17.2.0 INDUSTRIAL PLANT TECHNOLOGY

17.2.1 Introduction

This module unit is intended to equip the trainee with knowledge, skills, attitudes and competences that will enable him/her to install and maintain material handling equipment, pneumatic machines, hydraulic machines, refrigeration and air conditioning equipment and steam plant equipment in industry.

17.2.2 General Objectives

By the end of the module unit, the trainee should be able to:

a) demonstrate knowledge and understanding of occupational safety and health issues

b) apply acquired skills in material handling equipment, pneumatic equipment, hydraulic equipment, refrigeration and air-conditioning equipment and steam plant in industry

c) install material handling equipment, pneumatic equipment, hydraulic machines, refrigeration and air-conditioning equipment and steam plant

d) maintain material handling equipment, pneumatic equipment, hydraulic machines, refrigeration and air-conditioning equipment and steam plant

17.2.3 Module Unit Summary and Time Allocation

Code	Sub-Module Unit	Content	Time (Hrs)		
			Theory	Practice	Total
17.2.01	Material Handling and Equipment	• Definition of material handling • Classification of various materials • Operation of various material handling equipment	10	16	26
17.2.02	Pneumatics	• Definition of pneumatics • Application of compressed air • Types of compressed air distribution	18	36	54

		system • Components of compressed air distribution system • Classification of types of compressors • Constructional features of compressors • Operation of various types of compressors • Capacity control • Types of air receivers • Types of air dryers • Intercoolers and aftercoolers			
17.2.03	Hydraulics	• Principles of hydraulics • Types of hydraulic systems • Properties of hydraulic fluids • Hydraulic system components • Hydraulic circuits	10	16	26
17.2.04	Machine Installation and Alignment	• Definition of machine foundation • Types of machine foundations • Foundation materials • Properties of foundation materials • Types of foundation bolts • Vibration control • Vibration control	12	20	32

		materials • Factors affecting the choice of machine foundations • Need for machine alignment • Types of misalignment • Alignment equipment			
17.2.05	Refrigeration	• Types of refrigeration systems • Components of refrigeration systems • Desirable properties of refrigerants • Types of refrigerants • Refrigerant recovery and recycling	10	24	34
17.2.06	Air Conditioning	• Types of air conditioning systems • Components of air conditioning systems • Operation of various types of air conditioning systems • Need for ventilation • Types of ventilation systems	8	24	32
17.2.07	Turbines	• Types of turbines • Classification of turbines	8	20	28

		• Construction features of various types of turbines • Operations of turbines			
17.2.08	Steam Plant	• Uses of steam • Types of boilers • Principle of operation of a boiler • Statutory requirements of boilers • Boiler mountings and accessories • Types of steam plant • Components of steam plants • Layout of steam distribution systems • Steam distribution system components • Steam utilizing equipment • Need for feed water treatment • Effects of impurities • Methods of controlling impurities	30	60	90
Total Time			**106**		**322**

17.2.01 MATERIAL HANDLING AND EQUIPMENT

Theory

17.2.01T *Specific Objectives*
By the end of the sub-module unit, the trainee should be able to:
a) define material handling
b) classify various types of material handling equipment
c) explain the operation of various material handling equipment

17.2.01C Competence
By the end of the sub-module unit, the trainee should have the ability to:
i) install material handling equipment
ii) troubleshoot material handling equipment
iii) maintain material handling equipment

Content

17.2.01T1 Definition of material handling

17.2.01T2 Classification of various materials handling equipment
i) bulk material handling
- bucket elevators
- belt conveyors
- screw conveyors
- vibrating conveyors
- pneumatic conveyors
- hydraulic conveyors
- chutes
- bins
- hoppers
- silos
- bunkers
- tanks

ii) fixed material handling equipment
- derrick cranes
- jib cranes

iii) overhead travelling cranes
- gantry cranes

iv) unit material handling equipment
- containerization
- palletisation

17.2.01T3 Operation of various material handling equipment

Practice

17.2.01P *Specific Objectives*
By the end of the sub-module unit, the trainee should be able to:

a) install various material handling equipment
b) troubleshoot various material handling equipment
c) maintain various material handling equipment

Content

17.2.01P1 Installation of material handling equipment
17.2.01P2 Troubleshoot material handling equipment
17.2.01P3 Maintenance of material handling equipment

