Topic No.</b>	<b>Time Allotted (Hrs)</b>	<b>Marks Allotted (%)</b>
1	02	04
2	12	20
3	04	06
4	08	12
5	06	10
6	12	18
7	08	12
8	12	18
<b>Total</b>	<b>64</b>	<b>100</b>

**ELECTIVE**  
**6.5.1 AUTOMOBILE ENGINEERING**

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**RATIONALE**

These days, automobile has become a necessity instead of luxury. The diploma holders in this course are required to supervise production and repair and maintenance of vehicles. For this purpose, knowledge and skills are required to be imparted to them regarding automobile industry as a whole. This subject aims at developing required knowledge and skills in this area.

**1. COMPONENTS OF AN AUTOMOBILE (06 hrs)**

Introduction to the following units of an automobile:-  
The basic structure  
The power plant  
The transmission System  
The auxiliaries  
The controls  
The superstructure

**2. FRAMES, WHEELS AND TYRES (08 hrs)**

Functions of the frame  
loads on the frame  
Conventional frame construction  
Frame types  
Frameless construction  
Constructional details of wheels  
Wheel dimensions and tread design considerations.

**3. POWER SYSTEM (14 hrs)**

Nomenclature of cylinder bore, piston area, stroke, swept volume clearance volume, compression ratio  
Introduction of various components of an automobile engine.  
Concept of two stroke and four stroke engines.  
Working of petrol engine and diesel engine.  
Fuel supply systems for both petrol and diesel engines.  
Elementary idea about various systems like:-  
Cooling, lubrication, Starting, charging and ignition.

**4. TRANSMISSION SYSTEM (10 hrs)**

Function of clutch  
Constructional details of single plate and multiplate clutches  
Synchromesh gear box-construction, working of final drive and differential

**5. BRAKING SYSTEM (08 hrs)**

Principle of braking/back plate construction mechanical and hydraulic brakes.  
constructional detail of components of braking system.

**6. STEERING AND SUSPENSION SYSTEM (10 hrs)**

Introduction to suspension system, basic requirements for suspension, components of suspension like leaf springs, coil springs, shock absorbers  
Introduction to steering system, steering mechanism, steering linkages and steering gears.

**7. LIGHTING AND ACCESSORIES (08 hrs)**

Wiring circuits, components of wiring circuits. Function of windscreen wiper, horn, speedometer, central locking and power windows.

**INSTRUCTIONAL STRATEGY**

1. Teaches should demonstrate various systems and sub systems of automobile while dealing with the subject.
2. While imparting instructions, focus should be on conceptual understanding.

**RECOMMENDED BOOKS**

1. Automobile Engineering by R.B. Gupta, Satya Prakashan, New Delhi
2. Automobile Engineering by Kirpal Singh, Standard Publisher Distributor
3. Automobile Engineering by GBS Narang, Khanna Publishers, Delhi

**SUGGESTED DISTRIBUTION OF MARKS**

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1	06	10
2	08	12
3	14	22
4	10	16
5	08	12
6	10	16
7	08	12
<b>Total</b>	<b>64</b>	<b>100</b>



## 6.5.2 MECHATRONICS

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### RATIONALE

The mechatronics, the integration of electronic, of electrical engineering, computer technology and control engineering with mechanical engineering is increasingly forming a crucial part in design, manufacture and maintenance of wide range of engineering products and processes. The diploma holders need skills and knowledge that are not confined to a single subject area. They need to be capable of operating and communicating across a range of engineering disciplines and linking those having more specialized skills. So it is important to introduce this subject.