Suggested Teaching/Learning Resources

- Material handling manuals
- Material handling equipment
- Charts
- OSHA

17.2.02 PNEUMATICS

Theory

17.2.02T *Specific Objectives*
By the end of this sub-module unit, the trainee should be able to:

a) define pneumatics
b) explain the uses of compressed air
c) describe the different types of compressed air distribution systems
d) list the components of compressed air distribution system
e) classify the various types of compressors
f) describe the constructional features of various types of compressors
g) explain the operation of various types of compressors
h) explain the methods of capacity control
i) describe the various types of air receivers
j) describe the various types of air dryers
k) describe the various types of intercoolers and aftercoolers

17.2.02C Competence

The trainee should have the ability to:

i) install compressed air distribution system
ii) troubleshoot compressed air distribution system
iii) maintain compressed air distribution system

Content

17.2.02T1 Definition of pneumatics

17.2.02T2 Application of compressed air
- i) rotary tools
- ii) repercussive tools
- iii) direct
- iv) spray painting
- v) reciprocating
- vi) control instruments

17.2.02T3 Types of compressed air distribution system
- i) dead end
- ii) ring mains

17.2.02T4 Components of compressed air distribution system
- i) compressor
- ii) aftercoolers
- iii) intercoolers
- iv) air receivers
- v) dryers
- vi) pipings
- vii) filters

17.2.02T5 Classification of types of compressors
- i) reciprocating
  - diaphragm
  - piston
- ii) rotary
  - roots blower
  - sliding valve
  - axial
  - centrifugal
  - screw

17.2.02T6 Constructional features of compressors

17.2.02T7 Operation of various types of compressors
- i) volumetric reduction
- ii) positive displacement and dynamic
- iii) single and double acting
- iv) single stage and multi-stage

17.2.02T8 Capacity control
- i) on/off
- ii) constant speed
- iii) variable speed
- iv) by-pass
- v) dual

17.2.02T9 Types of air receivers
- i) horizontal
- ii) vertical

17.2.02T10 Types of air dryers
- i) refrigerant
- ii) deliquescent

17.2.02T11 Intercoolers and aftercoolers
- i) air cooled
- ii) water cooled

Practice

17.2.02P *Specific objectives*

By the end of the sub-module unit, the trainee should be able to:

a) install different types of compressors
b) troubleshoot different types of compressors
c) dismantle, repair and assemble different types of compressors
d) identify the main components of a compressed air distribution system
e) install a compressed air distribution system
f) trouble-shoot compressed air distribution system
g) dismantle, repair and assemble the components of a compressed air distribution system

Content

17.2.02P1 Installation of various types of compressors
- i) typical installation arrangements
- ii) controls
- iii) foundations
- iv) alignment
- v) piping
- vi) starting/stopping procedures

17.2.02P2 Troubleshoot various types of compressors
- i) low pressure
- ii) over heating
- iii) low volume output
- iv) overload
- v) vibration
- vi) starting problems

17.2.02P3 Dismantling, repairing and assembling different types of compressors
- i) isolation of compressor
- ii) dismantling
- iii) cleaning
- iv) inspection
- v) repair/replace
- vi) assembling
- vii) testing

17.2.02P4 Identification of the main components of a compressed air distribution system
- i) valve s
- ii) air receivers
- iii) regulators
- iv) lubricators
- v) air dryers
- vi) strainers
- vii) filters
- viii) separators

17.2.02P5 Installation of a compressed air distribution system
- i) pipe gradient
- ii) moisture separation
- iii) oil separation
- iv) pressure control

v) pipe anchors
vi) location of tapping points
vii) location of air receiver
viii) statutory requirements of an air receiver

17.2.02P6 Troubleshoot compressed air distribution system
i) blockages
ii) low pressure
iii) leakages
iv) water hammer
v) water logging
vi) excess oil

17.2.02P7 Dismantling, repair and assembling a compressed air distribution system
i) valves
ii) air receivers
iii) regulators
iv) driers
v) oil and water separators
vi) air traps
vii) lubricators
viii) filters

Suggested Teaching/ Learning Resources
- Pneumatic system components
- Pneumatic system manuals
- Tool kit
- Overhaul kit for compressor
- Pressure gauge
- Pneumatic tools
- OSHA

17.2.03 HYDRAULICS

Theory

17.2.03T *Specific Objectives*
By the end of this sub-module unit, the trainee should be able to:
a) explain the principles of hydraulics
b) explain different types of hydraulic systems
c) explain the properties of hydraulic fluids
d) describe the construction of hydraulic system components
e) sketch hydraulic circuits

17.2.03C Competence
The trainee should have the ability to:
i) install hydraulic sysytem
ii) overhaul hydraulic systems
iii) service hydraulic systems
iv) troubleshoot hydraulic systems

Content

17.2.03T1 Principles of hydraulics
- i) hydrostatic
- ii) hydrodynamic
- iii) hydrokinetic

17.2.03T2 Types of hydraulic systems
- i) open centre
- ii) closed centre

17.2.03T3 Properties of hydraulic fluids

17.2.03T4 Hydraulic system components
- i) accumulators
- ii) valves
- iii) actuators
- iv) seals
- v) reservoirs
- vi) pumps
- vii) piping
- viii) filters
- ix) intensifiers

17.2.03T5 Hydraulic circuits

Practice

17.2.03 *Specific objectives*
By the end of the sub-module unit, the trainee should be able to:
a) install hydraulic systems
b) troubleshoot hydraulic systems
c) overhaul hydraulic system components
d) service hydraulic system components

Content

17.2.03P1 Installation of hydraulic systems

17.2.03P2 Troubleshoot hydraulic components

17.2.03P3 Overhaul hydraulic systems

17.2.03P4 Service hydraulic system components

Suggested Teaching/ Learning Resources
- Hydraulic manuals
- Hydraulic system components
- Hydraulic trainer

17.2.04 MACHINE INSTALLATION AND ALIGNMENT

Theory

17.2.04T *Specific Objectives*
By the end of the sub-module unit, the trainee should be able to:
a) define machine foundations
b) explain the different types of machine foundations
c) list foundation materials
d) explain the properties of various foundation materials

e) describe the various types of foundation bolts
f) explain vibration control
g) describe vibration control materials
h) outline the factors that affect the choice of a machine foundation
i) state the need for machine alignment
j) explain various types of misalignment
k) describe various alignment equipment

17.2.04C Competence

The trainee should have the ability to:

i) install machines
ii) align machines
iii) test machines after alignment

Content

17.2.04T1 Definition of machine foundation

17.2.04T2 Types of machine foundations
i) flat
ii) plinth
iii) pit
iv) directly mounted
v) concrete

17.2.04T3 Foundation materials
i) concrete
ii) wood
iii) metal
iv) rubber

17.2.04T4 Properties of foundation materials

17.2.04T5 Types of foundation bolts
i) T-bolts
ii) Rawl bolts
iii) L-bolts

17.2.04T6 Vibration control

17.2.04T7 Vibration control materials
i) Cork
ii) Rubber
iii) Springs

17.2.04T8 Factors affecting the choice of machine foundations
i) weight
ii) stability
iii) rigidity
iv) vibrations
v) speed range
vi) shock
vii) noise
viii) size and shape

17.2.04T9 Need for machine alignment
i) wear
ii) noise
iii) vibration

17.2.04T10 Types of misalignment
i) axial
ii) parallel
iii) conical
iv) angular

17.2.04T11 Alignment equipment
- i) feeler gauge
- ii) dial test indicator (DTI)
- iii) plumb bob
- iv) straight edge
- v) spirit level
- vi) telescopic gauge
- vii) angle dekkor
- viii) autocollimeter

Practice

17.2.04P *Specific Objectives*
By the end of the sub-module unit, the trainee should be able to:
- a) install machines on foundations
- b) align machines
- c) test the machines

Content

17.2.04P1 Installation of machines on foundations
17.2.04P2 Alignment of machines
17.2.04P3 Testing the machines

Suggested Teaching/Learning Resources
- various foundations bolts
- various alignment equipment
- vibration control materials
- various foundation materials

17.2.05 REFRIGERATION

Theory

17.2.05T *Specific Objectives*
By the end of this sub-module unit, the trainee should be able to:
- a) explain the types of refrigeration systems
- b) describe the components of different types of refrigeration systems
- c) explain the desirable properties of refrigerants
- d) explain the types of refrigerants
- e) describe refrigerant recovery and recycling procedures

17.2.05C Competence
The trainee should have the ability to:
- i) install refrigeration systems
- ii) trouble shoot refrigeration systems
- iii) maintain refrigeration systems
- iv) recover and recycle refrigerants

Content

17.2.05T1 Types of refrigeration systems
- i) vapour compressor
- ii) vapour absorber

17.2.05T2 Components of refrigeration systems
- i) vapour compression
  - condenser
  - compressor
  - receiver
  - expansion devices
  - evaporator
  - pipings
- ii) vapour absorption
  - analyzer
  - rectifier
  - absorber
  - condenser
  - evaporator
  - reducing valves
  - pipings
  - generator
  - pumps

17.2.05T3 Desirable properties of refrigerants
- i) high latent heat of vaporization
- ii) moderate condensing pressures
- iii) moderate evaporating pressures
- iv) high critical temperature
- v) low specific volume

17.2.05T4 Types of refrigerants
- i) primary
  - halo-carbons
  - azeotropes
  - hydrocarbons
  - inorganic
- ii) secondary
  - brine
  - lithium bromide