### DETAILED CONTENTS

1. **Introduction** (04 hrs)
  - 1.1 Introduction to Mechatronics
  - 1.2 Mechatronic system
  - 1.3 Measurement systems
  - 1.4 Control system-open Loop, Close loop and sequential
  - 1.5 Microprocessor based controllers
  - 1.6 The Mechatronics approach
2. **Sensors and Transducers** (06 hrs)
  - 2.1 Sensors and transducers
  - 2.2 Performance terminology
  - 2.3 Displacement, position and motion sensors
  - 2.4 Electromechanical sensors and transducers
  - 2.5 Force sensors
  - 2.6 Liquid flow sensors
  - 2.7 Liquid level sensors
  - 2.8 Temperature sensors
  - 2.9 Light sensors
  - 2.10 Selection of sensors
  - 2.11 Simple problems
3. **Data Presentation Systems** (04 hrs)
  - 3.1 Displays
  - 3.2 Data presentation elements
  - 3.3 Magnetic recording
  - 3.4 Data acquisition systems
  - 3.5 Measurement systems
  - 3.6 Testing and calibration
  - 3.7 Simple problems

- 4. Pneumatic and Hydraulic Systems** (08 hrs)
- 4.1 Actuation systems
  - 4.2 Pneumatic and hydraulic systems
  - 4.3 Directional control valves
  - 4.4 Pressure control valves
  - 4.5 Cylinders
  - 4.6 Process control valves
  - 4.7 Rotary actuators
  - 4.8 Simple problems
- 5. Mechanical Actuation Systems** (06 hrs)
- 5.1 Mechanical systems
  - 5.2 Types of motion
  - 5.3 Kinematic chains
  - 5.4 Cams
  - 5.5 Gear trains
  - 5.6 Ratchet and pawl
  - 5.7 Belt and chain drives
  - 5.8 Bearing
  - 5.9 Mechanical aspects of motor selection
  - 5.10 Simple problems
- 6. Electrical Actuation System** (08 hrs)
- 6.1 Electrical systems
  - 6.2 Mechanical switches
  - 6.3 Solid-state switches
  - 6.4 Solenoids
  - 6.5 D.C. motors
  - 6.6 A.C. motors
  - 6.7 Stepper motors
  - 6.8 Problems
- 7. Basic System Models** (04 hrs)
- 7.1 Mathematical models
  - 7.2 Mechanical systems building blocks
  - 7.3 Electrical system building blocks
  - 7.4 Fluid system building blocks
  - 7.5 Thermal system building blocks
  - 7.6 Simple Problems

**8. Digital Logic** (04 hrs)

- 8.1 Digital logic
- 8.2 Number systems
- 8.3 Logic gates
- 8.4 Boolean algebra
- 8.5 Karnaugh maps
- 8.6 Applications of logic gates
- 8.7 Sequential logic
- 8.8 Simple Problems

**9. Microprocessors** (08 hrs)

- 9.1 Control
- 9.2 Microcomputer structure
- 9.3 Microcontrollers
- 9.4 Applications
- 9.5 Programming problems

**10. Input/output Systems** (04 hrs)

- 10.1 Interfacing
- 10.2 Input/output ports
- 10.3 Interface requirements
- 10.4 Peripheral interface adapters
- 10.5 Serial communications interface
- 10.6 Examples of interfacing
- 10.7 Simple problems

**11. Programmable Logic Controllers** (08 hrs)

- 11.1 Programmable logic controllers- Applications
- 11.2 Basic structure
- 11.3 Input/output processing
- 11.4 Programming-ladder diagrams
- 11.5 Mnemonics
- 11.6 Timers, internet relays and counter
- 11.7 Shift registers
- 11.8 Master and jump controls
- 11.9 Data handling
- 11.10 Analogue input/output
- 11.11 Selection of a PLC
- 11.12 Simple problems

## INSTRUCTIONAL STRATEGY

1. Use computer based learning aids for effective teaching learning.
2. Students should be taken to various industrial units for clear conception of various topics.
3. Efforts should be made to relate the process of teaching with direct experiences in the industry.