17.2.05T5 Refrigerant recovery and recycling

Practice

17.2.05P *Specific objectives*
By the end of the sub-module unit, the trainee should be able to:
- a) identify different types of refrigeration system
- b) evacuate and charge a refrigeration system
- c) detect leaks in a refrigeration system
- d) recover and recycle refrigerants
- e) install different types of refrigeration systems
- f) troubleshoot different types of refrigeration systems
- g) maintain different types of refrigeration systems

Content

17.2.05P1 Identification of different types of refrigeration systems
- i) vapour compression

ii) vapour absorption

17.2.05P2 Evacuation and charging a refrigeration system
- i) evacuation
  - triple
  - deep vacuum
- ii) charging
  - vapour
  - liquid

17.2.05P3 Methods of leak detection
- i) halide torch
- ii) electronic detector
- iii) sulphur candle
- iv) soapy solution
- v) nessler reagent

17.2.05P4 Recovering and recycling refrigerants
- i) recovery
  - liquid
  - vapour
- ii) recycling

17.2.05P5 Installation of different types of refrigeration systems
- i) pipework supports
- ii) pipework fittings
- iii) pipework routes
- iv) oil traps
  - suction line
  - discharge lines
- v) oil separators

17.2.05P6 Troubleshooting of refrigeration systems
- i) high suction pressure
- ii) high discharge pressure
- iii) low discharge suction
- iv) noisy system
- v) compressor not running
- vi) low suction pressure

17.2.05P7 Maintenance of different types of refrigeration systems

Suggested Teaching/ Learning Resources
- Vacuum pump
- Gauge manifold
- Indicating thermometer
- Halide torch
- Electronic leak detector
- Domestic refrigerator
- Window unit
- Various service valves
- Various refrigerants
- Refrigeration manuals
- Sulphur candle

17.2.06 AIR CONDITIONING

Theory

17.2.06T *Specific Objectives*

By the end of this sub-module unit, the trainee should be able to:

a) list various types of air conditioning systems

b) describe the components of air conditioning systems

c) explain the operation of various types of air conditioning systems
d) explain the types of ventilation systems

17.2.06C Competence

The trainee should have the ability to:

i) install different types of air conditioning systems
ii) troubleshoot different types of air conditioning systems
iii) maintain different types of air conditioning systems
iv) maintain ducting systems

Content

17.2.06T1 Types of air conditioning systems
i) split
ii) window
iii) central
iv) packaged

17.2.06T2 Components of air conditioning systems
i) evaporators
ii) heaters
iii) humidifiers
iv) dehumidifiers
v) eliminators
vi) filters
- dry
- viscous
- electrostatics

vii) fans
- centrifugal
- propeller
- axial

viii) dampers
ix) grills
x) louvers
xi) ducts
xii) mixing chamber
xiii) drainage systems
xiv) compressors
xv) condensers
xvi) cooling tower
- forced draught
- induced draught
- natural draught

xvii) pumps
xviii) pipings

17.2.06T3 Operation of various types of air conditioning systems

17.2.06T4 Need for ventilation

17.2.06T5 Types of ventilation systems
i) natural
ii) mechanical
iii) natural and mechanical

Practice

17.2.06P *Specific objectives*
By the end of the sub-module unit, the trainee should be able to:
a) install different types of air conditioning systems
b) trouble-shoot different types of air conditioning systems
c) maintain different types of air-conditioning systems
d) maintain ducting systems

Content

17.2.06P1 Installation of different types of air-conditioning systems

17.2.06P2 Troubleshooting of different types of air-conditioning systems

17.2.06P3 Maintenance of different types of air-conditioning systems

17.2.06P4 Maintenance of ducting

Suggested Teaching/ Learning Resources
- model air-conditioning systems
- components of air conditioning systems
- manuals

17.2.07 TURBINES

Theory

17.2.07T *Specific Objectives*
By the end of this sub-module unit, the trainee should be able to:
a) state types of turbines
b) classify turbines
c) describe the construction features of turbines
d) explain the operation of various turbines

17.2.07C Competence
The trainee should have the ability to:
i) install turbines
ii) troubleshoot turbines
iii) maintain a turbine

Content

17.2.07T1 Types of turbines
i) impulse
ii) reaction
iii) impulse reaction

17.2.07T2 Classification of turbines
i) axial
ii) radial

17.2.07T3 Construction features of various types of turbines
i) Steam
ii) Water

17.2.07T4 Operations of turbines
i) Pelton wheel
ii) Francis

iii) Kaplan
iv) Propeller
v) Steam
- impulse
- reaction

Practice

17.2.07P *Specific objectives*
By the end of the sub-module unit, the trainee should be able to:
a) select a turbine for a particular application
b) install turbines
c) troubleshoot turbine
d) maintain turbines