## RECOMMENDED BOOKS

1. Mechatronics by HMT, Tata McGraw Hill, New Delhi
2. Mechatronics: Electronic Control System in Mechanical Engineering by W. Bolton; Pearson Education, Singapore.
3. Fundamentals of Electrical Engineering and Electronics by BL Thareja; S. Chand and Company, New Delhi.
4. Basic Electronics by Gupta, NN Bhargava, Kulshreshtha, TTTI, Chandigarh.

## SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1.	04	06
2.	06	10
3.	04	06
4.	08	12
5.	06	10
6.	08	12
7.	04	06
8.	04	06
9.	08	12
10.	04	06
11.	08	14
<b>Total</b>	<b>64</b>	<b>100</b>

## 6.6 MAJOR PROJECT WORK

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Project work aims at developing skills in the students whereby they apply the totality of knowledge and skills gained through the course in the solution of particular problem or undertaking a project. The students have various aptitudes and strengths. Project work, therefore, should match the strengths of students. For this purpose, students should be asked to identify the type of project work, they would like to execute. It is also essential that the faculty of the respective department may have a brainstorming session to identify suitable project assignments. The project assignment can be individual assignment or a group assignment. The students should identify the project at least two to three months in advance. The project work identified in collaboration with industry may be preferred.

Each teacher is expected to guide the project work of 5-6 students.

- Projects related to increasing productivity
- Projects related to quality assurance
- Projects related to estimation and economics of production
- Projects connected with repair and maintenance of plant and equipment
- Projects related to identification of raw material thereby reducing the wastage
- Any other related problems of interest of host industry

A suggestive criteria for assessing student performance by the external (personnel from industry) and internal (teacher) examiner is given in table below:

Sr. No.	Performance criteria	Max. marks	Rating Scale				
			Excellent	Very good	Good	Satisfactory	Poor
1.	Selection of project assignment	10	10	8	6	4	2
2.	Planning and execution of considerations	10	10	8	6	4	2
3.	Quality of performance	20	20	16	12	8	4
4.	Providing solution of the problems or production of final product	20	20	16	12	8	4
5.	Sense of responsibility	10	10	8	6	4	2
6.	Self expression/ communication skills	5	5	4	3	2	1
7.	Interpersonal skills/human relations	5	5	4	3	2	1
8.	Report writing skills	10	10	8	6	4	2
9.	Viva voce	10	10	8	6	4	2
<b>Total marks</b>		<b>100</b>	<b>100</b>	<b>80</b>	<b>60</b>	<b>40</b>	<b>20</b>

The overall grading of the practical training shall be made as per following table

	<b>Range of maximum marks</b>	<b>Overall grade</b>
i)	More than 80	<i>Excellent</i>
ii)	65-80	Very good
iii)	50-64	Good
iv)	41-49	Fair
v)	Less than 40	Poor

In order to qualify for the diploma, students must get “Overall Good grade” failing which the students may be given one more chance of undergoing 8 -10 weeks of project oriented professional training in the same industry and re-evaluated before being disqualified and declared “not eligible to receive diploma ”. It is also important to note that the students must get more than six “goods” or above “good” grade in different performance criteria items in order to get “Overall Good” grade.

### **Important Notes**

1. This criteria must be followed by the internal and external examiner and they should see the daily, weekly and monthly reports while awarding marks as per the above criteria.
2. The criteria for evaluation of the students have been worked out for 100 maximum marks. The internal and external examiners will evaluate students separately and give marks as per the study and evaluation scheme of examination.
3. The external examiner, preferably, a person from industry/organization, who has been associated with the project-oriented professional training of the students, should evaluate the students performance as per the above criteria.
4. It is also proposed that two students or two projects which are rated best be given merit certificate at the time of annual day of the institute. It would be better if specific nearby industries are approached for instituting such awards.

The teachers are free to evolve another criteria of assessment, depending upon the type of project work.

It is proposed that the institute may organize an annual exhibition of the project work done by the students and invite leading Industrial organizations in such an exhibition. It is also proposed that two students or two projects which are rated best be given merit certificate at the time of annual day of the institute. It would be better if specific industries are approached for instituting such awards.