Content
17.2.07P1 Selection of turbine s
17.2.07P2 Installation of turbines
17.2.07P3 Troubleshoot turbines
17.2.07P4 Maintenance of turbines

Suggested Teaching/ Learning Resources
- testing rigs
- models
- manuals

17.2.08 STEAM PLANT

Theory

17.2.08T *Specific Objectives*
By the end of this sub-module unit, the trainee should be able to:
a) explain the uses of steam
b) describe the types of boilers
c) explain the principle of operation of a boiler
d) explain the statutory requirements of boilers
e) describe the various boiler mounting and accessories
f) explain the types of steam plant
g) describe the components of steam plants
h) explain the layout of steam distribution systems
i) describe steam distribution components
j) explain the operation of steam utilizing equipment
k) explain the need for boiler feed water treatment
l) explain the effects of impurities in boiler feed water
m) describe the methods of controlling impurities if feed water

17.2.08C Competence

The trainee should have the ability to:

i) install boiler, boiler mountings and accessories
ii) prepare boiler for inspection
iii) maintain boilers
iv) maintain steam plants
v) maintain boiler feed water treatment equipment
vi) troubleshoot boiler
vii) troubleshoot steam plant

Content

17.2.08T1 Uses of steam
- i) process
- ii) power production

17.2.08T2 Types of boilers
- i) fire tube
- ii) water tube

17.2.08T3 Principle of operation of a boiler

17.2.08T4 Statutory requirements of boilers

17.2.08T5 Boiler mountings and accessories
- i) boiler mountings
  - safety valve
  - stop valve
  - water level gauges
  - fusible plug
  - air vent
  - pressure gauge
- ii) boiler accessories
  - feed pump
  - super heater
  - air pre-heater
  - economizers
  - reheaters

17.2.08T6 Types of steam plant
- i) process
- ii) power
- iii) power/process
- iv) regenerative

17.2.08T7 Components of steam plants
- i) turbines
- ii) condensers
- iii) cooling tower
- iv) condensate extraction pumps
- v) feed pumps
- vi) hot wells

17.2.08T8 Layout of steam distribution systems

17.2.08T9 Steam distribution system components
- i) separator
- ii) steam traps
- iii) valves
- iv) accumulators
- v) anchors
- vi) expansion joints
- vii) pipes
- viii) lagging
- ix) strainers
- x) sight-glass

17.2.08T10 Steam utilizing equipment
- i) calorifiers

ii) evaporators
iii) boiling pans
iv) driers
v) heater batteries
vi) auto claves
vii) iron callenders

17.2.08T11 Need for feed water treatment

17.2.08T12 Effects of impurities
i) foaming
ii) carry over
iii) corrosion
iv) erosion
v) priming

17.2.08T13 Methods of controlling impurities
i) external treatment
- sodium zeolite
- hot/cold lime
- hydrogen exchange
- dealkalizer
- dimeneralizer

ii) internal treatment
- blow down
- phosphate
- softening of water

Practice

17.2.08P *Specific objectives*
By the end of the sub-module unit, the trainee should be able to:
a) identify different types of boilers
b) install boiler mountings
c) maintain boiler mounting and accessories
d) care for idle boilers
e) troubleshoot boilers
f) maintain boilers
g) prepare a boiler for inspection
h) install a steam plant
i) maintain a steam plant
j) install boiler feed water treatment plant
k) maintain boiler feed water treatment plant

Content

17.2.08P1 Identification of boilers

17.2.08P2 Installation of boiler accessories

17.2.08P3 Maintenance of boiler mountings and accessories

17.2.08P4 Care for idle boilers
i) wet
ii) dry

17.2.08P5 Troubleshooting of boilers

17.2.08P6 Maintenance of boilers
i) descaling
ii) cleaning
iii) soot blowing
iv) tube repair
v) blow down
vi) tube cleaning
vii) purging

17.2.08P7 Preparing a boiler for inspection

17.2.08P8 Identification of various types of steam plants

17.2.08P9	Installation of a steam plant	*Suggested Teaching/ Learning Resources* - Model boiler - Boilers - Boiler service manual - Boiler mountings - Boiler accessories - Steam process equipment - Boiler manuals
17.2.08P10	Troubleshoot steam plants	
17.2.08P11	Installation of boiler feed water treatment plant	
17.2.08P12	Maintenance of boiler feed water treatment plant	